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ENCYCLOPÆDIA BRITANNICA.

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THE

ENCYCLOPÆDIA BRITANNICA,

OR

DICTIONARY

OF

ARTS, SCIENCES, AND GENERAL LITERATURE.

EIGHTH EDITION.

WITH EXTENSIVE IMPROVEMENTS AND ADDITIONS;
AND NUMEROUS ENGRAVINGS.

VOLUME XII.

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ENCYCLOPÆDIA BRITANNICA.

HUME.

Hume, David.

HUME, DAVID, one of the most celebrated historians and philosophers of Great Britain, has already been twice noticed in the *Preliminary Dissertations*, where the principal doctrines of his metaphysics have been considered by Stewart, and those of his ethics by Mackintosh. This, happily, exempts the writer of the present article from touching on the same topics, except incidentally. But as the life and character of other celebrated men, no less prominent in the *Dissertations*, have been formally treated in the body of this work, it seemed due to the memory of Hume to give his biography a little more fully than in the few paragraphs dedicated to him in the previous editions; and the following sketch has therefore been inserted. It will be restricted to a brief account of his life and genius, an estimate of his merits as a writer, and probably a glance at one or two of such of his philosophical opinions as were too remote from the design of either Dissertation to challenge notice there, but yet may seem of sufficient importance to be referred to.

Hume has left us a very short autobiographic sketch of his own life; it is too scanty, too bare of details, to inspire the interest which belongs to some similar memoirs,—that of Gibbon for example. But though it is little more than a catalogue of dates and facts, the author offers a good apology for his conciseness:—"It is difficult," he says, "for a man to speak long of himself without vanity." He assures the reader that the notice shall contain little more than the history of his writings, and he has kept his word. From all danger of vanity in treating such topics—however delicate for an author—he flattered himself he had security in his early *failures*:—"The first success of my writings," says he, "was not such as to be an object of vanity." Yet the acerbity with which at that so distant day he remembers and records the slow steps by which he had emerged from obscurity into fame, and which all that fame had not been able to soothe, would seem to indicate that the philosopher had not quite so effectually mortified his vanity as he imagined. The tardy homage which the public paid to his merits is a theme to which he never tired of recurring, though, as will be seen in the sequel, not very reasonably.[1] Hume, David.

He was born at Edinburgh, April 26, 1711. His father was a scion of the house of the Earl of Home, or Hume, as the name was often spelt, and as our philosopher, in opposition to his brother's orthographic heterodoxy, always persisted in spelling it. His mother was daughter of Sir David Falconer, president of the College of Justice. His father died when he was a child; his mother, of whom he speaks in the fondest terms, was long spared to him, and well deserved the tribute of affection he pays her. "Though young and handsome, she devoted herself entirely to the rearing and education of her children." At the age of fifteen he was sent to the University of Edinburgh, and he tells us, what none will doubt, that he passed through the usual "course of education with success;" though his reading was marked at that time—and as regards the classics, was always marked—rather by extent than by accurate scholarship. Even at that early age he was possessed with an intense love of literature, and by that ambition of literary dis-

[1] "Every new edition was only an acknowledgment of the injustice which had been done him, and a poor instalment of his just dues. . . . Hume at last wore out the patience of his very publisher" (*Ed. Rev.*, Jan. 1847). As to the approbation or esteem of those blockheads who call themselves the public," thus he writes (1757) "and whom a bookseller, a lord, a priest, or a party can guide, I do most heartily despise it."

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tinction which was the ruling passion, not to say the only passion, of his life. Seldom, if ever, has the propensity to a studious life developed itself so early or so exclusively, or asserted its claims so imperiously. From the very first, and all along, it overmastered everything in the shape of pleasure or interest that could be brought into competition with it. As a younger brother, and a younger brother of no opulent house, he was, of course, to carve out his own fortunes in the world. "My patrimony," he says, "after the manner of my country, was but slender;" yet no lures, no exigencies could induce him to seek fortune at the expense of literature. In this case, the phlegm of the young philosopher seemed, in its way, as immovable as the enthusiasm of a young poet frequently proves; he could not, as the world would say, *calculate* consequences. To add to the wonder, Hume was most creditably anxious for independence, and resolved, at whatever costs of economy, to possess it. Nay, as his after-life showed, our philosopher was by no means insensible to the advantages of wealth; nevertheless, he was unwilling to adopt any course to attain riches at the expense of those literary pursuits which much more frequently conduct to penury. Thus all the schemes his friends formed on his behalf were frustrated by this one passion. His "studious habits, sobriety, and industry, led them to wish that he should devote himself to the law," in which surely these qualities, in conjunction with his surpassing acuteness and subtilty, might have easily won distinction; but while "they fancied he was poring over Voet and Vinnius—Cicero and Virgil were the authors he was secretly devouring." An experiment in mercantile life was equally unsuccessful. In 1734 he went to Bristol with introductions to "eminent merchants" in that city, but he found this "scene utterly unsuitable." He then exiled himself to France; and first at Rheims, then at La Flêche, devoted himself, in studious solitude, to literature and philosophy. During this time he made a "rigid frugality supply the deficiencies of fortune" (a course to which he resolutely adhered till the dawn of better days); and with singular decision of character, and obedience to the ruling passion, "regarded every object as contemptible except the improvement of his talents for literature." In this interval he meditated and composed his *Treatise of Human Nature*. This work was completed by his twenty-fifth year, and, as the production of so young a mind, must certainly be regarded as a prodigy of metaphysical acuteness. Indeed, there is reason to believe that the *results* of his speculation (if scepticism allow the term) must have been arrived at long before, even from his boyish days. In the account he gives of himself in that remarkable letter, first published by Mr Burton (vol. i., pp. 31-39), in which he anonymously consults a physician in relation to some singular but very prolonged hypochondrical affection (itself, probably, both symptom and effect of an overwrought mind), he discloses a style of thought and points to a method of speculation which strongly remind us of the conditions of mind under which Descartes commenced philosopher. Were there any proofs (as there are certainly none) of his acquaintance with Descartes' writings at this early age, it would have seemed almost certain that his method of philosophizing was sheer imitation; on the other hand, if this letter had been written *after* his residence at La Flêche, where Descartes felt so similarly, the same conclusion would have been inevitable. From this letter, as a clue to much in the character of his mind and its after history, and of its tendencies to morbid speculation at a very early date, we shall presently give some extracts.

In 1737, Hume came to London with his *Treatise on Human Nature;* and in the next year published it. "Never literary attempt," he says, "was more unfortunate; it fell dead-born from the press, without reaching such distinction as even to excite a murmur." He declares, however, that being naturally of a cheerful temper, he soon recovered from this and similar subsequent disappointments. Yet it is clear, from the details in Burton's *Life*, that the equanimity of our philosopher was sorely tried; that he had, with the exaggerations natural in a young author, been expecting that the world would have little to do for a time, except to read his lucubrations! He tells his friend Ramsay, that "he would not aim at anything until he could judge of his *success in his grand undertaking*, and see upon what footing he was to stand in the world;" and as the day of publication drew near, confesses to being perturbed at "the nearness and greatness of the event." Yet it is certain that he bore the disappointment of his hopes on this occasion much better than he did some far lighter failures of the same kind. Cheerful as might be his temper, buoyant as were his hopes, his mortifications of this sort, and especially that which befell him when he published the first volume of his *History*, were keenly felt and remembered, and engendered prejudices against the "Public," which little became a philosopher, and utterly prevented him from doing the said "Public" justice. Properly speaking, he never forgave its early neglect, and could not see that he had not been a very ill-used man, even when fame and competency had rewarded his at first unpromising labours. In the case of the *Treatise of Human Nature*, however, he himself admits, that in fact the public was in the right; which, indeed, any one would naturally expect, seeing that the philosopher was but five-and-twenty, and his philosophy the product of that mature age! That he was not insensible that his failure in the first instance was more attributable to himself than to the world is significantly shown by his acknowledgment of indiscretion in going to press so early. "I had always," he says, "entertained a notion, that my want of success in publishing the *Treatise of Human Nature*, had proceeded more from the manner than the matter" (equally from both, the public would say), "and that I had been guilty of a very usual indiscretion in going to the press too early." He tells us, he "set about remedying its defects." He cast the first part of it entirely anew in the *Enquiry concerning Human Understanding*, published 1747; but this, he confesses, had little more success than the former. In fact, he was still but serving his apprenticeship to fame—which many a man, as great, has had to do for a much longer period. In 1742, he published the first part of his *Essays*. These, which were buoyed up by large intermixture of more attractive topics than those of the *Treatise*, and were recommended by the fascinations of a far more finished style, met with a better reception, and they have since been always popular. The second edition, however, did not go off rapidly enough to satisfy the exacting temper of the author.—After publishing the *Treatise*, he lived for some time with his brother in Scotland, still ardently pursuing his literary occupations. This mode of life was not very agreeably diversified by the temporary charge of the half-mad, or at least wholly hypochondriacal Earl of Annandale (1745). Whether tutor or keeper be the more proper term for our philosopher during a year of very humiliating servitude, it seems hard to say. His next post (1747) was that of secretary to General St Clair, whom he accompanied "in his military embassy to the courts of Vienna and Turin." He was introduced, he tells us, as aid-de-camp to the general, and wore the uniform of an officer,—a droll transformation for our ungainly philosopher. Two years were thus spent, almost the only years of his life, he declares, in which he was "estranged from literature." Total estrangement can hardly be supposed, nor does one see any reason for it. If it were so, the military uniform in his case must have done more than even the active duties of a soldier's life could do in that of Gibbon, in whom the passion for literature was, however, still more ardent than in Hume. Gibbon's account, in his *Journal*, of the absolute possession which history had taken of him, of the enthusiasm with which

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he indulged dreams of literary ambition and pursued his studies even in his tent, affords a striking instance of the "ruling passion." But if Hume's occupations estranged him for a while from literature, the emoluments of his office were not to be despised; they so materially aided his very limited resources, that he sometimes pleasantly talked to his smiling friends of having achieved independent fortune: "I was now," says he, "master of *near* a thousand pounds!"

In 1749, he again repaired to his brother's house, where he took up his abode for two years. He spent his leisure in composing the second part of his essays, which he called *Political Discourses*, and his *Enquiry concerning the Principles of Morals*. His publisher now told him, that his writings, "all but the unfortunate *Treatise*, were beginning to be asked for and talked about." "It was a hopeful symptom too," he tells us, "that answers by reverends and right reverends came out two or three in a year;" and that he "found, by Dr Warburton's railing, that the books were beginning to be esteemed in good company."

In 1751, he removed from the country to Edinburgh, under the notion that the "capital was the true scene for a man of letters;" and in the following year he published the *Political Discourses;* "the only work of mine," says he, "that was successful on the first publication." It is difficult to say what is the criterion of success in the estimate of unreasonable expectation; but Hume was still a *young* writer, and he certainly had no reason to complain of the reception of the first part of his *Essays*. Conscious of power, he was too impatient for fame, and forgot that fame is a thing of slow growth; he wished to see the oak rise immediately from the acorn. Meantime, grumble as he might, his saplings, in the estimate of any sober judge, would be thought to be doing well enough.

In the same year, he published in London, his *Enquiry concerning the Principles of Morals*, of which he hesitates not to say, that "of all his writings, philosophical, literary, or historical, it is incomparably the best."

Hume wondered that Rousseau should prefer his *Emile* to his *Heloise*, and compares it to Milton's preference of his *Paradise Regained* to his *Paradise Lost*. Whether Hume himself be not another instance of a similar delusion, many readers will have their doubts. But much will depend on what is meant by "best." If Hume meant by "best," that the *Enquiry* was the most original and acute of his writings, that which displayed most *power*, posterity will hardly affirm his verdict; if by "best," he meant, that of all his writings, it is most free from paradox and error, it will probably be granted. Sir James Mackintosh has observed, that "it is creditable to him that he deliberately preferred the treatise which is least tainted with paradox, though the least original of all his writings." Sir James contends, however, for its pre-eminent excellence of style. For a very able criticism of its merits and defects, the reader is referred to the second Dissertation.

In 1752, Hume was appointed librarian to the Faculty of Advocates. The chief immediate value of the office, to which little or no emolument was attached, consisted in the access it afforded to a large library; indirectly, it was of greater advantage, as this last circumstance encouraged, if it did not suggest, his writing the *History of England*. Terrified, however, with the magnitude of the task, dreading, as he well might, to begin, after the orthodox manner, with the landing of Julius Cæsar, he commenced with the accession of the Stuarts, "an epoch," he thought, "when the misrepresentations began chiefly to take place;" but which, let them be what they would, could hardly transcend his own. His anticipations of success were, as in former cases, sanguine, and he was doomed, for a while, to see the usual frustration of his hopes. "Miserable," says he, "was my disappointment; I was assailed by one cry of reproach, disappointment, and even execration. English, Scotch, and Irish; Whig and Tory, churchman and sectary, freethinker and religionist, united in their rage against the one man who had presumed to shed a generous tear for the fate of Charles I. and the Earl of Strafford." Hume's indignation makes a droll mis-estimate of his own enormous delinquencies. If he had exercised common justice and impartiality, to say nothing of "generosity," in other cases, the few "generous tears" which the unwontedly sentimental sceptic could have managed to distil for Strafford or Charles, would never have given such mortal offence. It was yet more mortifying to the author, that the furious storm which greeted the first appearance of the work, subsided into a more vexatious calm; for what man would not sooner be railed at than forgotten? The *History* seemed doomed to oblivion. The publisher assured Hume, that "in a year he sold but forty-five copies." Hume himself confesses, that with two "odd exceptions,"—the *Primates of England and Ireland*,—he scarcely heard of any man of rank or letters who "could endure the book;" and that had it not been for the breaking out of the war with France (in spite of the "cheerful temper" with which he would have us believe his philosophy took such things!), he would have sought an asylum there, and changing his name, for ever renounced his country![1] As it was, his country was spared this dire infliction. Meantime, Hume persevered, and his second volume which appeared two years afterwards had somewhat better success.

In 1759, he published, according to the retrograde course in which he had commenced, the history of the House of Tudor, which also was received with a storm of disapprobation. But if we may trust his own averment, he was now "callous against the impression of public folly;" and gave the early history in two more volumes in 1761, "with tolerable, and but tolerable, success."

But that his complaints of want of success were, on the whole, unreasonable, is evident from his own statement, namely, that in spite of all "public folly," "the copy-money given him by the booksellers much exceeded anything formerly known in England." In fact he had been, as usual, too impatient of success. But even when he had become, and in a large degree from his literary labours, "not only independent, but opulent" according to his truly philosophical scale of riches,—he never forgave the "public folly" for not instantaneously recognising his merits.

Though his *History* had grievous defects, which he took care, in the indulgence of his prejudices (continually strengthening with opposition), to aggravate in every successive edition, it had also singular merits, and was secure of the popularity which the impatience of its author thought so tardy. It was nearly the first modern example of history treated in a philosophical spirit, while the charms of its unrivalled style would alone have insured its success.

In the interval between the first and second volumes of his *History* he published his *Natural History of Religion;* of which he says "the public entry was obscure;" its contents, acute as the treatise is, need not leave us in any wonder at that. For this neglect, however, he assures us he received *consolation*, in the shape of "a pamphlet by Dr Hurd, written with all the illiberal petulance, arrogance, and scurrility, which distinguish the Warburtonian school."

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[1] On a subsequent occasion, when complaining of the tardiness of his political patrons, Hume repeated this sort of *threat*.—"The fuming incense," says the critic in the *Ed. Review* (1847), "which the Parisians were offering him as a sort of male Goddess of Reason must have intoxicated him, or he never would have closed a letter with the formal notice,—'I have been accustomed to meet with nothing but insults and indignities from my native country; but if it continue so, '*ingrata patria, ne ossa quidem habebis.*'"

The *consolation*, from this mode of speaking of it, would not seem very soothing.

Hume was now (1761) fifty years of age, and meditated a philosophical retreat in Edinburgh for the rest of his days; but on receiving an invitation from Lord Hertford to attend him in his embassy to Paris, with the prospect of secretaryship to the embassy, he, after some hesitation, consented. He was soon appointed secretary, and in 1765, when Lord Hertford was made lord-lieutenant of Ireland, was left at Paris as *Charge d'Affaires* till the new ambassador, the Duke of Richmond, arrived. In 1766 he returned to Edinburgh, "*not richer*," he pleasantly says, "*but with much more money*."

During his residence in Paris, he was not only welcome, he was the *rage*. In spite of his philosophic shyness, his destitution of all personal graces and charm of manner, and even in spite of his French—French which only French politeness could have heard without laughing—he was overwhelmed with the most flattering attentions of combined rank and genius, youth and beauty. "The more I resiled from these excessive civilities," says he, "the more I was loaded with them." It is evident, nevertheless, from many expressions, that this homage was not a little soothing to our philosopher's complacency, and often excited a flutter of vanity which his philosophy would hardly have approved; and he would as certainly have been cured of it, had he been duly conscious of the ridiculous position in which his worshippers often placed him. "From what has been already said of him," says Lord Charlemont, "it is apparent that his conversation to strangers, and particularly to Frenchmen, could be little delightful, and still more particularly, one would suppose, to French women; and yet no lady's toilette was complete without Hume's attendance. At the opera his broad unmeaning face was usually seen *entre deux jolis minois*. The ladies in France gave the *ton*, and the *ton* was deism; a species of philosophy ill suited to the softer sex, in whose delicate frame weakness is interesting, and timidity a charm. . . . How my friend Hume was able to endure the encounter of these French female Titans, I know not."[1] Some of the scenes in which fashionable society doomed him to enact a part, must have been exquisitely comic; and had his friends intended to ridicule, not to honour him, they could hardly have devised any thing better adapted to the purpose. The scene described so vividly by Madame D'Epinay, must surely have been abundantly trying. We have hardly space for the passage, but it is so graphic, and indeed so instructive, that we cannot resist the temptation to give an abridged translation below.[2] On another occasion, still more trying to his gravity, if not to his modesty, he was compelled to listen to complimentary harangues from the Dauphin's children,—the youngest of the child-orators unhappily breaking down in the middle of his address; we shall give the scene in Hume's own vein of quiet pleasantry. It is clear that, however flattered by the homage he received, as other expressions in his letters prove, he was by no means insensible to the absurdity of the situation in which the extravagance of adulation sometimes placed him. "Do you ask me," says he, "about my course of life? I can only say that I eat nothing but ambrosia, drink nothing but nectar, breathe nothing but incense, and tread on nothing but flowers. Every man I meet, and still more, every lady, would think they were wanting in the most indispensable duty, if they did not make a long and elaborate harangue in my praise. What happened last week, when I had the honour of being presented to the D——n's children, at Versailles, is one of the most curious scenes I have yet passed through. The Duc de B., the eldest, a boy of ten years old, stepped forth and told me how many friends and admirers I had in this country, and that he reckoned himself in the number, from the pleasure he had received from the reading of many passages in my works. When he had finished, his brother, the Count de P., who is two years younger, began his discourse, and informed me that I had been long and impatiently expected in France; and that he himself expected soon to have great satisfaction from the reading of my fine *History*. But what is more curious, when I was carried thence to the Count D'A., who is but four years of age, I heard him mumble something which, though he had forgot in the way, I conjectured from some scattered words, to have been also a panegyric dictated to him. Nothing could more surprise my friends, the Parisian philosophers, than this incident."[3]

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The French of Hume could scarcely have been so bad as the malicious wit of Horace Walpole has represented it; if it was, it is hard to believe that, however prone may have been the French just at that moment to admire, he should have been able to get on in the saloons of Paris at all. Even French civility could hardly have kept its countenance. That it did not refrain from sarcasm we have some proofs, while Hume's English acquaintance exercised it abundantly. "The French," says Walpole with his customary cynicism, "believe in Mr Hume; the only thing in the world that they believe implicitly; for I defy them to understand any language which he speaks." And in a letter first published in the *Suffolk Correspondence*, he says, with still more reckless causticity, "as every thing English is in fashion, our bad French is accepted into the bargain. Many of us are received everywhere. Mr Hume is fashion itself, although his French is almost as unintelligible as his English." It is not Walpole only, however, that makes himself merry with the philosopher's French. One of Rousseau's suspicions of Hume was founded on a few words of French which he uttered in his sleep. Hume remarked that he was not aware that he dreamt in French; "He could not," quietly said M. Morellet.

Of his quarrel with Rousseau, which made so much noise

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[1] *Memoirs of Charlemont*, cited in Burton's *Life*, vol. ii., p. 223. To which we may add the following from Grimm's *Correspondance Litteraire*:—"Ce qu'il y a encore de plaisant, c'est que toutes les jolies femmes se le sont arraché, et que le gros philosophe Ecossais s'est plus dans leur société. C'est un excellent homme, que David Hume; il est naturellement serein, il entend finement, il dit quelquefois avec sel, quoiqu'il parle peu; mais il est lourd, il n'a ni chaleur, ni grace, ni agrément dans l'esprit, ni rien qui soit propre à s'allier au ramage de ces charmantes petites machines qu'on appelle jolies femmes. O que nous sommes un drôle de peuple!"—*Ibid.*

[2] "The celebrated David Hume, the great fat English historian, known and esteemed for his writings, has not equal talents for the social amusements for which all our pretty women had decided him to be fit. He made his debût at the house of Madame de T——. They had destined him to act the part of a sultan seated between two slaves, employing all his eloquence to make them fall in love with him; finding them inexorable, he was to seek the cause of their obstinacy; he is placed on a sofa between the two prettiest women in Paris, he looks at them attentively, keeps striking his hands on his stomach and knees, and finds nothing else to say to them than 'Eh bien! mes demoiselles . . . Eh bien! vous voilà donc! . . . Eh bien! vous voilà . . . vous voilà ici?' This lasted for a quarter of an hour without his being able to get any further. One of them at last rose impatiently. . . . Since then he has been doomed to the part of a spectator, and is not less welcomed and flattered. In truth, the part he plays here is most amusing. Unfortunately for him, or rather for philosophic dignity (for he seems to accommodate himself very well to this mode of life), there was no ruling mania in this country when he came here; under these circumstances he was looked upon as a new-found treasure, and the enthusiasm of our young heads turned towards him. All the pretty women are mad about him; he is at all the fine suppers, and there is no good fête without him; in a word, he is among our fashionables what the Genevese are to me" (*Memoires et Correspondance de Madame d'Epinay*, vol. iii., p. 284). Well might a writer in the *Edinburgh Review* say, "Since the exhibition of the old *Fabliaux* of Aristotle in love—down upon all-fours, and his mistress riding on his back—there has been no representation of philosophy so out of character, as it is shown us in the portrait of Hume by Madame d'Epinay" (*Ed. Review*, Jan. 1847).

[3] Burton, vol. ii., p. 177, 178.

at the time of its occurrence both in England and France, Hume, in the little sketch of his life, which comes up to within a short period of his death, says not one syllable. It certainly was not from thinking it of no importance, for it gave him a world of vexation; indeed he confessed it was one of the most painful, as well as the most extraordinary that had ever happened to him. It was perhaps partly from unpleasant remembrances, that he passed it by; but also probably from a more creditable motive. Angry, and justly angry as he had felt at Rousseau's ingratitude and absurdity—unphilosophically virulent as his language[1] had sometimes been, he doubtless felt inclined as time rolled on, to acquiesce in the view since generally taken, namely, that the French philosopher's "egotism" and "sentimentality" were not seldom undistinguishable from madness; and whether they had produced it or resulted from it might be a fair question. Of the whole quarrel, a most copious and interesting account will be found in Burton's *Life of Hume;* and it is no more than just to say that Hume comes out of it in a manner highly creditable not only to his honour but to his benevolence. His friends in France had forewarned him what a monster of intractable caprice and infinite egotism he was patronizing;—all which he found out when it was too late. Surely the scene which he himself paints with so much vividness, in which Rousseau, after fantastically misinterpreting an act of kindness into the most villainous malignity, suddenly relents, pops down into the surprised philosopher's lap, and sobs and blubbers out his momentary repentance amidst tears and kisses, —repentance soon to be followed by a relapse into as capricious resentment,—presents a picture of Rousseau, of which it is hard to say whether it be more pitiable or ludicrous; while we may easily conceive that to one of so "unsentimental" a nature as Hume, his involuntary *rôle* in so ridiculously "tender a scene" must have been profoundly mortifying.

"I endeavoured," says Hume, "to pacify you, and to divert the discourse, but to no purpose. You sat sullen, and was either silent, or made me very peevish answers. At last you rose up and took a turn or two about the room, when all of a sudden, and to my great surprise, you clapped yourself on my knee, threw your arms about my neck, kissed me with seeming ardour, and bedewed my face with tears. . . . . I was very much affected, I own; and I believe a very tender scene passed between us." The description of Rousseau is, as may be expected, still richer.[2]

After about two more years (1767–1769) of political service as under-secretary, a post to which he was preferred by General Conway, Hume finally retired to Edinburgh, and there anticipated a calm philosophic evening of life in the midst of his favourite society. To use his own words he was "very opulent," having a revenue of L.1000 a-year. His society was much courted by men of the highest literary reputation, and of the widest diversity of opinions, both political and religious. Freed from literary and all other cares, he entertained, "though somewhat stricken in years, the prospect of enjoying long his ease, and seeing the increase of his reputation."

These hopes were fallacious. In 1775 appeared the first symptoms of that long decay which terminated in his death, August 1776.

It is but justice to say that all concurrent testimony proves him to have borne this slow and harassing, though, it seems, by no means painful illness, not only with exemplary fortitude and patience, but with much sweetness of temper, and to have contemplated the great change with undiminished serenity. Convinced that his disease was incurable long before his friends would believe it, he refused to listen to false predictions of returning health. When Dr Dundas intimated that he should tell his friend Colonel Elphinstone that he "was much better, and in a fair way of recovery," Hume replied, "Doctor, as I believe you would not choose to tell anything but the truth, you had better tell him that I am dying as fast as my worst enemies, if I have any, could wish, and as easily as my best friends could desire."

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Sometimes, it is true, he regarded the approach of the last moment with a hilarity strangely unbecoming his situation, whether as a philosopher or a man; and his ill-timed pleasantry about Charon's boat might well have been spared. John Foster, in his review of Ritchie's *Life* of the philosopher, has observed, that even on the hypothesis that death is an extinction of our being, much more on that of Hume's scepticism, which left it *uncertain* whether death might not reveal the truth of what he had been doubting all his life long, anything bordering on levity in such an hour is utterly out of place. It is as though a man should laugh and caper in the cave of Trophonius. But, in other respects, it cannot be denied that Hume's last hours exhibit a serenity which, though often exemplified by religion, has rarely been exhibited by philosophy, and still more rarely by a sceptical philosophy.

Foolish inferences have been founded on what cannot without gross disingenuousness be denied—the philosophic fortitude and tranquillityof Hume's death,—and equally foolish attempts made to prove all that fortitude and tranquillity affectation. Experience ought to convince us that nothing can be inferred as to the adaptation of this or that system of philosophy or religion to produce calmness in a dying hour, from the phenomena of *any individual death-bed.* The best men have often encountered the great enemy with dismay, and the worst with tranquillity. We can as little infer from their conduct what death is to disclose, as we could infer what is at the bottom of a deep abyss, if we saw that, of a thousand men who were compelled to leap into it, some madly laughed, and some pusillanimously wept on the brink, before making the inevitable plunge. It should be sufficient to vindicate the superiority of at least a Christian's faith to every form of scepticism, that if he has really lived in accordance with his hopes and convictions, the *natural* tendency of his sentiments and conduct is to produce tranquillity at the last hour, whether, from physical causes, he attains that tranquillity or not; and that his "immortal hopes"—even if they were to prove delusions—are as naturally connected with a peaceful close of the great strife as any other *cause* with its *effect.* Nothing can be more true than the pointed declaration of Lord Byron: "Indisputably the firm believers in the Gospel have a great advantage over all others, for this simple reason, that, if true, they will have their reward hereafter; and, if there be no hereafter, they can be but with the infidel in his eternal sleep, having had the assistance of an exalted hope, through life, without subsequent disappointment, since (at the worst for them) 'out of nothing nothing can arise, not even sorrow.'"

On the other hand, even the least candid of sceptics will acknowledge that there is nothing in scepticism itself—least of all in such radical, devastating scepticism as that of Hume—*naturally* calculated to soothe a dying hour. Though a sceptic *may* meet it with tranquillity, from frigidity of temperament or hardihood of character, or fixed aversion to look at the future, or from a too complacent estimate of his own worth,[3] or a deficient moral sensibility, or from many other reasons, assuredly there is nothing in

[1] In the celebrated introduction to the letter to Baron d'Holbach, in which Hume first explodes in wrath, he says, "Mon cher Baron, Jean Jacques est un scélérat."

[2] Burton, vol. ii., p. 342.

[3] Hume certainly pronounces his own *éloge* with sufficient confidence: "My friends," says he in his autobiography, "never had

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the native tendency of a sceptic's sentiments to render a death-bed more tolerable.

And that such is the natural impotence of sceptical philosophy for all such purposes, would seem to be indicated by the frequent appeal of sceptics to this "instantia solitaria" of Hume's death-bed. The rarity of the phenomenon neutralizes it as an argument; if, like the calm or triumphant deaths of consistently religious men, such a phenomenon were too common to be specially noted at all, it would be something to the purpose.

For Hume's scepticism, charity, we think, may blamelessly make ampler excuse than the generality of readers have been disposed to make. One may suspect, considering its remarkably early, uniform, and inveterate character, that it had to do profoundly with the very structure of his intellect, and was *ab origine* far more involuntary than is generally the case. It may, in our opinion, be even surmised that it was connected with that singular morbid condition from which he suffered so much at so early an age. The very curious document in which he discloses so freely the symptoms which oppressed him has been already referred to, and the brief citations we proposed to give will be found below; but the whole letter, first published in Burton's *Life*, is well worthy of perusal *in extenso*. It reveals a condition of mind, considering the writer's extreme youth, at least as unhealthy as that of the body. At an age when other youths are for the most part only too credulous he was entertaining universal doubt; and when others are full of nothing but poetry and love, he was presumptuously exploring the deepest problems that can engage the human intellect, and declaring that nothing certain was yet established in philosophy or morals! At the very time that he was labouring under the cloud of hypochondriacal depression, referred to in the letter from which we give extracts below, he was intensely excogitating his philosophy. His whole state was unnatural.[1]

At the early age of twenty-two or twenty-three, his philosophical opinions were already nearly complete—that is, when he had hardly advanced beyond boyhood. His sceptical tendencies,—thus deeply radicated, and indulged at an age so portentously early,—everything in his nature tended to confirm, and nothing in his experience and subsequent history tended to correct. He was of a naturally frigid temperament,—entirely without enthusiasm,—with little sympathy for the lofty or heroic in sentiment or character. Nor, in his after life, was there anything to develope any latent germs of such qualities; he never passed through those agitating scenes of absorbing love, or joy, or sorrow, or hope, or fear, which form the discipline of life, and so often profoundly modify, and even revolutionize, the human character; which often develope qualities not suspected to exist, or shiver into atoms the sentiments and opinions formed in youthful inexperience. With only one dominant passion, as he himself admits,—that ambition of literary distinction, which tended rather to inflame than correct his early love of dazzling paradox,—he passed life in respectable epicurean tranquillity. A most commendable frugality made him content in youth with very little; he saw, as years rolled on, increasing prosperity in every desirable form,—an income which his moderation counted wealth, a steadily increasing reputation, "troops of friends," flatteries, uninterrupted health, and, in a word, everything that could lay to sleep (as prosperity very generally does) the susceptibilities and emotions of man's spiritual nature. His bark sailed on a smooth sea, and encountered none of those shocks or tempests which, more than most things, make the voyager of life consider whether his ship is constructed and equipped as well for the storm as for the calm. It may be added, that so habitually deficient is Hume in the sentiment of veneration,—so unnatural the apathy with which he regards religious phenomena,—so easy, apparently, the entire extrusion of the subject from his thoughts,—so frightfully contented does he seem with his scepticism,—that, though this state of mind was encouraged, no doubt, by the too congenial atmosphere of his age, and the French society he loved, it is difficult not to infer some *abnormality* in the very original structure of his moral nature; and it is the kindest apology that can be made for him.

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On any other hypothesis, he cannot be too severely censured for the indolent facility with which he seems to have ac-

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occasion to vindicate *any one circumstance* of my character and conduct." If by this he meant to claim exemption only from flagrant vice, there are few decent characters in life who could not say as much; but, with a deeper self-knowledge and profounder moral sensibility, most men would own that they were conscious of too many failings which men knew not, and which God only know, to permit them to plume themselves on any such grounds. But of the ordinary infirmities of man, and especially of the subtle spiritual vices of pride, vain glory, presumption, and prejudice, the biography and character of Hume present as little lack as those of other men.

[1] "Every one who is acquainted either with the philosophers or critics knows that there is nothing yet established in either of these two sciences, and that they contain little more than endless disputes, even in the most fundamental articles. Upon examination of these I found a certain boldness of temper growing in me, which was not inclined to submit to any authority in these subjects, but led me to seek out some new medium by which truth might be established. After much study and reflection on this, at last, when I was about eighteen years of age, there seemed to be opened up to me a new scene of thought, which transported me beyond measure, and made me, with an ardour natural to young men, throw up every other pleasure or business to apply entirely to it. . . . I was infinitely happy in this course of life for some months; till at last, about the beginning of September 1729, all my ardour seemed in a moment to be extinguished, and I could no longer raise my mind to that pitch which formerly gave me such excessive pleasure. . . . . In this condition I remained for nine months very uneasy to myself, as you may well imagine, but without growing any worse, which was a miracle. . . . . Though I was sorry to find myself engaged with so tedious a distemper, yet the knowledge of it set me very much at ease, by satisfying me that my former coldness proceeded not from any defect of temper or genius, but from a disease to which any one may be subject. . . . . I believe it is a certain fact, that most of the philosophers who have gone before us have been overthrown by the greatness of their genius, and that little more is required to make a man succeed in this study, than to throw off all prejudices either for his own opinions or for those of others. At least this is all I have to depend on for the truth of my reasonings, which I have multiplied to such a degree, that within these three years I find I have scribbled many a quire of paper in which there is nothing contained but my own inventions. This, with the reading most of the celebrated books in Latin, French, and English, and acquiring the Italian, you may think a sufficient business for one in perfect health, and so it would, had it been done to any purpose; but my disease was a cruel encumbrance on me. I found that I was not able to follow out any train of thought by one continued stretch of view, but by repeated interruptions, and by refreshing my eye from time to time upon other objects. . . . . I have noticed in the writings of the French mystics, and in those of our fanatics here, that when they give a history of the situation of their souls they mention a coldness and desertion of the spirit which frequently returns; and some of them at the beginning have been tormented with it many years. As this kind of devotion depends entirely on the force of passion, and consequently of the animal spirits, I have often thought that their case and mine were pretty parallel, and that their rapturous admirations might discompose the fabric of the nerves and brain, as much as profound reflections, and that warmth or enthusiasm which is inseparable from them.

"However this may be, I have not come out of the cloud so well as they commonly tell us they have done, or rather begin to despair of ever recovering. . . . . The questions I would humbly propose to you are: Whether, among all those scholars you have been acquainted with, you have ever known any affected in this manner? Whether I can ever hope for a recovery? Whether I must long wait for it? Whether my recovery will ever be perfect, and my spirits regain their former spring and vigour, so as to endure the fatigue of deep and abstruse thinking?" (Burton, vol i., p. 31-38.)

quiesced, in after life, in his first early conclusions—the very immaturity of which might well have awakened suspicion. There is no proof that, when he became a man in intellect, he ever seriously revolved them again. He must also be blamed for the resolute way in which he evaded or silenced every attempt to turn his mind to the reconsideration of his opinions. A remarkable instance of this disposition to get rid of expostulation occurs in one of his letters to Blair, cited by Mr Burton:—"Whenever," says Hume, "I have had the pleasure to be in your company, if the discourse turned on any common subject of literature or reasoning, I always parted from you both entertained and instructed. But, when the conversation was diverted by you from this channel towards the subject of your profession—though I doubt not but your intentions were friendly towards me—I own I never received the same satisfaction: I was apt to be tired, and you to be angry. I would therefore wish, for the future, whenever my good fortune throws me in your way, that these topics should be forborne between us. *I have long since done with all inquiries on such subjects, and am become incapable of receiving instruction.*"

Blair's letter, by the way, shows that Hume's Scottish clerical admirers did not hesitate to embrace opportunities of faithful expostulation as far as Hume's repellent humour permitted, and proves how unjust and uncharitable the suspicions which were sometimes founded on the intimacy between him and them. A man's Christianity would be equivocally evinced by renouncing all intercourse with such as renounce *it;* such conduct would suggest to those thus repelled a strange idea of the charity which professed to seek their spiritual welfare! It were rather to be desired that every Hume or Gibbon might have for his bosom friend a Bishop Butler or a Robert Hall.

Of the personal and social elements of Hume's character it is unnecessary to say anything, as the subject has been so admirably touched by Sir James Mackintosh, in his preliminary Dissertation. That he was very amiable, and well merited the admiration of his friends, cannot be doubted; though the eulogy of Adam Smith, uttered in the first freshness of grief at his loss is, as Sir James observes, "an affectionate exaggeration." "Such a praise," he justly says, "can never be earned without passing through either of the extremes of fortune, without standing the test of temptations, dangers, and sacrifices. It may be said, with truth, the private character of Mr Hume exhibited all the virtues which a man of reputable station, under a mild government, in the quiet times of a civilized country, has often the opportunity to practise."

In certain respects, Hume presented rather a curious contrast. He was by no means the impassive person his general coldness of temperament would lead us to conclude, and by no means the unprejudiced person which a sceptical philosophy may be presumed to have a tendency to form, and which he would fain be thought. Where his solitary passion—literary ambition—was in question, his vanity is as impatient, exacting, and querulous as that of any mortal; in spite of constantly brightening prospects and widening fame, he is perpetually harping about imaginary neglect and imaginary persecution. Similarly as to prejudice; his bitterness against the English[1] will just match, and no more than match, with Johnson's bitterness against the Scotch. In these two men, the two nations may justly consider themselves quits; and fortunately are never likely to have any more such absurd accounts to settle between them. It is the happiness of our age that Englishmen would as little tolerate the prejudices of Johnson as Scotchmen would those of Hume.—But it is in his *historical* writings that Hume's intense capacity of prejudice appears most signally. He who was the most sceptical of philosophers became, in fact, the most bigoted of historians; with this aggravation of his bigotry, however,—that all the acts and opinions of which, in his history, he was so keen an apologist, were in direct defiance of the general strain of his political sentiments and speculations, as disclosed in his *Political Essays*.

As to his character as a philosopher, his genius will probably be more appreciated, and its achievements less valued, by successive generations of readers. His capacity cannot be well exaggerated. That such a work as the *Treatise of Human Nature*, or the *Essays*, should have proceeded from so young a man, gives an impression of subtlety, acuteness, and ingenuity, seldom, if ever, surpassed. But these productions are chiefly remarkable as proofs of his genius, and for the searching investigations to which they led on the part of others; not for their intrinsic value. System, as both Stewart and Mackintosh observe, he had none; he is constantly shifting his ground, and contradictions without number may be detected in his writings. The fact is, that provided he could find any arguments to support the paradox of scepticism which happened to be the theme of one essay, he did not care how it might be opposed to some other paradox of scepticism which was defended in another essay. Thus, while speculatively arguing that neither "intuition," "demonstration," "experience," nor any other conceivable reason, really authorizes us to conclude that any one sequence will follow any one antecedent rather than another, or that the future will resemble the past, he, in his *Essay on Miracles*, declares all "miracles" utterly incredible,[2] because they would contradict the uniformity of nature as ascertained by experience:[3] ambitious to outdo Berkeley by annihilating not only matter but mind, and reducing every thing in the universe to "impressions and ideas," he abundantly contradicts himself (but here, to be sure, he could not help it) by saying in the same breath, that of the existence of these "impressions and ideas" even scepticism cannot doubt, since WE—that is, the doubted conscious unity, Mind—cannot but be conscious of them: similarly, while affirming, consistently enough in words all his life long, his belief in an intelligent First Cause (and it is the only determinate religious

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[1] Thus he speaks of the English in 1764, "That nation are relapsing fast into the deepest stupidity and ignorance. The taste for literature is neither decayed nor depraved here as with the barbarians on the banks of the Thames. . . . Can you seriously talk of my continuing an Englishman? Am I, or are you, an Englishman? Do they not treat with derision our pretensions to that name, and with hatred our just pretensions to surpass and govern them? . . (1775) I have a reluctance to think of settling among the factious barbarians of London, who will hate me because I am a Scotsman, and am not a Whig, and despise me because I am a man of letters. . . (1776) It is lamentable to think how much that nation has declined in literature in our time."

[2] This inconsistency with his speculative principles is the least defect in that acute but sophistical performance. But its fallacies have been too often pointed out to need being mentioned here.

[3] "For all inferences from experience suppose, as their foundation, that the future will resemble the past, and that similar powers will be conjoined with similar sensible qualities. If there be any suspicion that the course of nature may change, and that the past may be no rule for the future, all experience becomes useless, and can give rise to no inference or conclusion. It is impossible, therefore, that any arguments from experience can prove this resemblance of the past to the future; since all these arguments are founded on the supposition of that resemblance. Let the course of things be allowed hitherto ever so regular, that alone, without some new argument or inference, proves not that for the future it will continue so. In vain do you pretend to have learned the nature of bodies from your past experience" (*Essays*, vol. ii., *Sceptical Doubts*). "A wise man, therefore, proportions his belief to the evidence. In such conclusions as are founded on an infallible experience, he expects the event with the last degree of assurance, and regards his past experience as a full *proof* of the future existence of that event" (*Essays*, vol. ii., *Miracles*).

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tenet which he seems to have maintained), nearly all his speculative reasonings—especially his theory of causation—*tend* to show that of that primal truth there cannot be satisfactory proof, and he has even furnished atheism with a novel paradox in its support, founded on the world's being a "singular effect:" indignantly repelling, as a perversion of his meaning, the notion that he "had ever asserted so absurd a proposition as that any thing might arise without a cause," he has yet so expressed himself, that (as has been well said by one of his most acute critics) the entire metaphysical world has shared in the mistake! Magnanimously declaring at one time that the philosopher must abide by *truth*, even though it were proved pernicious to mankind,—quite in the lofty *fiat justitia ruat cœlum* style,—he, at another, advises (and it is a deep blot on his character) a sceptical friend to accept church preferment, and preach what he did not believe; affirming that "to pique oneself on sincerity in such matters is to put too great a respect on the vulgar and their superstitions!" Well may one of his most charitable critics proclaim himself "ashamed to print" the philosopher's words! Again, while in his *Essay on Polygamy and Divorce* he sees so clearly and illustrates so well the infinite importance of preserving the domestic relations pure, he speaks, in his *Inquiry into the Principles of Morals*, in an apologetic tone of vices which, if freely indulged, would soon dissolve society—an inconsistency which has called forth the just animadversion of Sir James Mackintosh.

In a word, there is no end to the incoherencies of Hume's statements, and which are only concealed so long as one essay is not collated with another. He wrote, as it were, with the old Roman *stylus*—a sharp pen at one end, and an instrument of erasure at the other.

His fame as a philosopher, therefore, will rest rather on what he was capable of than on what he achieved; and it may be said, by a somewhat similar paradox, that his fame as an historian will rest much more on his manner than on his matter. His work is everywhere disfigured with gross defects, inaccuracies, and prejudices, as Hallam, Brodie, and many others, have abundantly shown; but the charm of his style embalms and perfumes his errors, and men will still be willing to read him—though they disbelieve.

Not, indeed, that even his style as an historian is wholly free from defects. It is cold—that might be expected from the frigid temperament of the man. It is wanting in imaginativeness, and consequently in animation, and the perfection of graphic skill. This fault again is often aggravated by superficial knowledge of his materials; for a full mastery of details is the only thing which can render precise statement safe. Thus Hume often omits names and dates where they ought to be inserted, and conceals the necessity of definite statement in convenient vagueness. His assertions are often so general and so adroitly balanced and qualified, that they seem to betray a consciousness that he is standing on delicate ground, and that he had better not commit himself to too much exactness, lest some critic of greater knowledge of details should convict him of inaccuracy. These artifices he employs no doubt with great dexterity, but one would greatly have preferred that there should have been no occasion for them. Still, in spite of all these deductions, the narrative is so lucid, the grouping so admirable, the reflections so unforced and natural, and the style flows on in such a stream of tranquil beauty—combining so much both of flexile grace and natural dignity, that his work will ever stand high in the estimate of every cultivated taste. It is an instance of the importance of *style*, as Sir J. Mackintosh remarked of Butler. That profound thinker has been often undervalued for want of a style worthy of his thoughts: the work of Hume, in spite of its defects, has been raised into one of the most familiar manuals of history, because it has one. So senseless is that cry which one sometimes hears—that style is of little consequence, if facts be but stated! When was human nature ever got to disregard the medium and the manner in which truth was presented? So little is this to be expected, that though Hume's inaccuracies have been exposed a thousand times, he still maintains, in virtue of his style alone, the place of a classic of English history.

Hume, Joseph.

The same qualities of style are, if possible, more manifest in Hume's *Philosophical Essays*. Amidst that absence of all generous enthusiasm which we should expect in so complete a Pyrrhonist, and a prodigal use of subtle and ingenious sophistry that would seem to have had no other object than to confound and perplex the intellect of the reader, they abound in passages which, considered simply as composition, are exquisite specimens of refined simplicity—of that severe Attic grace which it is evident he had carefully studied and cultivated, as well as of a very quiet but most elegant pleasantry. And amongst such passages few are more striking than those in which the sceptic acknowledges the vanity of scepticism.[1]

The fullest and most authentic account of Hume's *Life and Writings* will be found in Burton's recent *Life*, 2 vols. 8vo, Edin. 1846; to which we willingly confess our obligations. (H. R.)

Hume, *Joseph*, an eminent political reformer of the nineteenth century, was born in 1777, of humble parents in Montrose. After such an education as the grammar school of his native place then afforded, he was apprenticed to a surgeon, and in 1793 began a course of medical study at the University of Edinburgh. After graduation he sailed for India, where he was attached as surgeon to a regiment; and his knowledge of the native tongues (which he took care to master immediately on landing), and his capacity for business, threw open to him the lucrative offices of interpreter and commissary-general. While still in the prime of life he was enabled to return home with a well-earned fortune. His first care on arriving in England was to study thoroughly the country and its resources, and in the various journeys which he made to see with his own eyes the actual state of the people and the practical operation of the laws, he amassed that stock of useful knowledge which was the real secret of his subsequent success in parliament. In 1812 he took his seat for the borough of Weymouth and Melcomb Regis, but was soon after obliged to resign it, when it was discovered by his Tory patron that he had had the audacity to talk of reform. Six years elapsed before he again entered the House, and during that interval he had made the acquaintance and imbibed the doctrines of James Mill and the philosophical reformers of the school of Bentham. In 1819, soon after his marriage, he re-entered parliament, and began unaided

[1] Nothing can be happier than the pleasantry in some of Hume's familiar letters, and it makes us regret that we have not more of them. We would willingly exchange for them portions either of his *Essays* or his *History*, bulk for bulk. Light and trivial in comparison no doubt they would be, but one might find consolation in thinking that elegant triviality was at least as good as grave error or pernicious paradox. How graceful is the following *badinage*;—"I live still, and must for a twelvemonth, in my old house in St James's Court, which is very cheerful, and even elegant, but too small to display my great talent for cookery—the science to which I intend to addict the remaining years of my life! I have just now lying on the table before me a receipt for making *soupe à la reine*, copied with my own hand. For beef and cabbage (a charming dish), and old mutton, and old claret, nobody excels me. I make also sheep's-head broth, in a manner that Mr Keith speaks of it for eight days after; and the Duc de Nivernois would bind himself apprentice to my lass to learn it! I have already sent a challenge to David Moncrief; you will see that in a twelvemonth he will take to the writing of history (the field I have deserted), for, as to giving of dinners, he can now have no further pretensions. I should have made a very bad use of my abode in Paris, if I could not get the better of a mere provincial like him."

Humerpoor ‖ Hungary.

and alone that career of reform in which he persevered to his death. Free-trade, financial reform, parliamentary reform, and Indian reform, were the elements in which he lived. At first despised and ridiculed, afterwards dreaded as the *justum et tenacem propositi virum*, he ended by gaining the respect of friends and foes, and the confidence of the whole nation. It was not by the force of a commanding intellect or the fascinations of a brilliant oratory that he achieved this end. The breadth of his action, his singleness of aim, his perfect independence of all party or personal considerations, and an almost heroic earnestness and self-denial in carrying out his views, were the secrets of his influence. Himself as incorruptible as Aristides, he made it a special duty to hunt out and expose political corruption under whatever guise it lurked, and the whole army of place-hunters and jobbers found in him their most indefatigable and inexorable foe. There were many abler, but there was no more useful member in the House during the greater portion of his parliamentary career. His death, which took place Feb. 20, 1855, was regretted by his countrymen as a national loss.

HUMERPOOR, a considerable town of Hindustan, situate on the right bank of the Jumna, at a spot where the river has a stream running in a channel half a mile in breadth with a rapidity of three or four miles an hour. The district of which this town is the chief place, has an area of 2240 square miles, with a population of 452,091, of whom 419,683 are Hindus, and the remainder Mohammedans. The town is situate 110 miles N.W. of Allahabad, in Lat. 25. 58., Long. 80. 14.

HUMILIATI, a monastic order founded in 1134 by several Italian noblemen who had been sent as prisoners to Germany by Lothar II., and were released on account of their *humility*. In 1151 they were embraced under the rule of St Benedict, and the order was confirmed by Innocent III. half a century later. They ultimately spread so widely as to have 98 houses under the jurisdiction of their order; but they were suppressed by Pius V. in 1576 on account of their luxury and cruelty. A female order instituted by the ladies of the original Humiliati have still some representatives in Italy.

HUMPHREY, LAURENCE, a learned English divine, was born at Newport-Pagnell, Buckinghamshire, about the year 1527. He received his school education at Cambridge, and afterwards became a fellow of Magdalen College, Oxford, where he took his degree as master of arts in 1552. In 1555 he retired, with other Protestant refugees, to Zurich, in Switzerland, where he resided for some time; but after the death of Queen Mary he returned to England, where he was restored to his fellowship in Magdalen College, from which he had been expelled, and in 1560 appointed queen's professor of divinity at Oxford. In 1570 he was made dean of Gloucester; in 1580 he was removed to the deanery of Winchester; and, if he had not been disaffected towards the Church of England, in other words, a moderate and conscientious Nonconformist, he would probably have been raised to the episcopal bench. Humphrey was considered as a great and general scholar, an able linguist, a profound theologian, and, for his time, an excellent writer. He died early in 1590, leaving a wife who had brought him twelve children. His works are, *Epistola de Græcis literis, et Homeri lectione et imitatione*, Basil, 1558; *De Religionis conservatione et reformatione, deque primatu Regum*, Basil, 1559; *De Ratione interpretandi auctores*, Basil, 1559; *Optimates, sive de Nobilitate, ejusque antiqua origine*, Basil, 1560; *Joannis Juelli Angli, Episcopi Sarisburiensis, Vita et Mors*, London, 1573; two Latin Orations spoken before Queen Elizabeth, one in 1572, and the other in 1575; *Sermons;* and some Latin pieces against the Papists, particularly Campian.

Hundred ‖ Hungary.

HUNDRED, HUNDREDUM, or *Centuria*, a part or division of a county, and anciently so called from its containing a hundred families, though the term was also applied to much larger county-divisions, as to the wapentakes of the northern counties. The jurisdiction of the hundred was vested in a sheriff, and he or his deputy held both a court-baron and a court-leet; sometimes this jurisdiction was by special crown grant vested in private persons. When damage was done within their district, the hundred were responsible unless they produced the felon. Sub-divisions of shires have existed since the time of Alfred, and hundreds are mentioned in records of still earlier date.

HUNGARY.

Geography.

THE kingdom of Hungary consists of Hungary Proper, Sclavonia, Croatia, Hungarian Dalmatia on the sea coast, Transylvania, and the Military Frontier. It is situated between 46° and 50° N. Lat., and between 15° and 25° E. Long. It is bounded on the N. by Galicia, on the E. by the Danubian Principalities, on the S. by Servia, Bosnia, and the Adriatic, and on the W. by Styria, Lower Austria, Moravia, and Silesia. The north-eastern frontiers are formed by the Carpathians, which jut out in different branches towards the banks of the Danube, and inclose Transylvania in the form of a double crescent. A no less natural boundary is the Danube, separating Southern Hungary from the Turkish Provinces. The least marked frontier is the western, separating Hungary from Lower Austria: it is in part formed by the small March River.

The exact extent of Hungary and its dependencies has not yet been precisely ascertained. According to the Austrian official statistics published by Czörnig, the superficial area amounts to 125,037 English square miles; more recent Austrian tables reduce that number, whereas the Hungarian statist, Alexius Fenyes, reckons the superficial area at 130,910 English square miles, of which Transylvania occupies about one-sixth, or upwards of 20,000 miles. The Hungarian kingdom is thus larger than Great Britain and Ireland by about 10,000, and than Prussia by 20,000 square miles.

The physical aspect of Hungary Proper is sharply marked by the contrast between the northern Carpathians, forming large plateaus, and the vast level land intersected by the Danube, Theiss, and Marosh; while in Transylvania, where the Alpine character predominates, the sudden diminution of the mountains allows only of undulating table-land, alternating with narrow valleys. The greatest part of Croatia, and part of Sclavonia, likewise consists of mountainous land, formed by the outliers of the Alps, the level land in the latter lying to the north.

Mountains.

Rising like a rampart between Hungary, and Moravia, Silesia, Galicia, and the Bukowina, the Carpathians, after running round Transylvania, extend to Orsova on the Danube. They form no connected chain, and are generally divided into frontier and central mountains. The frontier Carpathians, which are of less height than the latter, begin at Presburg. One group of these extends between the rivers Waag and March, and afterwards enters Moravia at the *Strany Pass*. The other group, known by the name of Beskid, runs between Hungary and Silesia, Galicia, and the Bukowina, and after traversing Moldavia appears as the frontier mountain of Transylvania. The inner or central Carpathians, which occupy much less ground than the frontier ones, are also divided into different chains or groups, among which the *Tatra* group in the north forms the most imposing mass. The whole granite plateau of this group is about 50 miles long and 15 miles broad. Its highest crests are the Lomnitzer, 8370, the Eisthaler, 8320, and the Krivan, 8230 feet high. The south-western branch of the Tatra extends to the mineral mountains. These, like a few other groups, are classified with the midland mountains, which are considered distinct from the central Carpathians. The *Matza* group in the county of Heves, the Buk, and Vine hills, where the tokay grows, are comprised in the northern chain. The eastern chain begins from the banks of

Hungary. the Bodrog, and extends over the greater part of Transylvania. The western branches of this chain pass into southern Hungary or the Banat, and then gradually sink into hills. As in Transylvania the highest chain is the southern or Fagaros mountain range, rising near Cronstadt, the summit of which measures 8515 feet high. The low western mountains of Hungary which come from Croatia and Sclavonia belong to the Styrian and Julian Alps, and are connected with the Carpathians by the midland mountains.

The great Hungarian plain, which is the largest in Europe, begins at the Matra group in the north, and extending over Southern Hungary, ends at the confluence of the Save and the Danube at Semlin. It is through this plain, called the Eastern Plain, presenting the richest soil, alternating with large barren sandy wastes, and which is hardly 140 feet above the level of the sea, that the Theiss pursues her meandering course towards the Danube. This plain is quite treeless and affords nothing to vary the monotonous scene except the mirage or *Fata-Morgana* (in Hungarian *deli-bab*). The smaller or western plain is separated from the former by the Bakonywood and its branches.

The frontier Carpathians consist mostly of sandstone formations, while the central or primitive mountains are of a granitic character, and contain strata of gneiss or beds of quartz, clay-slate, grauwacke, basalt, and diorite. The calcareous formations are particularly rich in iron and copper, whereas the porphyritic and granite rocks contain much gold and silver. The sandstone and other secondary strata abound in coal beds. The level land, rich in salt springs, is also impregnated with nitre and carbonate of soda.

Rivers. Turning to the hydrographic survey of the country, the Danube, the largest European river next to the Volga, first claims notice. Reaching the Hungarian territory at Presburg where the Carpathians begin to rise on its left bank, the Danube pursues a south-easterly course, dividing into three branches which receive the waters of the Layta, Raab, and the Waag, embracing moreover the two Schütt islands about Comorn, and then the St Andrew Island at Waitzen, after which its direction becomes more southerly, and after leaving Buda and the Osepel Island it rolls along the Hungarian plain and the Banat; its right banks reaching the Turkish territory at Semlin. There, where its course becomes retarded by the Servian mountains, it receives the waters of the Save, leaving the kingdom at Orsova, after forcing its impetuous waves through the *Iron Gate*. The breadth of the Danube varies in different parts, being about Presburg 900 feet, at Foldvar 1800 feet, between the former and Vanek 4000 feet, at Petervardein 3500 feet, at Belgrade 508 feet, and at the Iron Gate between 158 and 80 feet. The depth varies between 20, 40, 60, and 120 feet. The greatest tributary of the Danube, the Theiss (Tibiscum), rises from a double source in the county of Marmaros near Galicia, reaches the level land at Nagy Szöles, and winds its course through the large plain as far as Titel, where it flows into the bed of the Danube. The chief tributaries of the Theiss, remarkable for richness in fish, are the Hernad, Sajo, Bodrog, Szamos, Körös, and the Marosh, which is the chief river in Transylvania. The Drave, which rises in the Tyrol, flows through Styria into Croatia, and dividing it from Hungary, falls into the Danube near Essek. The Save, rising in Carinola, winds its course through Croatia, is fed by the Unna and Kulpa, forms part of the frontier towards Bosnia and Servia, and falls into the Danube at Belgrade. The Marosh, which ranks next to the Theiss, falls into the latter at Szegedin, after having received the Aranyos, famous for its gold washings, and the Kokel or Kükülö. The Alt or Aluta rises likewise in the Transylvanian mountains, entering Wallachia through the Red-Tower Pass.

All the Hungarian rivers flow into the Black Sea, with the exception of the Popard, which rises in the Zips from the Kongsberg, and flows into the Vistula.

Lakes. Among the lakes the largest is the Platten-see or Balaton, situated between the counties of Zala and Schumeg. Its length is about 50 miles and its breadth between 8 and 9 miles; and with the surrounding marshes, it occupies above 500 square miles. Its principal feeder is the Zala, and its only outlet is the marsh Sio. The Neusiedler-see in Hungarian Ferto, between the counties of Wieselburg and Oedenburg, fed by the Vulka, is 70 miles long and 10 miles broad; its shallow waters are impregnated with salt, and exhibit an ebb and flow, as yet unexplained. The Palver-see is, properly speaking, a marsh resembling many which are formed by the Theiss and Lower Danube. The Sar-ret in Bihar, the Ecseder in Szathmar, the Feketels in the Banat, are the largest marshes. The marshes covered with aquatic plants, such as Ecseder, are generally distinguished by the name of *lap*. Hungary.

The only canal of importance is that in the county of Bacs, called the Francis Canal, cut from Monoster to Foldvar, and uniting the Danube with the Theiss. It is about sixty miles long, and shortens the passage by about 200 miles. The Bega Canal, near Temesvar, is rather a river than a canal.

The Adriatic touches only the south-western extremity of the Hungarian kingdom, the sea-coast being variously called Hungarian Dalmatia or Illyria, the principal ports being Fiume, a flourishing town inhabited chiefly by Italians, Buccari, Porte-re-Zengg, St George, Tablonz, and Carlopago. The whole coast is mountainous, and in some parts steep, and exposed to violent south winds.

Caverns. As regards natural curiosities the numerous ossiferous caverns, amid the northern limestone mountains, deserve particular mention. The Agtelek Cave in Gömör, 16 feet high and about 50 feet broad, extending in a straight line to about 900 feet, contains fossil bones of the elephant, rhinoceros, and other large animals. Apertures in its sides open into recesses communicating with each other, and these as well as the main body of the cave contain springs. Of a similar description is the cave of Domeny-falva in Liptau, containing glacial masses, and not far distant from it is the Okno and Vadi. The Czerva or Black Cave exhibits columnar concretions, and the same formations are found in the deep Funatta Cave in Bihar, which is divided into five separate fissures or chambers filled with ossiferous fossils. In the Banat is the Veterani Cavern near the Danube, containing a cistern and a powder magazine, once forming an important military post. The most remarkable, however, is perhaps the Almas Cavern in the Szekler district of Transylvania. This spacious cavern presents, besides a labyrinth of precipices and chasms, marshes with floating beds or aquatic plants, and a rushing brook. No less curious is a small turbid stream near the Tatra group, looked upon by the people as a blood-sucker.

As may be inferred from its geographical position, Hungary contains the usual European quadrupeds, and its soil is productive of great varieties of vegetable life. It may be added that the Carpathians harbour the wolf, the bear, and chamois; and that if Hungary is not the land where the citron grows, it is superior to Italy in vines, and to all Europe in its exquisite melons. Füred, near the Balatan Lake, and Bartfeld, on the Galician frontier, watering-places much frequented in the summer season, have chalybeate springs, while Teplitz in Trenchin, and Mehadia in the Banat, have sulphurous springs. Parad in Borsad, and Borszek in Transylvania, have acidulous wells. No less famed are the hot springs of Buda.

Climate. The climate of Hungary varies greatly. In the counties of Arva, Liptau, Zips, and Marmaros, winter continues for fully six months, whereas in Southern Hungary the trees blossom as early as March, and in June the heat becomes burdensome, reaching its culminating point in July. From the partial meteorological observations that have been made, it appears that the highest temperature in Buda is 30°·6 R., and in Klausenburg (in Transylvania) 32°·6; and the mean is, in Buda 15°·19, and in Klausenburg 53°. This, however, is far from giving an idea of the climate in the different parts of the country, and especially in the level land in the south, or the larger plain, where at mid-day the heat is at times almost African; and yet in those very parts, as a geographer observes, even quicksilver was frozen in the unusually severe winter of 1816. The heat of the smaller or western plain is much tempered by the Bakonywood. The first half of January marks the minimum, and the second half of July the maximum of the temperature; whilst April and the first part of October coincide with the mean temperature. Blasts and the falling of hail happen most frequently among the Carpathians.

Races. The population of Hungary and its dependencies contains a great variety of races, some of which form but insignificant numbers; the four principal races are the Magyars, the conquerors and founders of the kingdom, the Sclavonians, the Wallachians, and the Germans. The ancient home of the Magyars or Ugri is Central Asia or ancient Scythia. Pressed by other tribes, they moved gradually round the Caspian Sea and the Euxine, till, at the end of the ninth century, they

Hungary. reached the Carpathians. Their leader Almus and his son Arpad, as the chroniclers say, in advancing to these mountains, burned to find out the fertile land of Attila, the king of the Huns, upon whom they looked as their ancestor. Hence, perhaps, may be explained the origin of the word Hungary and Hungarians, though some wish to derive that name from the term Ugari applied to the Magyars by the Sclaves. The Magyar population comprises several tribes distinguished as the Szekler, the Cumans, and the Jasiges. The Szekler, or Siculi, were the followers of Attila. After the dismemberment of the Hunnish empire, in the 6th century, they retreated to the eastern mountains of Transylvania, where they continued to live till the arrival of their kindred. The Cumans and Jasiges, on the other hand, repeatedly entered Hungary during the 12th and 13th centuries in the character of invaders, till at length they settled as friends. The entire Magyar population speaks the same language with some differences in pronunciation, and some provincialisms, as is the case in England, France, and almost every country. The Sclavonic population consists of several branches, speaking different dialects, the chief of which are the Slovaks, Ruthens or Russniaks, Rascians or Serbs (in German Raitzen), and Croats, the insignificant tribe of the Bulgarians, the Wends, Schokutz, and Montenegrins. The Slovaks and Russniaks belong to the northern Sclavonic stock, which comprises the Poles and the Czeches of Bohemia, while the Rascians and Croats belong to the southern Sclavonic family, the greater portion of which inhabits Turkey. All these Sclavonic races, with the exception of the Rascians, inhabited Hungary before the arrival of the Magyars. The Rascians came from Turkey about the year 1690, at the time of the victories of Eugene over the Ottomans. The German settlers called Saxons came to Hungary first, in the year 1143, having been invited by King Geysa II., by whom they were endowed with privileges and lands in Transylvania, and in more recent times, during the reign of Maria Theresa and Joseph I., though there were, no doubt, small numbers of them in Hungary previous to the Magyar conquest. The Wallachians or Roumins, who greatly resemble the Italians in physiognomy and language, were formerly known by the name of Petshengers, the inhabitants of Dacia, of which Transylvania formed a part. In the times of the Roman emperor Trajan, they became intermixed with the Roman colonists located beside the Danube, and hence their present language. The whole population of Hungary may thus be divided into four distinct races; the Eastern, comprising,—besides the Magyars, Jews, Armenians, and that most singular people, the Gypsies,—the Sclavonian, the Wallachian, and the Teutonic race.

Population. At the end of the great war in the beginning of the present century, the population of Hungary, Transylvania included, was 12,000,000, and, according to the last census, before the late war of 1848, it amounted to about 14,500,000. Of this number, 2,200,000, belong to Transylvania, and 490,267 to Croatia; the population of the military frontier being estimated at more than 1,000,000. With regard to the different races, the proportion is as follows:—

Magyars	5,418,773	Rusniaks	459,870
Slovaks	1,722,003	Wallachians	2,686,492
Rascians	1,293,995	Germans	1,273,677
Croats	943,995		

MINOR NATIONALITIES.

Jews	244,000	Greeks	5,000
Wends	40,000	Armenians	3,000
Bulgarians	12,000	Montenegrins	2,000
French	6,000	Clementines	1,600

The number of the Gypsies is variously estimated at 40,000 and 60,000. The different confessions are represented in the following approximate numbers:—

Roman Catholics	6,500,000	Calvinists	1,700,000
Greek Catholics	890,000	Lutherans	829,000
Non-United Greeks	1,800,000		

IN TRANSYLVANIA.

Roman Catholics	221,400	Calvinists	358,300
Greek Catholics	605,300	Lutherans	220,400
Non-United Greeks	725,700	Unitarians	44,600

Hungary. With regard to the relation of the races to the confessions, it may be observed that the Calvinists consist chiefly of the Magyars; the Lutherans, of the Slovaks and Germans; the orthodox and united Greeks, of the Rascians and Wallachs; the Roman Catholics, of about half of the Magyars and the rest of the Slavonic population and Germans.

The town population is estimated to form one-eighth of the inhabitants, a circumstance sufficiently proving the backward state of the country. The total number of towns in Hungary and Transylvania is 146; of boroughs, 881; and of villages, 16,450.

The character of the races is as different as their origin. The Magyars, both nobles and peasants, are marked by their Oriental pride and nobleness; by their love of liberty, hospitable customs, conviviality, and warlike spirit. Clinging with filial love to his superiors, the peasant—a gentleman in language and bearing—is, at the same time, alive to the sense of his own worth. In field labour and horsemanship, the Magyars surpass all the rest. The Sclavonians of North-western Hungary are mild, frugal, and industrious. The southern Sclavonians or Raitzen are, in character, very much like the Greeks, being, moreover, merry, warlike, and of a fierce disposition. The Croats partake more of the character of the Raitzen, than of that of the north-western Sclavonians; and as to the Germans, they preserve their usual traits of industry and peaceableness. The most neglected race is, perhaps, the Wallachians. Strongly resembling in physiognomy the Italians, a fact clearly verifying their intermixture with the Romans, they, like the Sclavonians, are bony, and of a tall stature, and are considered as one of the least active races.

The population in the principal towns and boroughs was in 1851 as follows:—

Pesth	106,379	Csoba	23,049
Buda (united to Pesth by a suspension bridge)	50,127	Mako	22,611
Debreczin	60,906	Temeswar	21,381
Presburg	42,178	Grosswardein	21,221
Szegedin	60,244	Arad	19,564
Vasarhely	33,090	Klausenburg (in Transylvania)	19,346
Keeskemet	32,308	Komorn	19,113
Kronstadt (Transylvania)	24,401		

The relation in which the different classes of the population stand to each other will be noticed hereafter in connection with the constitution at large.

History. The history of Hungary begins with the conquest of the Magyars, who united ancient Pannonia, Croatia, Sclavonia, and Transylvania into one kingdom. Previous to their arrival these countries were ruled over by petty princes, and inhabited chiefly by Sclavonians, Bulgarians, Wallachs or Roumins, and a few Germans, all of whom soon submitted to their new conquerors. The prevailing opinion assumes the Magyars to be the descendants of the ancient Scythians, and to belong to the Tartar-Mogulian stock; the ingenuity of antiquarians, however, has not been remiss in bringing up evidences of their relationship to the Parthians, Turks, and Finns. Some go even so far as to trace the pedigree of the Magyars to Japhet, confounding the word Magyarok (the plural of Magyar) with Magog. The Magyars are said to have wandered from the Ural Mountains to the Caspian Sea, and thence to Kiov possessed by the Russians, who succeeded in getting rid of their new masters by representing to them the fertility and beauty of Pannonia, the land of Attila. Divided into seven tribes, they arrived at the frontiers of Hungary in the year 889, under the leadership of Almus. At this juncture Almus died, and the chiefs of the tribes elected his son Arpad successor. From the foot of the Carpathians the followers of Arpad rapidly spread along the plains of the Theiss, crossing the Danube and occupying the banks of the Drave. From the date of the conquest to the year 1000, Hungary was ruled by dukes, royalty having been introduced simultaneously with Christianity a year afterwards.

The following is a chronological table of the Arpad dynasty which ruled over Hungary for upwards of three centuries:—

DUKES.

Arpad the Conqueror.	Taksony.
Zoltan.	Geysa.

Hungary.

KINGS.

	Years.
Stephan (St)	1000–1038
Aba and Peter (counter kings)	1038–1047
Andrew I.	1047–1061
Bela I.	1061–1063
Solomon	1063–1074
Geysa I.	1075–1077
Ladislaus I.	1077–1095
Coloman	1095–1114
Stephan II.	1114–1131
Bela II.	1131–1141
Geysa II.	1141–1161
Stephan III.	1161–1174
Bela III.	1174–1196
Ladislaus II. (counter king)	
Emeric	1196–1204
Andrew II.	1205–1235
Bela IV.	1235–1270
Stephan IV.	1270–1272
Laudislaus III.	1272–1290
Andrew III.	1290–1301

The following were the princes of the Houses that ruled Hungary from the extinction of the native dynasty to the commencement of the Hapsburg period:—

	Years.
Charles Robert (Anjou)	1308–1342
Louis I. (Anjou)	1342–1382
Maria & Sigismund	1382–1437
Albert of Austria	1438–1439
Elizabeth	1438–1442
Uladislaus	1442–1444
John Hunyadi (Gubernator)	1446–1452
Ladislaus Posthumus	1452–1457
Matthias Hunyadi or Corvinus	1458–1490
Uladislaus II.	1490–1516
Louis	1516–1526

The first century spent by the Magyars in Europe, then in its most enervated condition, was chiefly marked by their predatory expeditions. The shores of the Baltic, France, and Italy, all experienced the devastations of these swift horsemen, formidable for their archery and irresistible prowess. They received a check at the hands of Otho the Great, who defeated them before the walls of Augsburg in 955. A gradual change to a more peaceful life commenced during the reign of Geysa, who prepared the way for the introduction of Christianity by entrusting the education of his son Vaik to Adalbert, Bishop of Prague. On succeeding his father, Vaik determined upon assuming the regal title, and applied to Pope Sylvester II. for his consecration and benediction. His petition was granted, and he was crowned under the name of Stephan. It is to this first king that Hungary owed most of those institutions which survived down to the year 1848. Besides giving the country an ecclesiastical organization, Stephan divided it into counties, and laid the foundation of its municipal institutions. He also created a national council, consisting of the lords temporal and spiritual, and the *milites* or middle class nobility, and from this the subsequent Diets took their shape. The most important statutes enacted under his reign are contained in the Decrete of 1010. Stephan married Gisela, daughter of the emperor Henry II., an alliance which proved the source of much trouble after his death. Leaving no heir, as his only son Emeric preceded his father to the grave, the queen, assisted by the emperor, endeavoured to gain the throne for her cousin Peter, while Apa or Aba, an Arpadian prince, was proclaimed king by a part of the nobles. Both these princes having perished during the war, Andrew I. succeeded to the throne, but was soon compelled to yield it to his brother Bela I. Neither the reign of this king, nor that of his two immediate successors, offers anything worthy of remark. The reign of Ladislaus is remarkable in many respects. Besides repelling a Tartar invasion and vanquishing the Cumans, Ladislaus subdued Dalmatia and Croatia, and annexed them to the Hungarian kingdom (1078). Ladislaus was notorious for his religious zeal, which procured him the title of Saint. A ruler of much more talent was his successor Coloman, whose reign was contemporaneous with the first Crusades. But for the valour of this king, Hungary might have experienced the fate that befell the empire of the Palæologi, and been parcelled out among the Godfreys and Baldwins. Coloman issued several edicts, chiefly concerning the discipline of the clergy; and carried on a successful war against Venice for the possession of Dalmatia. Coloman died in 1114, leaving the throne to his son Stephen II., whose reign, like that of all those of the twelfth century, is barren of interest. The reign of Andrew II., called the Hierosolomitan, is famous for those wars of the nobles with the crown, which resulted in the grant, by the king, of the Golden Bull, the Magna Charta of Hungary. The chief provisions of this charter were as follows:—1st, That the states were henceforth to be annually convoked, either under the presidency of the king or the palatine; 2d, That no nobleman was to be arrested without being previously tried and legally sentenced; 3d, That no contribution or tax was to be levied on the property of the nobles; 4th, That if called to military service beyond the frontiers of the country they were to be paid by the king; 5th, That high offices should neither be made hereditary nor given to foreigners without the consent of the Diet. The most important point, however, was article 31st, which conferred on the nobles the right of appealing to arms in case of any violation of the laws by the crown. The other provisions contained in this charter refer to the exemption of the lower clergy from the payment of taxes and tolls, and to the determination of the tithes to be paid by the cultivators of the soil.

Hungary.

This Golden Bull was sworn to by all the subsequent kings of Hungary, including the fourteen of the Hapsburg house, but the 31st article was cancelled on the accession of Joseph, son of the emperor Leopold. It was promulgated by Andrew in 1222, shortly after his arrival from the Holy Land. He was succeeded by his son Bela IV., during whose reign Hungary was visited with the invasion of the Tartars under Batu Khan, who literally turned the country into a wilderness. The reigns of Stephan IV. and Ladislaus were chiefly marked by the wars waged against Ottoacer of Bohemia, who was engaged in hostilities with Rudolph, the founder of the House of Austria. With the assistance of Ladislaus, Rudolph defeated the Bohemian king at the battle of Lea in 1275. Amid fierce internal dissensions, caused by the Cumans, Ladislaus died, and was succeeded by Andrew III., the last of the Arpads. This prince had to turn his arms against the emperor Albert, who, irritated at Andrew's refusal to marry his daughter Agnes, had declared war against Hungary; and after defeating his adversary, ended by espousing the slighted Austrian princess. In 1301 Andrew died, leaving no issue, and there thus arose fresh and complicated wars.

The first phases of Hungarian history are thus obviously parallel to the contemporaneous annals of other countries, marked by internal dissensions between the dominant elements of society, or the claimants to the throne, and by religious wars. In social institutions, Hungary undoubtedly stood above the other states of Europe; and the only peculiar disadvantage under which it laboured consisted in the diversity of its population, and the great power which the clerical order had acquired.

After the death of Andrew III. three candidates aspired to the crown of St Stephan—Charles Anjou, nephew of Charles of Naples, and of Arpadian blood by his mother, who was daughter of Stephan IV.; Vencelaus, son of the king of Poland and Bohemia; and Otho, prince of Bavaria. Through the influence of Pope Boniface VIII. and the bishops, Charles Anjou or Carobert was raised to the throne. Under the reign of this prince, and especially of his son, Hungary made great progress in general culture, and extended its influence abroad; and while the blessings of peace were felt at home, the Hungarian sword held in subjection Bulgaria, Bosnia, Servia, Moldavia, and Wallachia. To this vast power, Louis, surnamed the Great, the son of Charles, added the crown of Poland, so that under his reign Hungary was the most formidable state of Europe. But by a strange fatality so strongly discernible in the annals of this country, this grandeur suddenly vanished, in consequence of the extinction of the male Anjou line. From a reverence to her father, the States, contrary to the rule, resolved upon raising Mary, daughter of Louis, to the throne, and, with her, her consort Sigismund of Brandenburg, son of the emperor Charles IV.—a determination pregnant with portentous events. It was soon after his succession to the throne that the Sultan Bajazet began to infest the provinces subject to the Hungarian crown, and to threaten Hungary Proper.

After gaining some victories over the Turks, Sigismund was completely routed at Nicopolis (1395), and obliged to fly the kingdom. During his absence, a party, headed by the palatine Gara, raised the standard of rebellion, and took him prisoner after his return. Scarcely was he released when he met with troubles in another quarter; having found a rival in Wladislaus, king of Poland, who had married Hedvig, the second daughter of Louis the Great. The circumstance of his having pawned the sixteen towns of the north called the Zips occasioned fresh discontent, and made them transfer their allegiance to his rival. After being elected Emperor of Germany and King of Bohemia, instead of providing for the safety of the country, Sigismund employed his time and resources in warring with the Hussites, and in presiding over the Council of

Hungary. Constance—satiating his impious zeal by condemning John Huss and Jerome to the flames. The learned Sigismund ended his inglorious reign in 1437, leaving a daughter of the name of Elizabeth, married to Albert, archduke of Austria.

After some misgivings the States proclaimed Albert king of Hungary, compelling him to confirm the privileges and rights of the country in a special manifesto resembling the Golden Bull. This Hapsburg king suddenly died, after a reign of three years. The States thereupon offered the crown to Wladislaus of Poland, and shortly afterwards the queen-dowager, the widow of Albert, was delivered of a son, called Ladislaus Posthumus. This was fresh cause for civil dissension, and, to add to the evil, Amurath prepared for another general invasion. The party of Wladislaus having triumphed and secured his coronation, he turned his arms against the Turks, already masters of the Danubian Principalities; and it was at this juncture that John Hunyadi, *alias* Corvinus, began to display those military talents which stamped him the first hero of the age.

The origin of Hunyadi is shrouded in mystery. The prevailing opinion is, that he was of Wallachian extraction, and the son of George Hunyadi, vayvod of Wallachia during the reign of Sigismund. As to his surname Corvinus, some derive it from his estate, Piatra di Corvo; others, from his ancestry. Having been nominated vayvod of Transylvania by Wladislaus, John Hunyadi met Amurath on the plains of Wallachia, and routing his army, compelled the Sultan to retreat. The Sultan then overran Servia; but here again the Janissaries were overpowered by the arm of brave Hunyadi. From Servia the Hungarians advanced into Bulgaria, conquered Nissa, and gained a signal victory before the walls of Sophia (1443). These victories inspired Pope Eugene IV. with the hopes of seeing the Turks chased from Europe; and, to accomplish the great work without delay, he formed a league with the King of Hungary, the Emperor John Palæologus, and the famous Scanderbeg, son of George Castriot, Prince of Epirus. The forces of these princes were, moreover, to be supported by a fleet, under the command of the Cardinal-Admiral Albert of Florence, destined to prevent the transportation of the Asiatic Turkish troops across the Hellespont. Apprised of these preparations, the Sultan sent ambassadors to the camp of Hunyadi with offers of peace; and, at the intercession of George, despot of Servia, peace was actually concluded for the term of ten years (1444). The Sultan, besides acknowledging the sovereignty of Hungary over Wallachia, bound himself to evacuate Bulgaria, and to restore all the Christian prisoners. The observance of the treaty, so advantageous and so needful to Hungary, was sworn to on the Gospel and the Koran. The Papal legate, Cardinal Julian, however, took care to have it turned into an immediate war. Besides representing the vast preparations made by the league, and the folly of losing the most favourable opportunity for entirely destroying the infidels (representations in themselves sufficient to shake the youthful and ambitious Wladislaus), the cardinal argued that the peace, inasmuch as it concerned all Christendom, and had been concluded without the consent of the Pope, was null and void; and, moreover, that no obligations could bind Christians to keep faith with the infidels. The cardinal's harangue produced the desired effect. Wladislaus bound himself by a solemn oath to begin the crusade the very same year. Hunyadi and Dracul, the vayvod of Wallachia, are said to have dissuaded the king from the expedition, but in vain.

Despite the advanced state of the season, and the disbandment of part of his Polish and Hungarian legions, Wladislaus took the field, and marched into Bulgaria towards Widdin. Here he awaited the Greek troops and Scanderbeg, as well as the arrival of the Italian fleet before Gallipoli. Abandoned by his allies, while, despite the fleet, Amurath safely landed his Janissaries at Gallipoli, Wladislaus determined upon a retrograde march, and encamped before Varna, which had been previously taken from the Turks. The rapid advance of Amurath having rendered farther retreat impossible, Cardinal Julian advised him to await the enemy within the walls of Varna; while Hunyadi, to whom the maintenance of a siege seemed impossible in consequence of the want of provisions and amunition, advised the acceptance of battle on the plain before the walls of the stronghold. The counsel of the vayvod prevailed. For three consecutive days and nights did the hostile forces combat each other without any decisive result. On the fourth day (the 10th November), Hunyadi, charging with his horse, twice put to flight the Janissaries. On this assault, Amurath, chafing with rage and terror, turned his back to the followers of the Cross, but was stopped in his retreat by one of his subordinates seizing the bridle of his charger. Meanwhile, two of the Hungarian bishops, as well as the king himself, despising the orders of Hunyadi, whose undisputed laurels they envied, left their position and rashly pursued the flying enemy, a movement which turned the day in favour of the Crescent. Wladislaus paid the penalty of his rashness with sudden death, having been cut down by the sabres of the Janissaries; and his death at once became the signal of panic and ruin to his army. Hunyadi alone, with a few followers, escaped the carnage. Cardinal Julian, the author of this perfidy, was also among the slain. Hungary.

The battle of Varna made the Sultan sole master of Servia and Wallachia, while the surrounding powers contrived to profit by the misfortunes of deceived Hungary. Venice attempted to conquer Dalmatia and Croatia; the Poles invaded Moldavia; the emperor Frederick III., the guardian of Ladislaus Posthumus, ravaged the provinces adjoining Austria. Frederick even refused to give up his ward to the Hungarians to be acknowledged king, and to hand over the crown of St Stephan, which had been left with him for safety. Amid these troubles the States proclaimed Hunyadi governor of Hungary. The first task of the governor was to wrest the young prince from the hands of the emperor by force of arms; but the incursions of the Turks rendered this undertaking for a time impossible. Pope Nicholaus, through his legate Cardinal St Angelo, repeated the promises of his predecessor; but Hunyadi was too sagacious implicitly to confide in the support of the Roman see. Having, with the aid of the Papal legate, concluded a truce of two years with Frederick III., he turned with all his energy against the Turks; but his expectations of victory were disappointed by the treachery of George, despot of Servia, who went over to the camp of the Mussulmans. It was in consequence of this defection that Hunyadi lost, in 1450, the battle of Kossova (Campo Merulæ), in which 8000 Hungarians and 34,000 Turks are said to have fallen. It need hardly be observed that the Papal promises proved an idle phantom. Pope Nicholas attempted to palliate his inaction on the ground that the Greeks, most concerned in the war, had refused to subscribe to the union-scheme prepared at the Congress of Ferrara.

In 1452 the emperor at last agreed to release Ladislaus Posthumus, who was greeted by the general acclamations of the Hungarians. Hunyadi, having resigned his office of governor, was nominated generalissimo by the king. The terror that seized Europe after the capture of Constantinople by Mohammed II. seemed to convince both the Pope and emperor of the necessity of assisting Hungary; and while the former issued an indulgence to crusaders, the latter convoked the German States at Regensburg, where 10,000 horse and 32,000 foot were voted against the common foe; a number more numerous than Hunyadi had expected. The Pope's indulgences, however, were too cheaply estimated; and the German levy did not go beyond the written resolutions. Exhausted Hungary was again left alone to fight the battles of Christendom. Slighting now his triumph over Bysanz, Mohammed set about preparing for the conquest of Hungary, and in 1456 he appeared before the walls of Belgrade with an army of 150,000 men. The garrison, under the command of Michael Orszag, numbered but a few thousands; the Papal indulgences, promised to every one who should serve for six months, proved for the most part fruitless; and, in addition to this, the king, admonished by Hunyadi to make speedy preparations, fled in dismay to Vienna. The generalissimo, left to his own resources, raised a force of 10,000 troops at his own expense; and to these were added a few thousand men that followed the cross of John Capistran, a Mennonite monk. It was chiefly with these forces that Hunyadi hastened to the relief of Belgrade. It is not here the place to dwell on a defence on which the fate of Europe hung; it is enough briefly to state that, after a siege of several weeks, the haughty Ottoman conqueror, after leaving about 24,000 slain, saw, on August 4, 1456, his lines broken and his soldiers flying precipitately to Adrianople. Excessive fatigue brought on the hero, immediately after this victory, an illness from which he died at Semlin on the 10th of September. He left to his country two sons, Ladislaus and Matthias, the former of whom was cruelly Hungary.

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executed by the orders of King Ladislaus Posthumus, while the latter was destined to reach honours and fame higher even than those of his father.

After the victory of Belgrade, the king returned from Vienna, and soon afterwards died at Prague. The subjugation of the Turks now became the common ground on which the rival princes built their hopes of the vacant throne. The three great rivals were the impotent Emperor Frederick, who held in his hands the crown of St Stephan; Casmir of Saxony, brother-in-law to the late king; and the King of Poland. Each of these candidates found adherents among the reckless and corrupt oligarchs, but they became the especial support of the Hapsburg emperor. At the head of his party stood Dionisius, archbishop of Gran; the palatine Gara, a sworn enemy to the Hunyadis; and Nicholas Ujlak, vayvod of Transylvania. The more patriotic of the nobles, longing for a native ruler, spontaneously turned their eyes to Matthias, the younger son of John Hunyadi, who had marvellously escaped the fate of his elder brother. Treacherously carried away from Buda to Vienna by Ladislaus Posthumus, Matthias, but fourteen years old, was conveyed to Prague, where he arrived just at the death of the Hungarian king. At this juncture he was rescued by Podiebrad, who was about to ascend the throne of Bohemia, and, as afterwards appeared, aimed at making the young Hunyadi his son-in-law.

The party of Frederick were masters of the fortress of Buda, and in their confidence issued writs for the assembling of the diet. The Hunyadi party found an able leader in Michael Szilagy, uncle to the young Matthias, and an army of 40,000 men stood ready before Pesth to support the cause of the young king. A sudden severe frost which covered the Danube with a thick sheet of ice, and thus facilitated the approach of Buda, turned the scale against the Hapsburg emperor. On the 24th of January 1458, the diet proclaimed Matthias king of Hungary, and declared Szilagy governor during his minority. A deputation immediately repaired in great pomp to Bohemia, and recovered Matthias from the hands of Podiebrad, who was presented with 60,000 ducats, and had the satisfaction of seeing his favourite marriage scheme realized.

All chroniclers agree in describing the tumultuous joy that was manifested in Buda-Pesth at the arrival of the boy-king. Though but fifteen years of age, Matthias spoke—besides Hungarian—Sclavonic, Bulgarian, German, and Latin, and understood almost every other European language. His father used to employ him as his interpreter and secretary, having been famous when a boy for his excellent writing at a time when (as a German historian of Hungary, whom we now follow, says) the vayvods and other high officials could hardly sign their names. To these accomplishments, and an acquaintance with the classics, Matthias added the talents of an impressive orator, and also of an able general. Simply in consequence of the hopes entertained of him as a warrior, the papal legate in Hungary, John of St Angelo, exerted his influence in favour of the Hunyadi party.

The Emperor Frederick, determined to dispute the Hungarian throne with Matthias, openly assumed the title of King of Hungary (1459); but after being defeated by the Hungarians, he agreed to an armistice, which Matthias employed in marching against the Turks, who were ravaging the Danubian Principalities, Bosnia, and Servia. Having compelled Mohammed II. to evacuate those provinces, Matthias again turned his arms against the emperor, and compelled him to conclude a peace in 1463, renouncing all claim to the dominion of Hungary, and delivering up to the Hungarians the crown of St Stephan. One of the conditions of this peace is said to have been, that in case of Matthias dying without issue, the right of succession should revert to the emperor, or his son Maximilian.

After this peace, Matthias again turned his arms against the Turks, having previously reorganized the military system of the kingdom. In room of the privileged commanders of the fortresses, he appointed men experienced in the art of war; and in place of the somewhat lawless irregular horse, he determined to make the foot soldiers the pivot of his strength, and among these the most famous were the Armigeri, *alias* the Black Legion. From the irregular horse he formed the hussars, a species of light cavalry, subsequently enrolled in almost every European state. All these troops were drilled by the king in person, inspired with a feeling of honour, and assured of meeting with due distinction. The Armigeri, as it appears, were in his camp what the tenth legion was in that of Cæsar, a succour for the archers. These changes being effected in the military system, Matthias began to turn his attention to the state of education. He founded a university at Buda calculated to afford accommodation for 40,000 students, and provided with a library of 55,000 volumes, bearing the name of Corvina, and possessed of many valuable manuscripts bought from Greek scholars who had fled from Constantinople, or such as were copied in different parts of Italy. To this was soon added a typographical establishment. But amid these occupations the hero king was summoned to the field.

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Mohammed, who vowed to unfurl the banner of the prophet on the ramparts of Belgrade, invaded Moldavia in 1466, after having come to a secret understanding with the vayvod Stephan; but here too the Hungarian arms were triumphant. Mohammed now sent ambassadors with offers of peace, while the papal legate was endeavouring to persuade Matthias to a war against Podiebrad and the Hussites. When it was deliberated in the diet, whether the continuation of the Turkish war or a war against the Bohemians was preferable, the prelates pronounced for the latter, and so did the king. Matthias thus undertook a war against Podiebrad, his former father-in-law, already excommunicated by the pope, announcing, however, in his proclamations, that he took up arms only to defend the rights of the Catholics against the Hussites. The Emperor Frederick secretly designing to secure the Hungarian throne for his son Maximilian, fanned the ambition of Matthias, whose armies marched from victory to victory, and in a few weeks conquered three kingdoms. Accordingly, in May 1469, Matthias caused himself to be proclaimed, at Olmutz, King of Bohemia and Moravia, and received, a few days afterwards, the homage of the Silesians at Breslau. Meanwhile, the Turks repeated undisturbed their incursions in Bosnia and Croatia, a circumstance which created in Hungary a party against the king, who was opposed in Bohemia by the king of Poland. Returning to his kingdom, and restoring order within, Matthias again marched to gain fresh laurels in conflict with his old foe. A most bloody battle was fought in Transylvania, on the banks of the Marosh, in 1479, where about 100,000 Turks, under Ali Beg, were defeated by Stephan Batory and Paul Kinisy. The victors, says a chronicler, celebrated a great feast on the battle-field—Paul Kinisy, a man of prodigious strength, having danced while holding a slain Turk between his teeth. Amid these victories Matthias celebrated his second nuptials, having married Beatrix, daughter of Ferdinand of Naples. The death of Mohammed, which happened in 1481, was an event calculated to relieve Hungary from all apprehensions, and to re-establish general peace, when the war with the emperor, encouraged by Pope Sixtus II., was rekindled. To this pope, who counteracted his designs on Veglia, in Dalmatia, and raised a rival to the bishop of Mordusch, nominated by himself, Matthias had the courage to threaten that Hungaria would exchange the double cross with the triple one, or that it would nominate a patriarch to herself. Pope Innocent VIII. Matthias defied by keeping in prison the Archbishop Varda. With the renewal of hostilities the Hapsburg monarch was destined to undergo most unexpected misfortunes.

After a siege of four months, Vienna opened its gates to Matthias (June 1485), and the emperor was obliged to roam in disguise from village to village. Matthias entered the capital of the Hapsburgs at the head of 8000 troops. The conquest of Austria so much heightened the credit of Matthias with the Turks, that Sultan Bajazet despatched to him an embassy, bearing the congratulations of their master, and followed by ten camels laden with presents.

Despite all the efforts of Frederick and his German allies, Matthias made Vienna for five years the seat of his government, and died there on the 22d of April 1490, in the forty-fourth year of his age, and thirty-third of his reign. Besides the Italian Galeotti, this powerful monarch of Hungary found his panygerist in Bonfinius, the author of *Decades IV. Rerum Ungaricarum*, both of whom have recorded many an anecdote and trait of private life, highly characteristic of their hero. During his reign Buda was the seat of many men of letters, whom he distinguished by peculiar favours, and who were mostly members of the two Hungarian learned societies established under his care.

At the death of Matthias the competitors for the Hunga-

rian crown were John Corvinus, a natural son of Matthias, the Emperor Frederick, his son Maximilian, and Wladislaus II. of Poland. The States declared for the last, whose inglorious reign is worthy of mention for the collection then made of the laws of the realm, and their sanction by the king and the States in 1514. This code is known as the *Tripartium Opus Juris Consuetudinarii inclyti Regni Ungariæ.* Some supplements were made to it in 1628, all of which were afterwards merged in the *Corpus Juris.*

After his death Wladislaus was succeeded by his son Louis, under whose short reign Hungary hastened fast towards destruction. The ambition of the oligarchs, no less than the carelessness of the king, left the frontiers unprotected, and that at a juncture when Soliman the Magnificent, the most powerful of Ottoman emperors, commenced his career. Having captured Belgrade and Petervardein, Soliman advanced at the head of 200,000 men into the interior of the country. This formidable force the weak king, idly confiding in the assistance of his brothers-in-law, the Emperor Charles V. and Ferdinand, had the rashness to meet with 25,000 men. The Turks lay encamped on the plain of Mohacs, near a town of that name, situated between the Danube and the Drave. After three days' skirmishing the archbishop of Kolosa, Paul Tomory, urged a general attack, and within an hour and a half the kingdom of Hungary lay in the dust. The king, two archbishops, five bishops, 500 of the higher nobles, and almost the whole army, perished in the carnage. This battle took place on the 29th of August 1526. After this victory Soliman marched onwards, captured Buda, where all that told of the fame of Matthias Hunyadi fell a prey to the blind rage of the Janissaries, and turning homewards, dragged in his train tens of thousands of prisoners.

We have now arrived at the point when the *quasi* Hapsburg reign commenced in Hungary, an event which proved the cause of wars for nearly two centuries. Before proceeding in our narrative, however, we shall briefly refer to the constitutional part of the history; and to preserve unity, we shall also add the fundamental laws enacted during the subsequent, or Hapsburg period.

Constitution.

Like the constitution of England, that of Hungary is the work of ages, the aggregate mass of consuetudinary and written laws or acts of parliament.

The right of succession belonged, from the very establishment of the Arpad dynasty, to the male line, though with the extinction of that line, and the accession of the Anjous, the States departed from the rule which excluded females from the throne. In the year 1687, the Emperor Leopold, under general terror, exacted from the States an acknowledgment of the right of both male branches of the House of Austria. In 1723 the Emperor Charles, who had no male issue, carried the point still farther, having brought the diet to acknowledge the hereditary right of the female line, and thus secured the Hungarian throne to his daughter Maria Theresa, and her descendants, in the order of primogeniture and lineal succession.

The exclusive privileges of the king are the right of nomination to the offices of state, of conferring titles of nobility, and convoking and closing the diet. The king, moreover, nominates the archbishops, bishops, and abbots; he may establish and endow new bishoprics, and appropriate to the regal chancery the revenues of vacant sees, dispose of Church property, abolish convents, and fix the number of the friars. He has the right of superintending the schools and nominating the teachers to the Catholic schools. By the *jus placeti* the king is empowered to regulate the intercourse of the prelates with the See of Rome, he regulates their oath of allegiance to the pope, and without his consent no bulls or briefs can be published. The legislative power is common to the king and the States, viz., the prelates, titled nobility, high officials, and the nobles. Among the barons of the realm the first in rank is the palatine, the second, the chief judge or *judex curiæ*, the third, the ban of Croatia, the fourth, the chancellor. By the concordat concluded in August 1855, the Emperor Francis Joseph surrendered to the pope the most essential privileges of the Church. This concordat transferred to the pope the right of nominating the archbishops, of forming new and changing existing sees, of administrating the estates of the Church, of superintending the schools through the bishops, and finally, authorized the direct communication of the bishops, clergy, and people with the papal chair.

The functions of the palatine, whose office dates from the earliest days of Hungarian history, are as follows:—He is the judge or mediator between the king and the people, the guardian of the minor kings, and regent during their minority and absence, president of the house of lords and the *chancellery*, commander-in-chief of the army, lord-lieutenant of the county of Pesth, and judge of the Cumans and Jaziges, a privileged portion of the Magyars. In 1608 it was enacted that, at each election of a palatine, the king must propose four candidates, two Catholics and two Protestants, from which the election is to be made by the diet. By another article of 1741, the office of the palatine can not remain vacant for longer than a year.

The *Judex curiæ* is the first member of the Septemvir Court and the Court of Chancery, and is president of the Upper House in the absence of the palatine.

The Ban is the hereditary chief of the border regiments (the borderers in general having a special commander), and president of the Banat court.

The Chancellor is member of the Septemvir Court, and presides over the Upper House in the absence of the palatine and *judex curiæ.* The barons immediate in rank are the two keepers of the crown. The other members composing the States, *ordines regni*, are the Roman Catholic prelates, and, since 1792, the bishops of the non-united Greeks; the lord-lieutenants of the counties, the magnates, the lower nobles, and the royal towns, each of which is equivalent to one noble.

By the law of 1791, confirmed in 1827, the diet must be convoked at least once every three years.

In former days the diet used to be held mostly on the plain of Rakos, near Pesth, or in Weissenburg, where the former kings used to be crowned. But since the accession of Ferdinand of Austria in 1527, Presburg was chosen as the seat of the diet, because, on account of its proximity to the Austrian frontiers, it offered the greatest security to the Austrian party. It was about that time that the legislative body became divided into two Houses, or, as they are commonly called, two *Tables.*

The bishops, high officials, magnates, and barons compose the Upper House; the lower nobility, who form the Lower House, do not attend in person, but are represented by their deputies, elected in the respective counties, which are fifty-two in number, each county sending two deputies to the diet. The free towns had also each a deputy at the diet, but their influence was merely nominal. The three Croatian counties included in the above number, however, chose, according to custom, their representatives, three in number, in a common congress. Of these one is sent to the Upper, and the other two to the Lower House. Transylvania has its own diet.

The initiative belongs partly to the king, and partly to the Lower House, though the royal proposals usually take the precedence. The Upper House has only the privilege of the veto or rejection, and in case of a lengthened disagreement between the two bodies both Houses meet together. Since the end of the last century the deputies of the four districts, into which Hungary is divided, used to meet separately in what was termed *circular sittings*, for the preliminary discussion of the questions, till by degrees all came to meet together, thus ascertaining beforehand the fate of every motion. Some writers have erroneously mistaken these circular sittings for separate chambers.

The diet of Transylvania (which, as may be seen from our narrative, maintained its independence against the Austrians till the end of the seventeenth century) is formed on the same model. As in Hungary, so here, the peasantry, consisting chiefly of the Wallachs, were excluded from all participation in the legislature, the diet having been composed of the Magyars, the Saxons, and the Szekler or the Magyar borderers. This abuse was here, as in Hungary, removed in 1848.

Much more efficacious than the diet against the usurpations of the crown was the internal organization of the counties, resembling, in many respects, the Swiss cantons. Next to the lord-lieutenant, the nominee of the crown, each county was governed by two sheriffs, elected by the nobles for the term of three years, and who, in the absence of the lord-lieutenant—a common occurrence—alone managed the public affairs. Besides preserving public order and administering justice, the sheriff or vice-lord-lieutenant presides over the county meetings, which are convoked several times a-year, and are of especial importance during the sittings of the general diet. The

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grievances of the county are here debated with more freedom than in the diet; and here are also prepared the instructions sent to the members of the diet, who, if not fulfilling their trust, are recalled. The most important feature in the county institutions, however, was the *vis inertiæ*, or the privilege of passive resistance to illegal orders, sent by the chancery or the other high courts of administration. It was this inert power that, till 1848, often proved the sheet-anchor of the Hungarian constitutions.

Next to the counties, and besides the royal towns, which are independent of the counties with regard to their internal administration, there are several privileged districts, whose inhabitants are exempted from all those burdens which, to the year 1848, were borne solely by the peasants. The military frontier, or that narrow tongue of land which extends along the Turkish frontier, as may easily be conceived, has an organization of its own, to which we shall return when speaking of the military force of Hungary.

Above all these political and civil subdivisions there were two central courts at Buda, and a separate chancellery at Vienna, whose sphere extended over the political, ecclesiastic, and financial and administrative departments at large. The evil effects of these irresponsible organs of general administration having of late years become more and more deeply felt, the final consequence was, that in 1848 King Ferdinand V. was obliged to comply with the wishes of the diet, and nominate an independent responsible Hungarian ministry. This compliance on the part of the Hapsburgs (as it will be found in its proper place) gave rise to instant war, which, after having been brought to an end by Russian intervention, resulted in the entire subversion of the fundamental laws of Hungary. To return to the political and social description.

The feudal privileges having exempted the nobles from participation in the public burdens, the whole weight consequently fell on the peasantry, the *misera plebs contribuens*. Besides the feudal labour called robat which he had to perform to his master, the peasant had to pay the military-tax, to supply the house-tax, from which the expenses of the administration of the counties were defrayed, to repair the roads and bridges, to give quarters to the soldiers, to convey, for a nominal price, the county officials or military officers, to pay the ministers and schoolmasters, and lastly, to give one-ninth of his produce to his landlord, and tithes to the Catholic clergy, even although a Protestant. An earnest cry against this evil was raised only within the last twenty-five years, and in 1848 the liberal party at last triumphed, both the court and prelates having felt obliged to sanction the abolition of feudalism.

Churches.

As regards the ecclesiastical institutions, they may chiefly be divided into three distinct parts—the Roman Catholic, the Protestant, and the Non-United Greek.

The Roman Catholic Church counts three archbishops and seventeen bishopries. The foremost among the prelates is the archbishop of Gran, the primate of Hungary. Since 1452 he has borne the title of *legatus natus* to the see of Rome, and since 1715 that of prince, and is moreover by right the lord-chancellor of Hungary, and lord-lieutenant of the county of Gran. It is his privilege to crown the kings of Hungary, while the archbishop of Vesprim claims the right of crowning the queens. In influence, however, the Roman Catholic bishop of Transylvania comes next to the primate. The united Greeks form one body with the Roman Catholics, and have four bishops. Each bishop has his own consistorium.

The Protestant or Lutheran Church is divided into four superintendencies, consisting of several seniorates or sections of a certain number of communities, and these in turn have each their inspector, and the right of electing their own pastors. Besides the ecclesiastical superintendent or principal, each superintendency has its lay-curator. The annual meetings of the Protestants are held at Pesth, under the presidency of a chief inspector. The internal organization of the Calvinists is with slight differences, and those also rather nominal, similar to that of the Lutherans. Since the end of the late war the Austrian government deprived both the Protestant churches of their liberties.

The head of the Non-United or Orthodox Greek Church is the archbishop and metropolitan of Carlovitz, who is chosen in a congress, and whose election must be confirmed by the king. This church counts seven bishopries, viz., at Temesvar, Verscez, Arad, Old Buda, Neusatz, Pakratz, and Karlstad.

The number of the ministers of the different confessions was, according to the latest census, as follows:— Hungary.

Roman Catholics	9734	Calvinists	1812
United Greeks	890	Lutherans	648
Non-United Greeks	2830		

Army.

According to ancient usage and laws, the military force of Hungary consisted of three different elements—1. The borderers, who date from the earliest days of Hungary, and who were again reorganized during the reign of Ferdinand I.; 2. The regular army; and 3. The levy of the nobles, who in times of danger took the field *en masse*, which was known by the name of *insurrectio*. The organization of the borderers, where every man is a soldier, is mixed up with a sort of patriarchal rule. Each family, though consisting of several members, occupies what is called one border-house, to which a small tract of land is allotted, and the management of which is carried on by the *pater familias*, no longer fit for military service. Every borderer is liable to be called to duty wherever the king pleases, though in general the service is confined to the *cordon* or the watching of the frontiers. And in such cases the borderer must be fed and clothed by his own family, in consideration of which it is entitled to an annual deduction of twelve florins from the taxes. The whole force consists of fifteen infantry and one cavalry regiment, besides a battalion of pontooners, called chaikists, and makes in times of peace a total of 46,000 men. On a war footing this force was capable of considerable increase. The number of men constantly employed at the cordon and quarantine averages between 4000 and 6000.

The regular military force of Hungary consists of thirteen (infantry) regiments of the line, besides the two Transylvanian and eleven hussar regiments, each infantry regiment numbering above 3000, and each cavalry regiment about 1800 men. The total military force is thus above 100,000.

In process of time the regular military force of Hungary became entirely merged in, and assimilated to, the Austrian army, the States contenting themselves with exercising the right of voting recruits, and fixing the term of service, which since 1830 was limited to ten years. Their gross and palpable neglect is shown in the fact that they quietly allowed Austria to carry on that subtle game by which the Hungarian troops were carried abroad, and foreign regiments introduced. The reforms of 1848 have done away with this antiquated abuse. The most important fortresses are Comorn, on the Danube, between Pesth and Presburg, Petervardein, also on the Danube, Arad on the Marosh, Temesvar, Ejsek, and lastly Buda, strong by nature. The most important fortress in Transylvania is Karlsburg. Transylvania forms a fortress in itself, and only a few narrow passes afford a passage through its mountain ramparts to an invading army. The principal passes are the Bozza, which leads to the Bukowina, the Ojtos, leading to Moldavia, the Törzburg, Tömös, and Red Tower passes, which communicate with Wallachia. It was through these last-named passes that the Russians penetrated in 1849. Mention must be made of the Dukla pass, leading from Galicia into the north of Hungary, and through which Prince Paskiewitsch came with the guns of the Russian army.

Having thus described the constitutions of the country, we shall now rapidly survey its resources. Resources.

The fertility of the Hungarian soil, and the variety of its produce, are universally known. Besides the different species of corn and maize, raised in great quantities, Hungary produces hemp and flax, various kinds of delicious apples, pears, and plums; two sorts of melons, rich crops of tobacco, and lastly, a great variety of wines; while the vast pastures and oak woods afford ample sustenance to herds of horned cattle, sheep, and swine. It is assumed, that with the aid of modern improvements in agriculture, and a little more industry, it could abundantly sustain a population twice as large as it actually possesses. The badness of the roads, the neglected state of the rivers, which, besides being closed to navigation, entail great losses by annual inundations, no less than the feudal institutions, and prohibitive system of Austria, all contributed to keep agriculture in a backward state, so that the vast produce may be said to come from the hand of nature alone. The home of the wheat is the Banat, and the counties of Bacs, Baranya, Simia, Arad, and Borsod. Rye is raised chiefly in the north among the Slovaks; barley, oats, and maize, in different parts. The last occupies an important place in the Hungarian harvest. With some of the Sclavonian population, such

as the Croats and Rascians, and the Wallachs, maize bread is a great favourite.

Melons are raised in gardens and the open field, occupying sometimes continuous tracts of land of 100 acres. Of the water-melons the most famous are those of Heves, of more than two feet in diameter. The yellow or sugar melons are generally of a much smaller size. Tobacco grows almost everywhere, and greatly varies in flavour; the Csetneker of the county of Gömör, the Verpeleter and Debroer of Heves being the most highly prized. The annual crop is upwards of 650,000 cwts. Potatoes form but a secondary article in Hungarian economy.

Among the vine hills and gardens, cultivated since the thirteenth century, and which occupy no inconsiderable part of the Hungarian soil, the most valuable is the Hegy-alja, or southern promontory of the Carpathians, and which comprehends the Tokay mountains situated round the town of that name. The whole promontory occupies above 50 English square miles, of which only one-third is under cultivation. The Tokay wine is of a crystalline yellow, and sometimes greenish colour, and is known under two names, the *Ausbruch*, the stronger, containing more of the essence, and the *Maslas*. The whole annual produce is 180,000 gallons. Next in rank to the Tokay is the Menes, a red wine of the county of Arad; and inferior to it, though by no means inferior to Burgundy, are the red wines of Erlau, Szeksard, Villany, and Buda. Among the yellow table-wines, particular mention may be made of the Nesmeler, Somloer, Badacsoner, and Ermeleker. The county of Simia is, moreover, particularly famous for its red wines, the most known of which is found on the Fruska Gora mountain. No less famous are some of the Croatian wines, marked by a spirituous flavour, as well as the wines of Transylvania. The total produce of wine, Transylvania not included, is estimated at 328,748,000 gallons.

Animals. The animal kingdom exhibits no less abundance. The Hungarian oxen are the largest breed in Europe. They have a grayish white skin and long straight horns. The largest herds graze on the wide pastures situated between the Theiss and the Danube. The original Hungarian horse, marked by its middle size, broad neck, and compact build, is now only to be found in some parts of Transylvania. The introduction of English full-blood stallions by several of the magnates, has of late years ennobled the breed, and the general improvement has been hastened by the royal studs at Mezö-hegyes and Babolna. Of late years much progress has been made in the breeding of sheep, though the first step dates from the reign of Maria Theresa, when the Merino was, for the first time, imported into Hungary. The oak-woods pasture large herds of swine, part of which arrive annually from Servia, Bosnia, and the Danubian Principalities, for the purpose of being fattened, and thereafter exported to Austria. Mules, asses, buffaloes, and goats, are only to be found in very small numbers. As the war of 1848 made a great havoc in the animal kingdom, the census of 1850 cannot afford a fair representation of the capabilities of the country. We shall therefore give here the statistics of the year 1840, which stood as follows:—Horses, 1,000,000; horned cattle, 4,260,000; sheep, 17,000,000; hogs, 4,000,000. In Transylvania, the numbers were these:—Horses, 397,388; horned cattle, 800,000; sheep, 2,000,000; hogs, 350,000. To this abundance must be added a great number of domesticated fowl, especially geese and turkeys, and a variety of game, such as ducks, partridges, pheasants, &c. The rivers abound in carp, pike, and sturgeon—the Theiss being reckoned the richest; the peculiar Hungarian fish called *fogas*, is only found in the Balaton Lake, or Platton-see. Some of the waters yield trout, and large quantities of leeches.

The approximate amount of the productive soil, both in Hungary and Transylvania, in the latter of which the forests form more than one-half, is, according to the Austrian official tables, 40,200,000 *joch*, or 57,204,600 English acres, of which 10,131,760 belong to Transylvania. The relative division is as follows, in English acres:—

	Acres.		Acres.
Soil under tillage....	22,651,438	Pastures.....	5,662,299
Vineyards.....	1,659,962	Forests.....	15,880,680
Meadows.....	5,711,773		

In the above numbers is not included the military frontier, the productive soil of which occupies about 6,000,000 acres; the forests forming one-third. The produce in corn is—Hungary, 281,000,000 bushels; Transylvania, 30,000,000; military frontiers, 12,000,000; total, 323,000,000 English bushels. The value of the natural products is estimated at L.29,000,000, while the value of the crops in England and Wales is estimated by M'Culloch to be only L.83,656,071.

Let us now glance at the mineral kingdom. The mountains, which are partly worked by the government and partly by private enterprise, contain metals of almost every kind, viz., gold, silver, iron, copper, lead, antimony, zinc, alum, orpiment, tellurium, and many other minerals, besides coal and salt. In the neglected state in which the gold mines are kept, the produce is only about 2400 marks. The silver mines yield 65,000 marks. Of great importance are the copper mines in the Banat; the richest vein, however, is at Schmölnitz. Those in Transylvania, at Damokos and Deva, yield 1200 cwts. The produce of lead is estimated at 26,000 cwts. The iron mines are found chiefly in the counties of Gömör, Sohl, Ung, and Zips; the average produce of the former being 250,000 cwts. The richest rock-salt mines are in the county of Marmoros, and the total produce amounts to upwards of 800,000 cwts., a quantity which, however great, is far from sufficient for the wants of the country. Several places yield also soda, saltpetre, alum, and potash. Pit coals, which, till very lately, and before the introduction of railways, had been entirely neglected, lie in deep formations almost unwrought. The total produce is 1,000,000 cwts. The value of the mineral produce in Hungary is L.872,000, that of Transylvania, L.169,000; the military frontiers yield almost nothing in this respect. It must be added, that Hungary possesses also precious stones and marble of various descriptions.

The chief articles of manufacture are cloth, linen, and silk stuffs, carpets, leather, iron wares, and chemical products, including alum, saltpetre, and potash manufactures. All these are as yet in an incipient state, especially cloth manufacture, if it be considered that in wool Hungary is the richest country in Europe. Linens are chiefly manufactured in the north. The county of Zips produces about 6,000,000 yards. The largest silk manufacture is at Pesth, giving employment to between 400 and 500 men. Of greater extent are the leather manufactures; but even of this article much is imported. The most productive iron works are in the county of Gömör, among which are particularly distinguished the manufactories of Pohorela, and Vorosko, belonging to the Prince Saxe-Coburg. The whole iron produce of Hungary is estimated at 500,000 cwts. per annum, half of which belongs to Gömör. In several counties there are potteries and glass-works, as well as powder-mills; and also clay-pipe works, some of which, as at Debreczin and Papa, produce 20,000 bowls weekly. Soap is chiefly manufactured in Szegedin, Kecskemet, and Debreczin, the last of which produces 7000 cwts. annually. The distilleries are mostly in the north among the Sclavonic population; and the breweries, 300 in number, are situated round the large towns of mixed population, as beer is no favourite drink with the Magyars. Sugar refineries have also of late risen in several parts of the country; but this article also requires importation. The cigar manufactories, introduced within a very recent period, had imparted a new impetus to the cultivation of tobacco; but the introduction of the tobacco monopoly at the end of the late war, at once extinguished this branch of industry.

The inferiority of the roads, only compensated to some extent by two railway lines, and steam navigation on the Danube and Theiss, but especially the restrictive commercial system of Austria, sufficiently account for the insignificance of Hungarian commerce, both foreign and internal. The centre of commerce is the capital, Pesth, situated on the banks of the mighty artery of the kingdom, the Danube. The chief feature of internal trade is the exchange of products between the northern and southern districts; the former sending to the south minerals and timber, and the latter carrying to the north grain and cattle, an intercourse facilitated by the great number of rivers navigable to vessels and boats of small freight. The annual fairs held at Pesth mark the culminating points of commercial activity, the chief marketable article being wool, of which, according to Fenyes, upwards of 120,000 cwts. are sold annually. The other towns of commercial importance are—in the south, Becse exporting to Austria; Fiume, the Hungarian littorale, and Semlin, communicating with the Turkish pro-

vinces: in the west, Waitzen and Presburg; in the north, Koshau and Eperies.

Exports.

The following details, collected by Fenyes, will give a general idea of the extent and progress of the foreign commerce during the five years immediately preceding the late war:—

Exports in 1840.	Cwts.	Exports in 1845.	Cwts.
Wheat	1,313,626	Wheat	2,408,118
Rye	190,770	Rye	942,013
Barley	201,194	Barley	364,614
Oats	488,639	Oats	782,812
Wool	237,740	Wool	214,446
Tobacco	336,473	Tobacco	211,625

The number of exported cattle in 1845 was 106,230, that of hogs, 352,440. The total value of exports that year was estimated at 71,735,683 florins, which, at the rate of ten florins to a pound, is equal to L.7,173,568.

Imports.

The value of imports, both from Austria and other countries, was, in the same year, 68,514,437 florins, or L.6,851,443. Foreign countries, it must be added, enter only for one-fourth of this intercourse, the rest belongs entirely to the Austrian dominions. Since the end of the late war the custom-duties between Hungary and Austria have been abolished. In how far this change has hitherto affected the commerce of the former would, in consequence of its abnormal political state, be difficult to decipher, even if the requisite data had been made public. As difficult would it be to form a sure estimate of the revenue and expenditure of Hungary since the late war, as both rest on momentary arbitrary measures undertaken either as precautions against revolution or in consequence of the periodical sickness of the Austrian finances. Ample data, however, are extant as to the public revenue and expenditure of Hungary before 1848. The chief sources of revenue up to that date were—the house-tax, war-tax, the toll duties, the crown and fiscal domains, and salt revenues, which, with the minor sources of income, such as the lottery, the post-office, and the mines, yielded, according to Fenyes, L.3,400,000, a sum less than that of Lombardy, but more than sufficient to cover public expenses, in consequence of the internal organization of the counties, where the salaries of the constitutional officials were but nominal. In the new *regime* a not unimportant item in the public revenue is the tobacco monopoly introduced into the Hungarian dominions by an imperial edict of November 1850. By this edict no one may cultivate tobacco, except by previous permission, specifying the place and mode of cultivation, each owner being obliged to deliver up his produce to the government, which determines its value. The monopoly in itself, no less than the domiciliary visits to which it gave rise, greatly injured this thriving branch of Hungarian industry. A great many, indeed, have in consequence of this given up its cultivation, dispensing even with its use.

Education.

Education, which has likewise undergone great changes since the war of 1848, has within late years made greater progress than general industry. The existence of feudality, we need hardly say, was incompatible with the education of the lowest and most numerous class of the population, the peasants; nor could much be expected from a *bourgeoisie* just starting on the road of activity and wealth. Mental culture thus became chiefly restricted to the nobles. They sent their sons to the colleges to acquire that knowledge and attain those degrees without which they could have made no figure in public life. Hence the vast number of advocates in Hungary, of whom only a small fraction make their appearance at the bar. Among the Protestants, who had enjoyed complete independence with regard to their ecclesiastical affairs and instruction, elementary schools had been established in almost every village, so that the rising generation of that confession surpass at least their parents in the knowledge of reading and writing. Among the Roman Catholic and Greek Catholic population the number of elementary schools is comparatively very small, and the case is the same with the Non-United Greeks, who, like the Protestants, are in this respect independent of the government.

The higher schools of both confessions have generally each a fund, derived mostly from landed property, though the Catholic schools are much richer, and, as already observed, stand under the immediate control of the government. Hungary numbers one university (at Pesth), 21 lyceums, 28 theological and 17 philosophical schools, 95 gymnasiums, and 2293 elementary or reading schools. This number does not include Transylvania, which possesses 25 gymnasiums and 286 reading schools, besides 8 lyceums and 10 seminaries, where theological and philosophical courses are given. The difference between the lyceums and philosophical schools is, that in some of the former the philosophical studies are but preparatory, though in general, and especially in those that are Protestant, they embrace also chemistry and law. The university of Pesth, where instruction is gratis, counts 45 professors, besides extraordinary lecturers. Of these 8 occupy the theological, 6 the juridical, 18 the medical, 14 the philosophical chairs, and 1 fills the chair of mathematics. The philosophical course lasts for two, law for three, theology for four, and the medical course for five years. The last entitles to the degree of M.D. The students of surgery do not, like those of medicine, in a wider sense, require to have previously passed the philosophical course. Most of the lectures at this university are delivered in Latin, although of late years some of the professors began to employ the Magyar language. The university boasts of a rare collection of natural curiosities, a large library, and a spacious botanical garden. In the year 1847 there were at the university 65 theological, 214 juridical, 559 medical, 253 philosophical, and 43 mathematical students; total, 1134.

The number of children attending the elementary schools was estimated at 230,617. A deadly blow was inflicted on both public and private education by the *concordat* already referred to, by which the schools are placed under the direct surveillance of the bishops. Even the Protestant schools must restrict themselves to the use of the books selected by the papal censors; and we find that even Cicero and Demosthenes have been placed on the list of proscribed authors. Amongst the most promising institutions are the Physical Society, established in 1841, and the Assembly of Naturalists, annually held in different parts of the country. The Hungarian Learned Society or Academy of Sciences is the supreme representative of the national culture. This society, first constituted with royal sanction in 1830, consists of 212 regular, and a large number of corresponding members, a certain number of the former participating in a small annuity. The programme of the society is rather ambitious, being divided into six sections, viz., philology, philosophy, history, mathematics, jurisprudence, and natural philosophy. Two of these sections, history and jurisprudence, enter but nominally into their labours, being virtually proscribed by the Austrian government.

The national museum at Pesth, founded by Francis Szecheny, father of the famous Stephan Szecheny, deserves particular mention. The collections in the museum, both in the numismatic and natural departments, are varied, and of the most precious kind, and so, especially in a national point of view, is the library department, comprising, besides a great number of rare books, many valuable manuscripts. The department of art vies in excellence and rarity with the rest, and its value was considerably increased by the munificent present of 340 pictures, made by Ladislaus Pyrker, archbishop of Erlau. The massive edifice, situated in the centre of the town, in a free open square, is in good keeping with the rich treasures it contains.

Literature.

Knowing the Asiatic origin of the Magyars, it is hardly necessary to say that their language is also Asiatic, though it has by no means hitherto been exactly determined to which great class it belongs. According to Balbi, who divides the known languages into five classes, the Magyar belongs to the Oural stock, comprising the Finnish, Lapland, and Permean languages, and which as such are contradistinguished from the Asiatic stock in which the Samoied and Tartar languages are comprehended. The Hungarian antiquarians, on the other hand, while likewise classifying the Magyar among the Oural tongues, include in this classification, besides the Finnish, also the Mogul, Tartar, Samoied, and Turkish languages, and thus make it a strictly Asiatic idiom. Recent travellers have pretty safely established the correctness of the latter opinion. The Magyar language is sonorous and mellow, rich in inflexions, copious in expression, and most logical in its derivatives. The literature of Hungary has suffered severely from the exclusive worship long paid to the Latin, a circumstance due to the influence which the foreign monks naturally acquired on the conversion of Hungary to Christianity, and her simultaneous transformation into a monarchy on a European model. Raised by King Stephan to the peerage and the highest offices, the

Hungary. ecclesiastical order, at first the sole lawgivers, and for centuries the only class possessed of European knowledge, became the means of establishing the Latin at court, of introducing it into the administration, and, from their ignorance of the Magyar language, of introducing it exclusively into public worship. Having thus become the language of the higher classes, or the *ordines regni*, the Latin continued, despite the Reformation, to monopolize the field of literature till the close of the eighteenth century.

The earliest publications in Latin worthy of particular mention, are the *Chronicle* by the anonymous notary of King Bela II., of the middle of the twelfth century, which describes the first ages of Hungarian history in connection with the Huns; the *Chronicle* of *Simon Keza*, a writer of the thirteenth century; the *Chronicon Budense*, and the *Chronicon Rerum Hungaricarum* of Johan Thurocius. A great stimulus was imparted to literature by Matthias Hunyadi, or Corvinus. Most of the *beaux esprits* that crowded to his magnificent court at Buda were Italians, invited to Hungary partly by Beatrix of Naples, the second wife of Matthias, though there were also several of the natives who earned well-deserved fame. The foremost among the Italians is Bonfinius, reader to the Queen Beatrix. His principal work is *Decades IV. Rerum Hungaricarum*, which comprises the Hungarian history from the earliest times to the death of King Matthias. Departing from the rule of the other Hungarian chroniclers, Bonfinius diversifies his narrative with a mass of legendary gossip; and though his attempt to imitate Livy failed, his history is highly instructive, and the most readable of all the historical productions of the time. The best edition of the *Decades* was published, by Sambucus, his continuator, at Basel in 1568. Galleotti, the principal librarian of King Matthias, wrote *De ejus Dictis ac Factis*, while the Neapolitan envoy at Buda, Peter Ramzan, composed a brief epitome *Rerum Hungaricarum*. The Tuscan Callimach procured himself a name by his three books on the reign of Wladislaus as well as his *Attila*. Among the natives the most prominent place belongs to Csinige *alias* Janus Pannonius, a famous Greek and Latin scholar in his age, and who in his youth went in search of knowledge to Italy, having spent fourteen years at Ferrara alone. Besides translations into Latin from Homer and Plutarch, Pannonius composed in Latin, epigrams, panegyrics, and a few epic poems, the greatest part of which is comprised in the *Delicice Poetarum Hungaricarum*, published at Frankfurt in 1619. Contemporaneous critics all agree in lauding the classical learning and poetic genius of Pannonius, comparing him now with Scaliger, and now with Erasmus. But however that may be, it must appear a matter of some surprise that the example of Dante and Petrarch should not have inclined his muse to sing in the language of the living.

As regards the native, or the Magyar idiom, up to the sixteenth century, all that is known of it consists in MSS. of a few legends of the saints, some fragments of historical rhymes, and translations of the Scriptures. Ladislaus Batory, a Pauline monk, was the first who performed the task of translating the Bible. This translation, which was executed in the middle of the 15th century, is preserved, but in an imperfect state. Relics of another kind belonging to this period, are the oath which John Hunyadi took when elected governor of Hungary, and a few verses sung by the children at Pesth, at the coronation of his son Matthias. As in other countries, so in Hungary also, the cultivation of the native idiom received a stimulus from the Reformation, though the melancholy days that commenced with the sixteenth century, and continued for two hundred years, afforded no general seat for the muses. , Among the poets who wrote in the Magyar language, the best known are Baczai, Temesvari, Bogali, Valkai, and Tinodi, who were ambitious enough in pretending to sing the exploits and glories of the two Hunyadis, and the deeds of Soliman, and the principal Turkish generals, and whose strains it would be difficult to rank above the level of rhymed chronicles. Kakony sang the deeds of Cyrus; and Csaktorny, improving upon Homer, rechanted Ajax and Ulysses. Of a higher order than these poetasters were Balassa and Rima, who belong to the second half of the sixteenth century. Much more important were the labours of the translators of these days. These were Komyati and Pisti, who produced a Magyar version of the *New Testament* (1536) among the Catholics; and John Erdösi and Heltai among the Protestants, who translated the entire Scriptures. A new translation of the *Bible* for the Catholic confession was prepared in 1626 by George Kaldi, while the Protestant version was corrected and republished by Albert Molnar, the most learned of the Calvinist ministers. A few of the Latin classics were rendered into Hungarian by Decsi and Benko, and Heltai translated the laws or *Tripartium*, compiled by Verboczy, and the *Decades* of Bonfin. A writer of considerable merit and great erudition, is John Sambucus, who studied medicine as a profession, and cultivated the study of history and the classics from pleasure, having spent more than twenty years at the universities of Italy, France, and Germany. Besides translating into Latin from Plato, Hesiod, and Hippolytus, editing several Latin authors, which procured him great contemporaneous fame, and composing several treatises on theology, Sambucus continued Bonfin's *Decades*, to the reign of Ferdinand of Austria. The patronage he enjoyed at the hand of Maximilian was little calculated to favour his reputation as a historian. Hungary.

The seventeenth century, marked by the persecuting spirit of the reigns of Rudolph, Ferdinand, and Leopold, is but little better than the former, though it can boast of a few names which, in history, poetry, and theological controversy, have acquired for themselves a lasting celebrity in Hungarian annals. Nicholas Isvanfi, the *locum tenens*, or vice-palatine, in the reign of Rudolph, wrote, in classic Latinity, the *History of Hungary from the death of Matthias Corvinus to Matthias II. of Austria*, a work of great merit, though too grossly biassed in favour of the Austrian party. The Calvinist minister, Albert Molnar, already mentioned, distinguished himself by his philological labours, and especially by the composition of a Greek, German, Latin, and Hungarian dictionary; while the Jesuit Peter Pazman, afterwards primate and cardinal, enriched the national language with religious productions of a polemical nature. As regards poetry, a new era commenced with the appearance of Nicholas Zrinyi, grandson of Zrinyi the heroic defender of Sziget against Soliman in 1566. The noblest production of his lyre is the *Zriniad*, or the Siege and Fall of Sziget. Gongyösi sung the deeds of Maria Szechy, the defender of the fortress Murany against the Austrians. In the eighteenth century, a period of peace, Hungary seemed sunk into a state of torpor, which, in the reign of Maria Theresa, was assuming, as far as the magnates were concerned, a denationalizing tendency, and producing a complete neglect of the native idiom. From this lethargy, the nation only recovered during the reign of Joseph, in consequence of his violent measures for the Germanization of Hungary. Societies for the cultivation of the language were now simultaneously formed in different parts of the kingdom, periodicals were started, and the language submitted to severe investigation, to be purged from foreign expressions, rendered more fixed in grammar, and to undergo a total reform. These linguistic efforts, begun by Revay, were carried on with unremitting zeal and signal success by Francis Kazinczy. The adversaries of the linguistic reform attempted to throw ridicule on the labours of Kazinczy by publishing a lampoon entitled *Mondolat;* but they were soon obliged tacitly to respect a man who, actuated by patriotic feelings, laboured unwearedly to remove the mental inactivity and torpor that lay heavily upon the national body, and who felt convinced that, with the revival and culture of the sonorous native idiom, the people would regain that self-esteem, buoyancy, and openness which once formed the chief features in their character. Kazinczy was far from being an original or powerful thinker. His powers mainly lay in his aptitude for adapting to the taste and opinions of his own country the ideas and general knowledge which he culled from foreign literature. The attractive and popular manner in which he advanced new rules and theories, was the chief secret of his success; and, though placed in circumstances incomparably more disadvantageous, Kazinczy may be said to have done for Hungarian literature what Herder had already accomplished for Germany. (See *Hungary, Past and Present*, chap. viii., by Emeric Szabad.) His patriotism cost him, like a few of his contemporaries, several years' imprisonment, but on his release he renewed his labours with redoubled vigour. The more prominent authors and poets of that time are Dugonics, Csokonay, Dayka, Virag, and Alexander Kisfaludy, among whom the last attained the greatest popularity. Kisfaludy excited great attention by his long lyrical poem, *The Love of Himfy*, published in 1801. He also wrote several historical dramas of comparatively little merit, and highly in- Hungary.

Hungary.

teresting tales of ancient Hungarian life. A few glowing odes flowed from the pen of Daniel Bersenyi; Dobrentei and Vitkovics excelled in popular songs; while Charles Kisfaludy surpassed his brother in the drama. An author of higher parts than any of these was Francis Kolcsey, whose articles in the periodical *Elet es Literatura* (Life and Literature) are beyond doubt the finest specimens of Hungarian æsthetical criticism. Kölcsey was also great as an orator, and next to Count Szeibeny, the most influential leader of the reform party. Before proceeding further it is necessary to remark, that about the end of the eighteenth, and the beginning of the nineteenth century, much was done in historical writing. The two Jesuites Pray and Katona have each, with much research, written in Latin the history of Hungary, from the earliest period to the reign of Maria Theresa; while Engel and Fessler have performed the same task in the German language. A brief history reaching only to the fourteenth century was composed in the Hungarian language by Virag.

Michael Vörösmarty may be called the father of the more recent and more genuine Hungarian poetry. The first fruit of his lyre which attracted general attention was a historical tragedy, *King Solomon*, published in 1821, which, though deficient in dramatic effect, is distinguished, like his other productions, by the beauties of a chastely figurative language and noble sentiment. Three years afterwards Vörösmarty gave forth an epic, *The Flight of Zalan*, embodying an episode of the conquest of the Magyars, which was followed by a romantic poem, and another epic, *Cserhalom*, having for its burden the victories of the Magyars over the Cumans. He wrote numerous exquisite lyrical pieces. He also translated several of Shakspeare's plays, and, as a member of the Academy, contributed much to the philological department. Next to him in rank are Bajza, Czuczor, and Garay, the last of whom acquired unusual popularity by his series of ballads relating to the Arpad period. More recently Alexander Vachot, John Erdelyi, Francis Csasar, and a few others, earned a high name as poets; and in 1842 Hungary received the first fruits of Alexander Petöfy, destined soon to become the most popular of her bards. His most successful pieces are those descriptive of country life. Petöfy disappeared amid the carnage of battle in 1849, and since then nothing has transpired as to his real fate. Tompa, another popular poet, is in some respects superior to Petöfy; and Arany gained a sudden popularity in the field of epic poetry. As a humorist, the palm belongs to Sarossy; his *Golden Trumpet*, descriptive of the late war, being a very singular production. The most promising of the recent minstrels are Hiador, Szász, Gulay, and Levay.

Baron Josika may be said to have done for prose what Varösmarty did for poetry, having been the first to produce genuine novels. The most popular works of this prolific author, now an exile in Belgium, are,—*The Bohemians in Hungary*, in which Matthias Corvinus appears on the scene; *The Last of the Batorys;* and *Abafi, Prince of Translyvania.* Baron Oetvös, better known as a politician, earned celebrity as a writer of political novels; while Kuthy, an author more original, and possessed of a richer fancy than either of the preceding, enriched the literature with several works of fiction, chiefly descriptive of Hungarian life and scenery. The familiar prose writers belonging to a more recent date are Baron Kemeny, Charles Berczy, and Moritz Jokay. This last author is as productive as he is popular. Political writing dates from Count Stephan Szechenyi; his first production, *The Credit*, embodying a series of proposed reforms, not a little startling to the feudal lords, was published in 1830. It soon called into action the pen of Count Joseph Dessefy, and several other conservatives; and was followed by another work, *The Light* (A Világ), and the *Stadium.* In the last the Count particularly expounds the necessity of means of communication, and of reforms in the laws of credit, as well as the importance of capital for the promotion of industrial activity. At the appearance of Kossuth on the field of journalism in 1841, Szechenyi came forth with his *People of the East* (Kelet Nepe), a most remarkable mixture of polemics and prophecy, and which called forth a separate answer from the powerful and popular editor of the *Pesti Hirlap.* Szechenyi's last work, *Political Fragments*, was issued on the eve of the war of 1848. Of considerable influence were the political writings of Baron Oetvös and Szalay, who superseded Kossuth in the editorship of the *Pesti Hirlap.* Szalay also contributed short biographical sketches of modern English and French statesmen; as a sort of supplement to which, there lately appeared, under the editorship of Csengery, sketches of Hungarian politicians; and since the late war he has written also a *History of Hungary.* The most valuable contribution in the field of literature is Count Joseph Teleky's voluminous history of the Hunyadi period (*A Hunyadiak Kora*). The noble author, formerly governor of Transylvania, dedicated upwards of twenty years to the composition of this work. In antiquarian research and natural sciences the most prominent names are Stephan Horvat, Fejer Koller, and Schedius. In Peter Vajda, distinguished as a poet, who was carried away by premature death, Hungary lost one of its most original philosophic writers. Since the end of the late war, literature has assumed a more scientific and abstract tone, as is shown by the increasing number of text books of natural science published within the last few years. The approximate number of books that appeared in 1853 was 230, and in 1854 this number was more than doubled. The effects of the censorship are best seen in the diminution of newspapers, which (in Magyar) averaged in 1854 between 10 and 15. Of this number only one belongs to Translyvania, *The New Magyar Museum*, edited monthly by Francis Toldy, secretary to the Academy of Sciences. This indefatigable savant is engaged with the republication of the authors of the last three centuries.

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Having thus surveyed the present political and social conditions of Hungary, we shall resume the thread of history, which we left at the battle of Mohacs (1526), when the throne became vacant by the death of Louis II., brother-in-law to Ferdinand of Austria.

Later history.

It is the fashion with some foreign writers here to stop short, and henceforth to merge Hungarian history into the annals of the House of Austria, a course utterly unwarranted by the nature of events. As well might a historian ignore the War of Independence of the Netherlands, and treat it incidentally in the general history of Spain.

Before entering upon this so-called Hapsburg period, we shall premise a list both of the kings of Hungary and the princes of Transylvania. The latter country maintained its independence till the end of the seventeenth century:—

HUNGARY.

	Years.		Years.
Ferdinand I. (rival, John Zapolya)	1527-1564	Joseph I.	1705-1711
Maximilian (Segis. Zapolya)	1564-1576	Charles III.	1711-1740
Rudolph I.	1577-1608	Maria Theresa	1740-1780
Matthias II.	1608-1619	Joseph II.	1780-1790
Ferdinand II.	1619-1637	Leopold II.	1790-1792
Ferdinand III.	1637-1657	Francis I.	1792-1835
Leopold I.	1657-1705	Ferdinand V.	1835-1848
		Francis Joseph (present Emperor).	

TRANSYLVANIA.

Stephan Bathari	1564-1576	George Rakoczy I.	1637-1657
Stephan Bocskay	1577-1608	Emerik Tökoli, Abafi	1657-1705
Gabrial Bathari	1608-1619	Francis Rakoczy	1705-1711
Bethlen Gabor	1619-1637		

The general consternation caused by the victory of the Turks at Mohacs had barely subsided, when the majority of the nobles proclaimed John Zapolya, vayvod of Transylvania, king of Hungary; and he underwent, in the usual forms, the ceremony of coronation at Weissenburg. Several of the magnates, influenced partly by envy to the vayvod, partly by the prospect of the favours and distinctions of a foreign court, rallied round Ferdinand of Austria, brother of the emperor Charles V., who, in addition to the family alliance upon which he grounded his right, urged the claims arising from his compact with his brother-in-law, Louis II. A year later Ferdinand likewise received the royal unction, and war accordingly commenced. Assisted by his brother Charles, and the hereditary States, Ferdinand sent an army into Hungary, before which his over-confident rival was soon compelled to retire. Zapolya took refuge for a time in Poland, whence he solicited aid both from Soliman and Francis I. of France. The French king, then at war with the emperor Charles V., could hardly do more for Zapolya than send an ambassador to Hungary laden with fair promises. But the powerful Sultan, though equally importuned by Ferdinand, determined to aid the native king. A large Ottoman army, led by Soliman in person, entered Hungary in 1529, and drove the Austrians before them to the gates of Vienna. An attempt to take that capital having failed, the Sultan retraced his steps. After the conclu-

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sion of an armistice between Ferdinand and Zapolya, the war was renewed, and at last peace was concluded at Grosswardein in 1538. The basis of this peace was the partition of Hungary—Zapolya retaining Transylvania and several counties on the Theiss, and Ferdinand Western Hungary, Croatia, and Sclavonia. After the death of Zapolya the whole kingdom was to revert to Ferdinand. An additional clause provided for a future alliance between the offspring of the two rivals. Two years afterwards Zapolya died, leaving a son called Sigismund. The queen dowager Elizabeth, backed by a strong party, and guided by the councils of George Martinussus (who, from the position of a monk, was raised by the deceased king to the rank of bishop), determined to gain the throne for her infant, who was actually proclaimed King of Hungary. The war with Ferdinand was forthwith renewed, and occasioned the second intervention of the Turks in 1541; the Sultan, Soliman, having vowed to protect the interests of the infant Magyar king against the Austrians. From this point till the close of the seventeenth century, the Ottomans maintained the possession of the greater part of Hungary.

In 1547 Ferdinand and the emperor Charles at last succeeded in buying from the Sultan a truce for the term of five years, in consideration of an annual tribute of 30,000 ducats, the young Zapolya now depending entirely on the pleasure of his Ottoman protector. With the expiry of the truce the Turks again took the field, and, on the grant of a new annual tribute promised by Ferdinand, concluded a further truce for eight years in 1562. In the meantime Ferdinand died, and was succeeded in 1564 by his son Maximilian. The irregular payment of the tribute having kindled the fury of Soliman, the Janissaries were anew set in motion, to be arrested at the fortress of Sziget, not by the numerous armies of the imperialists, who wisely remained at a distance, but by a handful of Hungarians, commanded by Nicholas Zrinyi. With a garrison of but 3000 men, Zrinyi defended Sziget against the whole Mussulman host long after its walls had been demolished; and when all hope was gone, and his band was reduced to sixty men, he threw open the gates, rushed with his followers upon the thick masses of the besiegers, and met death sword in hand. This event, the most remarkable in the history of modern sieges, happened in 1566.

Meanwhile, the Reformation made rapid progress, especially among the higher classes, who, with the exception of three families, embraced the new creed—the Socinians gaining many adherents in Transylvania, where they were favoured by the young Sigismund Zapolya. To preserve the Catholic Church from annihilation, the archbishop Olah invoked the aid of the Jesuits, the most renowned among whom was one named Peter Canisius, commonly called Canis Austriacus. In 1576 Maximilian died, and was succeeded by his dreamy, bigoted son, Rudolph, with whom the days of religious persecution commenced. In Transylvania religious liberty found a protector in Stephan Bathory, who was elected prince, with the consent of the Sultan Selim, in 1571. The efforts of the Jesuits to kindle the resentment of this prince, who subsequently became so greatly distinguished as king of Poland, completely failed. A well-known saying of his was, "that God reserved exclusively to himself three things—to create something out of nothing; to know the future; and to rule over conscience."

The persecutions commenced in Hungary Proper against the Protestants, under the legal sanction of a dietal enactment passed in 1604, gave rise to fresh war. Stephan Bocskay, the leader of the Protestants, protected by the Porte, after having gained several victories over the imperialists, and penetrated into Austria, soon cooled the fanaticism of Rudolph, and a peace was concluded at Vienna in 1606. With Matthias II., brother of Rudolph, the dawn of happier days was ushered in. His reign, however, lasted but a few years, and Hungary was destined soon to experience the fanaticism of Ferdinand II., the hero of the "Thirty Years' War."

The accession of Ferdinand II. to the throne was signalized by the rise of the Protestants of Bohemia, and the renewal of persecutions in Hungary. The latter were fomented by the Jesuit primate Peter Pazman, the most learned of the Hungarian prelates. In this emergency Hungary found a defender in Gabriel Bethlen, prince of Transylvania, a zealous Protestant. Bethlen entered into an alliance with the Porte, with the Protestants of Austria, and with the Bohemians. The Bohemians had elected as their prince, Frederick of the Pfalz, son-in-law of James I. of England. The revolutions in the seraglio at Constantinople, and the dastardly conduct of Frederick, content to abandon his subjects and save himself by flight, destroyed *in embryo* this combination. Notwithstanding, the Transylvanian prince, after having gained several advantages over the imperialists, led by Bouguoi, forced Ferdinand to a peace, which was concluded at Nikolsburg in 1621. By the terms of this treaty, Ferdinand engaged to observe strictly all the laws of the country, and maintain inviolate the privileges of the Protestants; and Bethlen was acknowledged prince of Transylvania and of seven counties of Hungary Proper, and promised the possession of the duchies of Oppeln and Ratisbon, in Silesia. The infraction of this treaty on the part of the emperor led to a second war, which terminated in another peace, concluded in 1628 at Presburg. And now, when the Protestant party were about to receive a formidable defender in Gustavus Adolphus, Bethlen suddenly died. Meanwhile, the Jesuits succeeded in regaining to the Roman Church many of the most powerful of the aristocracy, who carried along with them their numerous serfs. Ferdinand dying in 1637, and the religious persecutions being continued during the reign of his son and successor, Ferdinand III., the country was again exposed to the horrors of war, and in the present instance also the national cause found a defender in the prince of Transylvania, George Rakoczy, who extorted the peace of Lintz, concluded in 1645. His elder son having preceded Ferdinand III. to the grave, he was succeeded by his second son, Leopold, whose reign forms the most tragic page in Hungarian annals.

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At his coronation this prince engaged himself to maintain the laws of the country in a diploma containing the important provision, that without the consent of the diet no war should be proclaimed, nor foreign troops introduced into the country. Despite these promises, however, Leopold ordered fresh troops to enter Hungary, ostensibly for the purpose of protecting his partisan, Kemeny, in Transylvania, against Abafi, the designated prince of the Porte, but actually for the suppression of the heretics. Hereupon the Grand Vizier led his forces up the Danube, but, aided by a corps sent by Louis XIV. of France, the imperialists gained the battle of St Gotthard (1664), a victory which Leopold availed himself of for signing a hasty peace with the infidels, in order the more easily to check the heretics. Persecutions, as well as depredations, which fell equally heavy on the Catholics, now followed each other in rapid succession, and the result was, that the most devoted magnates of the House of Austria conspired to save the nation from ruin. The heads of this conspiracy were the palatines Vesselenyi, Peter Zriny, the ban of Croatia, and the chief-justice Nadasdy. The plot having been prematurely discovered, these leaders were partly seized and partly decoyed to Vienna, placed before a foreign tribunal, and executed. The consternation became general, and the archbishop Szelepcseny established a tribunal at Presburg, before which upwards of 200 Lutheran and 75 Calvinist ministers were compelled to appear. The mad zeal went so far as to sell many of those victims as galley-slaves, some of whom recovered their liberty (at Naples, whither they had been conveyed), by the intercession of the Dutch admiral, John de Haen. The Protestants, in despair, rose in arms, and found an intrepid leader in Emeric Tököli (1678). The Marquis de Bethune, the ambassador of Louis XIV. in Poland, greatly encouraged the Hungarians, and concluded a treaty with Tököli, from which much was expected, but which remained unfulfilled in consequence of the conclusion of the peace of Nimeguen. No other ally was thus left to Hungary except the Porte, not a very reliable friend in hours of extreme danger. The grand vizier, Kara Mustapha, who, despite the remonstrances of Tököli, marched straight forward to Vienna (1683), was, as is well known, compelled to raise the siege, and then routed, by the valour of Sobiesky, king of Poland. The misfortunes that henceforth overtook the Turks in Hungary, the alliance with Tököli, and the fate of the malcontents, were but little thought of at Constantinople, then ruled over by imbecile Sultans. Nor did the court of Vienna neglect to attempt rendering Tököli an object of suspicion to the Porte, in consequence of which he was thrown into chains and carried prisoner to Constantinople. Leopold now took revenge upon Hungary. A scaffold was erected in the market-place of Eperies, in the month of March 1687, and kept standing to the end of the year. For nine long months the Hungarians beheld their

Hungary. countrymen dragged to open butchery, and if contemporary historians are to be believed, the executioners were weary of sacrificing the multitude of victims, which were without much distinction delivered up to them. These massacres, perpetrated under the auspices of General Caraffa, are known in the Hungarian annals by the name of the Butcheries of Eperies. The scaffolds were yet standing when the emperor caused the diet to proclaim the crown of Hungary hereditary, and to crown his son Joseph. After these massacres Tokŏli, now released from imprisonment, again called the people to arms, resting his hopes of success on fresh engagements with the Porte. But the victories of Prince Eugene, which resulted in the Peace of Carlowitz in 1699, gradually dissipated all hopes, and the patriotic leader, with his followers, had no other chance left but to seek refuge in the Turkish territory at Nicomedia.

The oppressive rule was persevered in even after the total destruction of the national party; but by an almost incredible vitality, the nation at large was, three years after the peace of Carlowitz, enabled again to make a gigantic effort for independence. The victory of the Austrians under Prince Eugene, which led to the peace of Carlowitz, was gained in 1697, at Zenta, a village on the Theiss. By this peace the Porte abandoned Hungary and Transylvania to the emperor, but was confirmed in the possession of the Banat. The relinquishing of this fertile province to the Turks, as well as the fact that the emperor concluded that peace without the knowledge of the States, was sufficient to create the indignation even of the Austrian party, which largely affected their subsequent success. The leader in this fresh war, which lasted from 1703–1711, was Francis Raykoczy, prince of Transylvania. Its issue greatly depended on the great European war then carried on between France on the one hand, and England, Holland, and Austria on the other. Louis XIV. too well felt how favourable a diversion the war in Hungary created for his interests not to encourage and negotiate with Prince Raykoczy; while on the other hand, England and Holland were equally anxious to render him inclined to accept peace.

Through the mediation of the envoys of these two countries a temporary armistice was concluded, and deliberations for a final settlement of disputes were in course, when the victories of Eugene and Marlborough rendered all appearance of moderation on the part of Austria superfluous. Hostilities thus recommenced, and were at first in favour of the Hungarians, who assembled in Onod (1707), and declared the Hapsburg dynasty dethroned. But the favourable turn which affairs took on the Rhine enabled the Emperor Joseph to send reinforcements to the Danube, and the cause of the confederates began rapidly to decline. Raykoczy, discouraged and deceived in his expectations with regard to France and Charles XII. of Sweden, left the battle-field for Poland, under the pretence of seeking aid, and in his absence peace was concluded (1711) by Karoly, the chief of the Hungarian generals. At this juncture Joseph I. died, and was succeeded by his brother Charles VI. From this time no serious disturbance or open war took place between Hungary and her Hapsburg rulers until 1848. Charles secured the establishment of the right of succession in the female line. This right, known by the name of "Pragmatic Sanction," he obtained at the diet of 1722. In the year 1740 Charles died, leaving his throne to his daughter Maria Theresa, after having exasperated the minds of the nation by the issue of the war made in common with Anne, empress of Russia, upon the Porte, and which ended in abandoning to the Turks the fortress of Belgrade, and several other districts that belonged to the Hungarian crown.

The share which Hungary had in saving the Austrian empire from complete dissolution, during the reign of Maria Theresa, is too familiar to be here described. Threatened by Prussia, Bavaria, and France, and appearing at Presburg as a fugitive, she had to appeal but once to the magnanimity and compassion of the States to make all of them shout with tears in their eyes, *Moriamur pro rege nostro*, and to make them immediately effect the *insurrectio*, or the general rise of the nobles. This tragico-dramatic scene took place on the 11th of September 1741, the young sovereign addressing in Latin the *ordines regni* with her infant Joseph—but six months old—in her trembling arms.

The chief merit of Maria Theresa lay in alleviating the condition of the serfs by the salutary changes which she effected in the feudal system. These reforms are known by the name of *Urbarium*. Transylvania was raised into a principality; the Banat, which had been governed separately since its recovery from the Turks, was incorporated anew into the mother country, while the littorale, or the district of Fiume, likewise received a Hungarian government. Besides the establishing of the Theresianum in Vienna, Maria Theresa enlarged the university at Tyrnau, which in 1777 was transferred to Buda—established military schools for the nobles in Waitzen and Klausenburg, four academies at Tyrnau, Raab, Agram, and Kashau, and regulated the whole system of instruction. In short, her repeated and long stays at Buda, her measures in favour of commerce, and the creation of a Hungarian guard, were all calculated to gain for her the affections of the nation, though her consent to the repeated persecutions of the Protestants, instigated by the Jesuits and some of the prelates, does not redound to her honour. One of the Hungarian bishops, Martin Biro, went so far in his zeal as to publish a pamphlet in which, to save the credit of the Church of Rome for bloodshed, he strongly advised the *burning* of the heretics. Even Frederick the Great, at a distance, felt shocked at the procedure of that sanguinary prelate, of which the queen-empress took no cognizance at all. In 1780 Maria Theresa died, and was succeeded by her son Joseph, the last of the male line in the Hapsburg family. Hungary.

The reign of this philosophic monarch produced events of a different character. Hurried away by his zeal for reform, Joseph, whose Edict of Toleration shocked all bigoted minds, and who aspired at transforming the Austrian States into a uniform monarchy, thought it better to dispense with diets, and so pay no regard whatever to ancient usages, and consequently began to govern Hungary by edicts. Not content with this, he enjoined the exclusive use of the German language in the schools, courts of justice, and administration, and imprudently carried the crown of St Stephan to Vienna. To crown all, the exorbitant taxes which he raised for the prosecution of a war against Turkey, in conjunction with Catherine II. of Russia, produced new discontent. The whole country was thus on the eve of a general war, when the king-emperor recalled all his edicts, promised redress, and suddenly died (1790). His brother and successor, Leopold, was obliged to confirm the liberties and rights of Hungary in a more explicit manner than any of his predecessors had done.

Leopold was succeeded by his son Francis at a time when all the dynasties of Europe were meditating the destruction of revolutionary France. Francis swore to the laws of Hungary as readily as the other Hapsburgs had been in the habit of doing; and the States of Hungary contented themselves with furnishing the Viennese court with men and money. The king had but to mention the dangers with which the throne and the "glorious privileges" of the feudal lords were threatened by the French Revolution, and levy followed levy *en masse*. The feudal lords of the Danube were not even impelled by a feeling of curiosity to think a while of what happened on the Seine. One abbot, Martinovich, and a few others, who pondered over the *Declaration of the Rights of Men*, paid for their curiosity with their lives.

No other Hapsburg king of Hungary convoked the States so regularly and at such short intervals as Francis I. did, from the commencement of the Great War to the period when (as the phrase ran), to save Europe, he sacrificed his daughter Maria Louise; and at no other period were the Hungarian nobles more lavish in sacrificing their lives and treasures. In the year 1809 alone 50,000 nobles took the field, and their equipment entailed an outlay of more than 14,000,000 florins, besides the armaments of the counties. At the same time Hungary became inundated with bad coin and paper money, and was made to feel deeply the effects of the Austrian state bankruptcy. The States then began to approach the throne with loud complaints; but the close of the Great War led the emperor to choose, for the sake of avoiding useless recrimination, the easy method of altogether discontinuing the holding of the diets. This system was persevered in amid loud manifestations of discontent, till the year 1825, when the convening of the States and the exculpatory speech of the monarch again restored harmony between him and his subjects. It is to this date that the reform movement in Hungary, resulting in 1848 in the abolition of feudality, must be traced. The reconciliation of the Viennese court, where Prince Metternich, the personal friend of the emperor, possessed the greatest influence,

to the idea of constitutionalism in Hungary, was no doubt much owing to the unsettled state of Europe, and in particular to the war of independence of the Greeks, which reacted on all the Christian provinces of the Ottoman empire.

Upon the whole, the diet of 1825 was of a retrospective character, but it remained immovable from the appearance of Count Stephan Szechenyi. The young count, then a captain in a hussar regiment, startled the lords spiritual and temporal, who strictly adhered to the use of Latin, by delivering his speech in the Magyar tongue; and on that occasion he, more than any other magnate, contributed to the establishment of a Hungarian academy, or learned society, offering towards this object his income of one year. This diet being ended, he left the army, and boldly assuming the task of a reformer, began to apply himself to political writing. He advocated the redress of some grievances connected with feudal tenure, reform in the laws relating to credit, and an increase and improvement of the means of internal communication. The effects produced by his writings were shown in the spirit of the diet of 1832, when earnest appeals were made by the liberals in favour of the peasantry, and when the antiquated privileges of the nobles began to be called by their right names. A loud cry was also raised on behalf of Poland, then suffering all the horrors of a vanquished people. The results of that diet, however, were futile, although the progress which the idea of reform made in public opinion had by that time become palpable enough. Next to Szechenyi—engaged with the creation of clubs, the introduction of horse-racing, and plans for the regulation of the rivers, and for railway lines and other public works—the pioneers in the path of progress were Francis Kölesey, the most classical of Hungarian authors; Stephan Bezeredi, who may be styled the Wilberforce of the Hungarian serfs; Francis Deak; Gabriel Klauzal; and Eugene Bocthy. The last—who, after a stay of a few years in Britain, died in 1854 an exile in Hamburgh—was remarkable for his wit and his extempore harangues, and contributed much to the progress made in matters pertaining to religion. The Viennese court, to intimidate public discussion, resolved to visit a few of the liberals with imprisonment,—a fate which fell also to the lot of Louis Kossuth. But this arbitrary conduct served only to render more animated the diet of 1840. On this occasion, too, when the question of the liberty of speech came under debate, the voice of Szechenyi made itself be heard with more freedom than that of any other nobleman, unequivocally stating the difficulty of a true union between constitutional Hungary and absolute Austria. The noble orator, in hinting to the court of Vienna to abandon its denationalizing measures, exclaimed—"We may perhaps be murdered, but we can never be fused into the Austrian dominions; nay, it is a question whether we can even be murdered—I at least do not believe it." The results of this diet were also nugatory. Public discussion, however, entered into a new phase, in consequence of the appearance of the political journal (*Pesti-Hirlap*) edited by Louis Kossuth. The effects of his leading articles were rapid and unexampled, exciting the attention of the most benighted and most apathetic. At this juncture Szechenyi stepped in to oppose his schemes, in a pamphlet called *The People of the East*, which served to add to the importance of the *Pesti-Hirlap*. Another adversary that rose against Kossuth was Count Dessefy Aurel, who became the editor of a conservative journal.

Despite the influence of Kossuth's labours as a journalist, and the stimulus given to public opinion by the liberal tendency of the literature, then in its most flourishing state, all that the diet of 1843 accomplished was an enactment conferring on the serfs the right to purchase their complete independence by paying a sum equivalent to the value of the land they possessed. Marriages between Roman Catholics and Protestants, solemnized by Protestant clergymen, were declared to be legal, and provision was made for enabling Roman Catholics to make a legal transfer of their profession from the Popish to a Protestant creed.

With reference to the use of the native idiom, or the Magyar, it was enacted,—1*st*, That it shall henceforth supersede the Latin in the speeches from and the addresses to the throne; 2*d*, That it should be used in the central courts of administration and in the public schools, as well as in the diet. Croatia was exempted from the general rule, and left free to use Latin as its own tongue in the courts and assemblies. With regard to the diet, however, the Croatian members were exempted from using the Hungarian language only for the term of the next six years. However reasonable it was to substitute in the dietal debates a living idiom for the Latin, and however true it was that no other idiom except the Hungarian or Magyar could have been made the parliamentary or diplomatic language, these measures gave rise to a feeling of animosity in Croatia, which produced melancholy results. The question that was followed by a complete failure in the diet of 1843, was that which related to the commercial interest of Hungary. Hungarian commerce having long been obstructed by toll and custom duties established between Hungary and Austria, the liberal party now determined to remedy the evil by a radical change. In this their efforts proved unavailing, though an experiment was afterwards made to encourage home industry by way of association,—an idea conceived by Kossuth, and readily supported by Count Casmir Batthanyi. Meanwhile a new step of the court of Vienna served greatly to increase the political excitement of the country. As observed in the proper place, the counties which alone were able to withstand the encroachments of the Viennese court were governed by sheriffs, nominated by election for the term of three years, while the nominal head of each county was the lord-lieutenant—a dignity, in some instances a hereditary privilege of some families, but in the main conferred by the crown, and anything but lucrative. To render ineffectual the passive resistance of the county municipalities, Metternich hit upon the scheme of introducing a new class of officials, called administrators, both in counties where the office of lord-lieutenantcy was vacant, and in some instances despite the actual lord-lieutenant. This measure alarmed all who were in favour of constitutional government. The county assemblies and the daily press echoed with this question, and the liberals were soon split into two parties. The Kossuth party urged the re-affirmation of the county institutions, while a newer party, called the centralists, insisted on the nomination of a responsible ministry. The leaders of the latter party were Baron Oetvös, Ladislaus Szalay, who followed Kossuth in the editing of the *Pesti-Hirlap*, and afterwards also M. Szemere, who in 1848 became minister of home affairs. On the approach of the elections for the diet of 1847, both liberal parties coalesced, having published their political creed in a programme.

In this important document, in declaring that they will avail themselves of all the means allowable to an opposition in a constitutional country, the liberals laid down the following points, to carry out which they promised to devote all their energies at the next session:—1. Reform in the feudal system. 2. The due representation of the towns. 3. Equality before the law. 4. General taxation for all classes, nobles and commoners. 5. Publicity in the courts. 6. The reunion of Transylvania with the mother country. 7. Liberty of the press; and, finally, a responsible ministry. They particularly appealed in this document to the laws of 1790, sanctioned by Leopold II., which distinctly declare that in its administration Hungary is an independent country, having nothing in common with the laws and institutions of the other parts composing the Austrian empire; and declared, moreover, that, while thus striving after reform, they by no means intended to place the interests of Hungary in opposition to those of the entire monarchy. An additional feature of this programme was the intimation, that, had the hereditary provinces of Austria continued to enjoy their former liberties, or, if a constitutional existence were granted to those provinces, then there would be no difficulty whatever in reconciling the interests of Hungary with those of the whole monarchy.

On the 11th of November 1847 the diet was opened by King Ferdinand V. in person, the business having, according to usage, commenced with debates on the proposals of the crown. The first duty was the election of a palatine in the person of the Archduke Stephan, who was appointed to the office. In the address to the throne, particular stress was laid, along with the mention of other *gravamina* or grievances, on the recent change introduced into the county administration. The final solution of the reform questions, especially opposed by the upper table or the House of Lords, was quickened by the unexpected February revolution of Paris. A numerous deputation conveyed the demands of the diet to Vienna. The troubled state of Lombardo-Venetia, and the revolutionary aspect of the capital, followed by the flight of Metternich, allowed the

Hungary. court but short time for equivocation; and Count Louis Batthanyi, who had latterly served the cause of reform, was entrusted by his majesty with the formation of a Hungarian responsible ministry. Its members were:—Home affairs, M. Szemere; foreign affairs, Prince Paul Esterhazy; finance, Kossuth; justice, Deak; public works, Count Szechenyi; public instruction, Baron Oetvös; commerce, Klauzal; and war, Meszaras, then colonel in the army of Radetzky in Italy. The principal laws passed were,—The abolition of feudality; general taxation for all classes; the extension of the franchise to commoners, including also those occupying the military frontiers; the equality of all received religions, including the Unitarians; the reunion of Transylvania with the mother country; liberty of the press; and trial by jury. On the 11th of April King Ferdinand repaired to Presburg, and closed the diet amid the enthusiastic acclamations of the people.

As it afterwards became manifest, the court of Vienna, far from readily acquiescing in these reforms, rather meant them as a bait for drawing large supplies from Hungary against the Italian provinces, having immediately conceived the unenviable idea of preventing the consolidation of the new state of affairs by fanning internal discord. This was easily accomplished. The Rascians, who chiefly inhabit the Banat, and the Croats, demanded separate rights and separate administration, and instantly commenced to arm. The Rascians, who first unsheathed the sword of civil war, and many of whom were military borderers inured to arms, soon gained the ascendancy over the Magyars and Germans that inhabited the same districts, while their large supplies of arms and ammunition clearly indicated that they were receiving external assistance. Nor was it long before it became evident that Austrian officers were in their camps, directing their plans of attack. This state of things could not but hasten a collision between the Hungarian ministry and the court of Vienna with regard to a most sensitive question,—the army,—the former having necessarily urged the recall of the Hungarian regiments. Without complying with this demand, the Viennese court—which as yet feigned surprise at what happened in Southern Hungary, and stigmatized the Rascians and Croats as rebels—placed at the disposal of the Hungarian ministry a few foreign regiments, the commanders of which were soon found to be acting according to secret orders. The ranks of the Rascians were also swelled by levies openly made in Servia by the Austrian consul. While the Banat was thus all but a smouldering flame, Transylvania was becoming the theatre of a no less savage conflict. The Wallachs, that fine but neglected race, inflamed against their former feudal lords, and furnished with arms, destroyed Magyars, and everything that belonged to Magyars, with indiscriminate fury. The Saxons, flattered with hopes of great separate privileges, though preferring to keep within the walls of their towns, likewise contributed to the carnage; and, in addition to this general distress, Baron Jellachich (lately nominated Ban of Croatia) undisguisedly prepared an expedition against Pesth. The ministers turned to the fountain of justice, and King Ferdinand readily issued proclamations admonishing the "rebels" to peace and obedience; while the "rebels," in strange mockery, were boasting at that very moment of fighting for the king and his throne.

Amid this slaughter and devastation, the court of Vienna, directing its conduct in Hungary according to the state of the war in Lombardo-Venetia, went a step further in its dissimulation. The diet was convoked at Pesth with the avowed object of providing for the defence of the country (July 5). In the speech from the throne, the palatine, who opened the diet as vice-regent, declared the determination of the king to protect the integrity of the Hungarian throne. The secret object in view of the imperial dynasty in convoking the diet, as it appeared, was to obtain fresh levies for Italy, an idea sufficiently extravagant. The parliamentary deliberations on that head were however cut short by the approach of the Ban Jellachich. Count Batthanyi resigned, and Kossuth determined to proceed to the country and call the people to arms. The terror of the Croatian invasion soon proved a farce. Having advanced till within 25 miles from Pesth, the Ban was defeated in an engagement which took place at Paakozd, and fled toward the Austrian frontiers during a three days' armistice that was granted to him. A few days afterwards, his rear, consisting of 10,000 men, was compelled to a surrender. The court now prepared for a regular invasion of Hungary, while the diet was equipping the levy of 200,000 men formerly decreed, and from which decree royal sanction had been withheld. Meanwhile a dynastic revolution was accomplished. The weak Ferdinand was made to resign and to give place to his cousin, the Archduke Francis Joseph, son of Francis Charles, the heir-apparent to the throne. The new emperor proclaimed his ascension in a manifesto, announcing, among the primary things, the reduction of Hungary, while at the same time the diet declared this dynastic change unconstitutional and illegal. The real intentions of the court had been shortly before divulged by the interception of the correspondence of Count Latour, the Austrian minister of war, and the seizure of the papers of the palatine, who had fled to Vienna when he was supposed to be repairing to the camp to take the lead of the Hungarian troops. Hungary.

Having dispersed a Slavonic congress held at Prague, and reduced the capital to obedience, Prince Windischgrätz, joined by the troops of the ban, began marching against Pesth. A part of the Hungarian national army, or the *Honveds*, which opposed his progress, were commanded by Görgei, lately a subaltern officer in the Austrian army. Without meeting much opposition, the Austrians advanced, in the beginning of 1849, to the vicinity of Pesth, which they occupied, after the diet and the committee of public defence had determined to transfer their seat to Debreczin, a town situated on the upper side of the Theiss. The heavy falls of snow, the severity of the season, the badness of the roads, naturally enjoined on the Austrian commander the necessity of a short respite, and during that interval the national government gained time for effecting a concentration of troops, and for procuring the *materiel* of war. With regard to the latter, the efforts and inventive powers of Kossuth surpassed every expectation.

On the advance of the Austrians in February 1849, the first engagement which took place at Kapolna proved decisive for neither party; but, a few days afterwards, a Hungarian corps, withdrawn from the Lower Danube, and commanded by Damyanics, one of the most valiant of officers, routed the Austrians at Szolnok. In the meantime, the Görgei corps, which, at the taking of Pesth by the Austrians, made a flank movement to the north, made its way amid numerous privations and difficulties through the Carpathians to join the army on the Theiss; while in Transylvania the war entered into quite a new phasis. After the Hungarians, led by the intrepid Bem, a general known as a Polish hero since 1830, had defeated both the Austrians commanded by General Puchner, and the Wallachs, application was made to Russia, and General Luders, the Russian commander in the Danubian Principalities, forthwith penetrated into Transylvania, occupying Hermanstadt and Cronstadt, two towns inhabited by the Saxons. Even this foreign aid proved ineffectual. The victorious national legions led by Bem, took Hermanstadt by storm, and compelled both the Russians and Austrians to seek safety in the territories of the Porte.

By this time a large national army was ready on the Theiss to commence the offensive against Windischgrätz. The command was given to Görgei, and the different corps were led by Damyanics, Klapka, and Aulich. After crossing the Theiss, the Hungarians, in a high pitch of enthusiasm, advanced on the road leading to Pesth, meeting with the first serious resistance at the mountains of Gödölö. After an obstinate battle the Austrians were driven from their positions, and successively defeated in four other pitched battles, the bloodiest of which was that of Isaszeg, fought on the 6th of April. Windischgrätz, abandoning the capital to the rebels, hastened to recross the Danube, leaving behind a small garrison at Buda.

Amid these victories, Kossuth, the president of the committee of public safety, proposed in the diet the dethronement of the Hapsburg dynasty, and the proposal was carried by acclamation. Hatred to the Austrian dynasty was much increased, both in consequence of its having called in the Russians, and by the new constitution promulgated (March 4) by the emperor Francis Joseph, which made a *tabula rasa* of all the ancient laws of Hungary. The substance of the act of independence, passed on the 14th of April, runs to the following effect:—That the House of Hapsburg having treacherously levied war against the nation, broken up the integrity of the kingdom, and called in the aid of a foreign power to accomplish its aims, has by

Hungary. these facts destroyed all the treaties that bound it to Hungary, and is therefore declared for ever excluded from the throne of the Hungarian kingdom. The future form of government was to be fixed afterwards, and in the meantime Kossuth was nominated governor, and a new responsible ministry formed. The legislators at Debreczin little suspected that that very moment couriers between Vienna and Petersburg were preparing a second Russian invasion, and that Europe would raise no voice against such an act. The English and French governments refused even to admit into their presence the Hungarian envoys. Though the warlike preparations of Russia were now immense, the Hungarians, under Damyanics, gained (April 18) the battle of Nagy Sarlo, which, if followed up, would have placed in their hands the Austrian capital, and thus have rendered them secure against Russian power. The commander-in chief, Görgei, however, instead of advancing, led the army back to Buda, which, after a three weeks' siege, was taken by assault on the 21st of May; the divisions of Generals Nagy and Kmety having been the first to scale the ramparts. The Russians meanwhile concentrated their forces in Poland, while the Hungarian government, not to offend European diplomacy, proved its forbearance, by refusing to order the corps of observation in the north to advance into Galicia, and thus anticipate the Russian invasion. Neither Russia nor the Western powers showed any sense of this moderation.

The Russians, commanded by Paskiewitsch, began to pour in upon the Hungarian territory in June. As is evident from the official Russian statement, Paskiewitsch's army consisted of 168 battalions of infantry, 138 squadrons of cavalry, besides 52 of Cossacks; with 68 generals, 359 staff officers, and 528 guns. The army commanded by Luders, which invaded Transylvania, numbered 28 infantry battalions, 16 squadrons of cavalry, 18 of Cossacks, with 56 guns; 11 generals, and 58 staff officers. The whole invading army thus amounted to upwards of 200,000 men. The Austrians were now placed under the command of Haynau, who was at Presburg, joined by a Russian corps under General Panutin. The fact alone, that no protest was made, no word raised against the Russian invasion, served greatly to discourage both the people and the national troops. The combined armies of the two emperors reaped no small advantages from the refractoriness of Görgei, who, jealous of his comrades, prevented a speedy concentration of the troops. Obliged for the second time to abandon the capital, the diet and government repaired now to Szegedin, a town situated on the Theiss. After occupying Pesth, Haynau and the Russian corps joined to his army advanced towards the new seat of the diet; and at the same time the main body of the Russians advanced in two columns upon Miskolcz and Debreczin. The diet then transferred its seat to Arad, the fortress of which, like Comorn and Petervardein, was in the hands of the nation, and now the great struggle was drawing to its melancholy close. In Transylvania, the army under Bem was finally overpowered and routed; and in Hungary, Haynau and the Russian corps first drove the Hungarians, commanded by Dembensky, from their position at Szegedin, and then gained a signal victory near Temesvar (August 9). It was two days after this latter defeat that Görgei, after a flank movement, undertaken at his own suggestion, arrived at Arad, where a pitched battle was to have been fought with concentrated forces; but this plan was naturally much affected by the defeat of Temesvar. At this juncture Kossuth resigned (August 11), having, in concert with those ministers that were present, nominated Görgei dictator of Hungary, and soon afterwards left Arad. The new dictator, who for some time back had been negotiating with the Russians, no sooner entered upon his office, than he at once settled with the Russian commander-in-chief the conditions of a surrender. This was soon accomplished on the 13th of August at Vilagos, a place near Arad; 24,000 men laid down their arms, and delivered 140 guns to the Russian General Rudiger. Bodies of troops that were in the immediate vicinity were compelled to do the same, and the fortress of Arad also opened its gates to the Russians. The belief of many among the Hungarian army, it may be observed, was, that the Grand Duke Constantine was to be the king of Hungary, and that he promised to give a constitution. Hungary.

A few thousand men followed Bem and Guyon to Turkey, whither Kossuth and several others of the principal leaders had retreated, while all the prisoners of war were delivered by the Russians to General Haynau; and by the 2d of October the last rock of hope disappeared in the capitulation of Comorn, governed by General Klapka. "Hungary lay now entirely prostrate. The Russians began to take their backward route to the north and east, the Servians returned to the south, only the Austrians remaining with their commander Haynau, surrounded by bloody tribunals and hangmen. In almost every town of importance sat these foreign judges, to whom Francis Joseph confided the complete pacification of Hungary. Arad and Pesth, however, were the centres of these judicial proceedings. By an inexorable decree of Haynau, all the officers below the rank of a general, if not consigned to prison, were pressed as privates into the Austrian service, while the generals were sentenced to perish by the rope." The following eleven generals perished on the gallows at Arad on the 6th of October:—Kiss, Török, Aulich, Lahner, Schweidel, Lemingen, Vécsey, Knezich, Nagy Sandor, and Damyanics. The last, the Hector of the Hungarian army, was dragged to the scaffold, despite his fractured leg. On the same day were executed at Pesth with the bullet, Count Louis Batthanyi, Baron Prenyi, and several others, whose memory is endeared to the nation.

Despite the fact, that the constitution promulgated by the emperor in March 1849, meant to give equal rights to all the parts of the monarchy, was subsequently declared inapplicable, the new *regime* in Hungary was based on the ruins of all the ancient institutions. The office of the palatine, the county municipalities, the rights and privileges of the Protestant churches, all were swept away by periodical organic laws or ordinances. A treacherous hand dug up the crown of St Stephan, to deliver it to the emperor. But Francis Joseph, too glad of its possession, hitherto declined to undergo the ceremonies of coronation. From a kingdom, Hungary thus sunk into a province, broken up into three parts, viz., two crown lands (the whole empire being divided into 20 crown lands), and a *vayvodship*. This latter province, comprising the Banat, consists of the counties Bacs, Krasso, Temes, Torontal, and part of Syrmia. The three Croatian counties, Agram, Kreutz, and Varasdin, and the three Sclavonian counties, Posega, Veröze, and Syrmia, along with the Hungarian littorale, were erected into a crown land; the rest of the kingdom, divided into six districts, forms the other crown land. Transylvania is divided into five districts.

That the people feel the loss of their political rights, and look with anything but contentment upon the *tabula rasa*, feeding a host of foreign officials, and the infinitely less pleasant secret spies, may easily be understood. The exorbitant taxes which have already ruined part of the county gentlemen, however, would alone suffice to keep up those feelings which the court of Vienna flatters itself have disappeared. It is no secret, that the 119 million florins which Hungary contributed in 1854, to the well-known voluntary loan of 500 million, was, in the proper sense, a compulsory tax, levied with the voice of command and intimidation. As if willing still more to brave the feelings of Hungary, the emperor surrendered to the pope the privileges of the Hungarian king by the concordat concluded in August 1855. The progress that is being made in the improvement of the means of communication, and the reforms introduced in several departments of judicature, are advantages well worth mentioning. Nor ought it to be forgotten, that, however violent the changes introduced, and however at the mercy of a few civil and military officials, Hungary remains in possession of the noblest act of the revolution—the liberation of the serfs. (E. S—D.)

Hungary-Water || Hunter, John.

HUNGARY-*Water*, a distilled water prepared from the tops of flowers of rosemary, and so denominated from a queen of Hungary, for whose use it was first made.

HUNGER. See DIETETICS, and PHYSIOLOGY.

HUNGERFORD, a market-town of England, Berkshire, on the Kennet, 27 miles W.S.W. of Reading. It consists chiefly of one long street, in the centre of which stands the market-house. It has no manufactures of importance, but carries on a considerable trade in agricultural produce, by means of the Kennet and Avon Canal. It is also connected, by a branch, with the Great Western Railway. There is a free grammar school in the town. Market-day, Wednesday. Pop. (1851) 2255.

HUNNI, or CHUNI, in English, *Huns*, the collective name of several nomadic Scythian tribes, who contributed powerfully to the overthrow of the Roman empire of the West in the first half of the fifth century. Their early history is very obscure. They seem to have belonged undoubtedly to the Mongolian family, and their habits, appearance, and physical characteristics, as described by their contemporaries, confirm the idea. The great plains of Tartary, on the confines of China, are assigned as the cradle of the race, which, long before the Christian Era, had grown strong enough to keep its neighbours in constant alarm. The Chinese, who had suffered particularly, are said to have built the Great Wall (about 200 B.C.) to secure themselves from their incessant attacks. Driven back on this side, the Huns now directed their course to the West, and about the middle of the fourth century are found settled in the country lying between the Caspian Sea and the River Dniester. For about sixty years from this date they were chiefly occupied in defending their new settlements from the attacks of the neighbouring tribes. The most formidable of these, the Alani, a tribe of kindred blood to the Huns themselves, were, after many sanguinary contests, nearly annihilated. Such of them as survived the war were incorporated with the conquerors. About the year 376, the Huns, pursuing their westward course, attacked the Gothic tribes on the northern side of the Danube. The Visigoths, to the number of 200,000, took refuge in the Roman territories, where lands were allotted to them; and the Gruthungi, or Ostrogoths, soon followed their example. Reinforcing their ranks from the other hordes that joined them, and for a time making common cause with the Goths, the Huns next attacked the Romans, and, in a great battle near Adrianople, slew the emperor Valens. Their power continued steadily to increase till about the middle of the fifth century, when it culminated under Attila. (See ATTILA, and ROMAN HISTORY.) After his death, the various tribes which his genius had amalgamated into one people became broken up and dispersed, and, being attacked in detail by the Goths, who hated and feared them as much as the Romans did, they were driven back across the Don. Some of them settled in Pannonia, and left an enduring trace of their presence in the name of the country now called Hungary. A branch of the Hun family, known as the Nephthalitæ or White Huns (whose physical characteristics were in many respects different from those of the Huns Proper), are found invading Persia in the reign of Firoze, but before the middle of the sixth century they cease to be mentioned in history, and were practically extinct. (See *Ammianus Marcellinus; Priscus; Gibbon;* De Guignes' *Histoire des Huns;* Neumann's *Die Völker des Südichen Russlands;* and R. G. Latham in Smith's *Dict. of Geog.*)

HUNTER, JOHN, an eminent surgeon, naturalist, and anatomist, the brother of Dr William Hunter, was the youngest son of John Hunter, a Scottish yeoman, and born about February 14, 1728, at Long Calderwood, a small family estate in the parish of Kilbride East, county of Lanark. His mother was the daughter of a citizen of Glasgow, named Paul, who held the office of treasurer of the corporation. His father died when he was ten years of age, and being, in consequence, left much to his own guidance, he preferred country sports and occupations to literary pursuits. He had a brother-in-law, a cabinetmaker in Glasgow, named Buchanan, who had married his sister Agnes; and when about seventeen years of age he went to Glasgow, and stayed with Buchanan with the hope of being able to assist in freeing him from the pecuniary difficulties into which his convivial habits and inattention to business had led him. It is probable that it was here, as a cabinetmaker, that he acquired some of the manual dexterity he afterwards displayed, and it was this visit which probably gave origin to the statement of his biographer Foot, that he had served an apprenticeship to a millwright or carpenter. Hunter, John.

When in his twentieth year John Hunter went to London to join his brother William. He was struck while at Glasgow by the report of his brother's success, and receiving a cordial invitation to join him, he set off on horseback in September 1748. His anatomical dexterity satisfied his brother, who employed him in his dissecting-room during the following winter session, and obtained leave for him to attend the practice at the Chelsea Hospital, under Cheselden, during the following summer. Cheselden was now more than sixty years of age, and had retired in a great degree from professional life, with the highest professional honours. It was under this great surgeon that John Hunter received his first instruction in surgery. He continued to attend regularly at Chelsea during the summers of 1749 and 1750, but in the following year Cheselden was obliged to withdraw from his duties in consequence of an attack of paralysis, and Hunter entered as surgeon's pupil, under Pott, at St Bartholomew's.

John Hunter was now a medical student, and seems to have been under little restraint as to his general conduct. He was known by the convivial and low associates with whom he mixed as "Jack Hunter," a nick-name he never wholly lost. He was employed by his brother to provide subjects for the dissecting-room, and became intimate with the bold, dissolute class of men who stole bodies from the grave, and known under the cant phrase of "resurrection-men." One of the amusements in which he took particular pleasure was to mingle with the rabble in the shilling gallery of the theatres, for the purpose of assisting to damn the productions placed on the stage—an office in which he is said to have displayed peculiar tact and vigour. This taint of coarseness and vulgarity was never eradicated during his subsequent life.

In the summer of 1752, John Hunter went into Scotland, and brought back his sister, Mrs Buchanan, now a widow; and in 1753 he was entered as gentleman commoner at St Mary's, Oxford. This attempt on the part of his brother William to elevate and refine his mind was unsuccessful, for in speaking of the circumstance afterwards to Sir Anthony Carlisle, when the latter was a student, he said, "They wanted to make an old woman of me; or that I should stuff Latin and Greek at the university; but," added he, significantly pressing his thumb-nail on the table, "these schemes I cracked like so many vermin, as they came before me."

Having decided upon being a surgeon, John Hunter entered, in 1754, as surgeon's pupil at St George's Hospital, and continued to follow the plan of assisting in the dissecting-room during the winter session, and attending hospital practice during the summer. Two years afterwards he served the office of house-surgeon to the hospital, the duties of which are such as particularly give the holder an insight into practical surgery.

In May 1754, John Hunter made the dissection upon which he laid claim to the discovery of the mode of connection between the uterus and placenta. Dr Mackenzie,

Hunter, John.

then an assistant with Dr Smellie, had been very successful in injecting the arteries and veins of the uterus in a woman who had died pregnant, and applied to John Hunter for his assistance in dissecting it. This he rendered, made anatomical preparations of the parts, and showed the results to his brother William, who at first doubted his inferences, but afterwards acknowledged their accuracy. Twenty years afterwards, when Dr Hunter published his work on the *Anatomy of the Human Gravid Uterus*, he gave no *special* credit to his brother John for the discovery, an omission which led to a quarrel and entire severance of their friendship.

In the year 1755 John Hunter entered into partnership with his brother in the anatomical school, and had to deliver a proportion of the lectures. He was not, however, qualified for this position, for he had always great difficulty in speaking extempore, an acquirement absolutely essential to success in a teacher of anatomy. Hence, notwithstanding his thorough knowledge of his subject, he never gained a popular style. He now turned his mind to anatomical research in conjunction with his brother, and engaged with him in those disputes as to priority of discovery which constantly arise from time to time amongst scientific investigators. William carried on the warfare with his pen while John worked with the scalpel. Two of these disputes were with the Monros—one, as to the first successful conjecture of the *tubuli testis* with mercury, the other as to the functions of the lymphatics. It is generally allowed that as to the latter the doctrine of the two Hunters was the correct doctrine. Another dispute was with the great surgeon Pott, whom William Hunter accused of stealing, without acknowledgment, from himself and his brother the anatomy of congenital hernia. Pott denied the accusation; but, in fact, Haller had already anticipated the Hunters. In one particular point of the subject the credit of priority is due to John Hunter, for he was undoubtedly the first to explain the cause and mode of descent of the testis in the fœtus.

About this time John Hunter traced the anatomy of the first pair of nerves within his nose. He subsequently published engravings in his *Animal Economy*, executed from his anatomical preparations of the parts. In 1758 he completed a series of experiments, instituted with the object of determining the accuracy of the doctrine that the veins are the only absorbents, and came to the conclusion that absorption was carried on through the lymphatics and lacteals exclusively. Modern research has shown that *both* are absorbents in the *vertebrata*, but that in the *invertebrata* no lacteals exist, and absorption takes place through the blood-vessels.

After having studied human anatomy for ten years, John Hunter began the pursuit of comparative anatomy, and it was therefore at this period of his life he laid the foundation of his future distinction. His health, however, had began to suffer, and in the spring of 1759 an attack of inflammation of the lungs ended in a state of health which threatened pulmonary disease of a phthisical character. It was, therefore, thought necessary that he should leave London, and seek a more genial climate. With this object in view, he applied to Adair, the Inspector-General of Hospitals, for a medical appointment in the army, who immediately made him a staff-surgeon. John Hunter embarked early in 1761 with the armament sent to lay siege to Belleisle, during which, although short, he had ample opportunities for treating gun-shot wounds. In 1762 he proceeded to Portugal, where he remained till the end of the year. In 1763 peace was proclaimed, and John Hunter was put on half-pay.

While with the army, John Hunter studied comparative anatomy and physiology. He made experiments on lizards and snakes to ascertain whether digestion was carried on during hybernation, and he instituted inquiries into the faculty of hearing in fishes. It was during these campaigns that he made the greater number of his observations on gun-shot wounds, and that many of his peculiar views on inflammation were suggested. Hunter, John.

Hewson had succeeded John Hunter in the anatomical school; so that the latter had to decide upon his course of life when he returned to London on half-pay. He determined to commence practice there as a surgeon, and entered into competition with Pott, Sir Cæsar Hawkins, Bromfield, Samuel Sharp, and Warner. Although his natural talents and professional knowledge were much in his favour, he laboured under a great disadvantage in his want of gentlemanly bearing and tact. "The stone had need be rich that is set without foil," is a remark of the great father of the inductive philosophy. It was long, therefore, before John Hunter obtained a large share of practice. As a means of increasing his income he commenced to give lectures on anatomy and surgery to a private class; but so far were his views and talents from exciting the attention he might have reasonably expected, his hearers never numbered twenty.

John Hunter occupied this period of forced leisure from the labours of professional life by unremitting researches into comparative anatomy. He got the carcases of animals from the Tower or from itinerant zoological collections, and would purchase rare animals for these menageries on the condition that when they died the dead body was to be restored to him. Sir Everard Home used to state that as soon as he had accumulated fees to the amount of ten guineas, he always purchased some addition to his collection. Indeed, he was sometimes quite ready to borrow from his friends when his own cash was run out, and the temptation great;—"Pray, George," said he one day to Nicol the bookseller, with whom he was very intimate, "have you got any money in your pocket?" Nicol replied in the affirmative. "Have you got five guineas? because, if you have, and will lend it to me, you shall go halves." "Halves in what?" inquired his friend. "Why halves in a magnificent tiger, which is now dying in Castle Street." Nicol lent the money, and John Hunter got the tiger.

John Hunter had by this time fully entered into the great business of his life, namely, the building up of human physiology and pathology from the sure foundations of natural history and comparative anatomy, and he pursued it with characteristic energy and enthusiasm. As many of the inquiries and experiments he wished to make were impracticable in a town, he purchased a piece of ground at Brompton, called Earl's Court, and built a small house on it. Here he had a menagerie, and here he pursued most of the researches which were communicated to the Royal Society, or published in his work on the *Animal Economy*. It was his greatest pleasure to attack the animals playfully, and excite them to put into action their various instinctive methods of self-defence. On one of these occasions, a little bull, which the queen had given to him, and with which he had been wrestling, threw him down, and would have injured him seriously, if one of his servants had not come to his rescue. He had also an awkward adventure with two leopards which had broken their chains, and got amongst the dogs. The animals had a fierce encounter, and Hunter hastened to separate them by leading the two leopards back to their den. When the danger was over, he became so agitated at the recollection of it, that he fainted.

In 1767 John Hunter was elected a fellow of the Royal Society, before his brother William, who had been ten years longer in London. In this year he ruptured his *tendo Achillis* while dancing. In 1768 he was appointed to the office of surgeon to St George's Hospital, and soon after became a member of the Corporation of Surgeons. He now began to take pupils, having with each a fee of 500 guineas. Jenner, in 1770, was one of these; but all his pupils were

Hunter, John.

distinguished in their profession. Hunter subsequently kept up an intimate correspondence with Jenner at Berkeley, with whom he had a community of pursuits in the study of natural history. Anything curious "either in the fish or flesh way" was always acceptable from Jenner, who forwarded to him hedge-hogs, fossils, salmon-spawn, bats, a porpesse, crows' nests, and the like.

In May 1771 Hunter published the first part of his *Treatise on the Teeth;* the second part did not appear until 1778. In 1771 he was married to Miss Home, the daughter of a surgeon in the army. Her brother Everard was Hunter's pupil, and was subsequently made a baronet. In 1772 he communicated to the Royal Society the results of his observations on the *post mortem* digestion of the stomach by the gastric juice. In the spring of 1773 he had an alarming attack of spasm—the first indication of that disease of the heart which was ultimately fatal. It seemed to have been closely connected with his gouty predisposition, and to have been immediately induced by severe mental emotion. In the autumn of the same year, he commenced his first distinct course of lectures on surgery. To him lecturing was so irksome a task, that he never commenced his course without taking laudanum to relieve his uneasy sensations; yet he continued the practice for many years. His *Researches on the Torpedo* were published this year. In 1774 two of his papers were published in the *Transactions* of the Royal Society; one on the air-receptacles of birds, the other on the stomach of the gillaroo trout. His professional success was now sure, but this year was the first in which his income exceeded L.1000. All this time his museum had been enlarging, and his opportunities for research extending, until it was necessary to have special help. He, therefore, engaged Mr Bell for ten years as his assistant, but he ultimately remained with him fourteen.

In 1775 Hunter entertained thoughts of founding a School of Natural History, and sought the co-operation of Jenner, premising that it was necessary that the latter should be "able and willing to lay down 1000 guineas." Jenner declined, and the project fell through. In this year he communicated to the Royal Society a paper on the heat of animals and vegetables.

The appointment of surgeon-extraordinary to the king was conferred upon John Hunter in 1776. In the course of the same year, he drew up, at the request of the Royal Humane Society, a memoir on the means to be employed in the recovery of drowned persons, which was published in the *Philosophical Transactions.* He also commenced this year a series of six Croonian lectures on muscular motion.

In the spring of 1777, Hunter was attacked with a cerebral affection, characterized by constant vertigo and morbid acuteness of the organs of sense; and in the autumn of the same year he went to Bath for three months for the benefit of his health. Jenner saw him there, and his diagnosis of Hunter's disease was, that it was *angina pectoris,* a serious and very painful affection of the heart.

In 1778 he presented to the Royal Society his second memoir on the heat of vegetables and animals, and in 1779 his memoir on the hermaphrodite black cattle, or *free-martin.* In 1780 he sent to the same society a paper on the structure of the placenta, in which he claimed for himself the discovery of the true mode of union between the uterus and that organ. Five years previously, William Hunter had claimed the same discovery in his work on the *Gravid Uterus,* and it could hardly be expected that he would allow John's claim to pass uncontradicted. The result of the affair was a complete estrangement on the part of the two brothers. Three years after this, when William was on his death-bed, John requested permission to see him, which was granted, and he continued to attend him until his death, and occasionally passing the catheter for him.

In March 1781 Hunter appeared as a witness in the celebrated trial of Captain Donellan for the murder of his brother-in-law, Sir Theodosius Boughton. In the same year he was elected a fellow of the Royal Society of Belles Lettres at Gottenberg. In 1782 he completed his Croonian lectures. In 1783 he was elected a member of the Royal Academy of Surgery and the Royal Society of Medicine at Paris. In the same year he began to build his museum in Leicester Square, which was not completed until 1785. He also, in conjunction with Dr Fordyce and others, took an active part in 1783 in establishing the "Society for the Improvement of Medical and Chirurgical Knowledge." His paper on inflammation of the veins was published in the first volume of the *Transactions* of this society.

In 1785 his cardiac affection assumed a new form, coming on in spring after the cessation of some slight symptoms of gout, and continuing to recur paroxysmally during the rest of his life, whenever he had any unusual exertion to make or mental anxiety to suffer. He again sought health and rest at Bath. It was after his return that he practised the new method of tying the artery for popliteal aneurism.

In 1786 he was appointed deputy-surgeon-general to the army. Early in the same year he published his work on the *Venereal Disease,* and towards the close, his *Animal Economy,* which consisted chiefly of his most important papers from the *Philosophical Transactions.* In 1787 his memoirs on the specific identity of the wolf, jackal, and dog, and on the structure and economy of whales, were printed in the *Philosophical Transactions.* In this year, also, he received the Copley Medal from the Royal Society, and was elected a member of the American Philosophical Society. He had added in 1783 the skeleton of Byrne or O'Brien, the Irish giant, to his museum, at the cost of five hundred pounds, and, having in all respects completed its arrangements, he threw it open to the public during the months of May and October in each year.

In December 1789 Hunter experienced a sudden and entire loss of memory for half an hour, a state of the brain evidently in intimate dependence on the state of the heart. The spasms about the præcordia were now so readily induced by any mental excitement that he was accustomed to say his life "was in the hands of any rascal who chose to annoy and tease him."

In 1792 he contributed his last paper to the *Philosophical Transactions,* being the results of his observations on the hive-bee for twenty years. His fondness for bees was always great, and he had several hives in his conservatory at Earl's Court. In this year he resigned his lectureship on surgery in favour of his brother-in-law Home, principally with the view of completing his treatise on *Inflammation.* He did not live, however, to see the entire work through the press. On the 16th of October 1792, he attended a board meeting at St George's Hospital, with the view of obtaining a modification of a bye-law recently passed regulating the admission of pupils, in favour of two of his countrymen just come to London. In the course of his remarks he made some statements which one of his colleagues thought it necessary instantly and flatly to contradict. Hunter immediately ceased speaking, and hurried into the adjoining room, where he instantly fell lifeless into the arms of Dr Robertson, one of the physicians to the hospital. His body was examined to ascertain the cause of death. The carotid arteries and their branches within the skull were in fact thickened and ossified. The result of his pulmonary attack in 1759 was found in the form of firm adhesions between the left lung and costal pleura; in addition to thickening of the pericardium, the coronary arteries and tricuspid and mitral valves were much ossified. The aortal valves were also thickened and rigid. John Hunter died in his sixty-fifth year. His body was interred in the church of St Martin in the Fields.

Hunter, John.

Hunter, Dr William.

In person, John Hunter has been described as about the middle stature, of a vigorous and robust frame, with high shoulders and short neck. His features were rather large and strongly marked; his eyebrows projecting, his eyes of a light colour, his cheeks high, his mouth somewhat underhung. In mental character he was a genius, and one of a family in which talent was hereditary. Joanna Baillie and Dr Baillie were the children of a sister; and, besides his brother William, another brother of the family, whose career was cut short by death, manifested considerable mental talent. He had a large power of induction, acute powers of observation, a vivid and fertile imagination, and unwearied energy. He wanted a natural refinement of feeling; he had never been taught self-control; he had had no literary culture. He was therefore often coarse in his language, violent in his temper, quarrelsome, selfish, and egotistical. Of religious sentiment he made no profession.

John Hunter's museum was purchased in 1799 by the nation, and placed in the keeping of the College of Surgeons of London. The occasion was seized for securing a new charter for the College, containing the grant of the prefix Royal to its title, and permission to examine for its diplomas. From this event a new era in British surgery may be dated; and in connection with the name of John Hunter, the "Hunterian Museum" is one of the national institutions. Unfortunately, in 1812, his brother-in-law (afterwards Sir Everard Home) took away the ten folio volumes of minutes of dissections which John Hunter had left, along with many other valuable papers, without permission being had from the trustees, but with the alleged intention of preparing from them a catalogue of the museum. Time passed on; no catalogue was forthcoming; and at last, after repeated inquiries, Home acknowledged that he had burnt the whole, pretending that in doing so he had acted in accordance with the directions of John Hunter. The allegation was altogether incredible; but another and more probable cause was surmised, namely, that these volumes would, on examination, have been found to have supplied the substance of the papers which Sir Everard Home contributed to the Royal Society in greater number than any other single member of that distinguished body had contributed since its foundation. (T. L.)

HUNTER, *Dr William*, an eminent anatomist and physician, was born on the 23d of May 1718, at Long Calderwood, in the parish of Kilbride East, county of Lanark, Scotland. He was an elder brother of John Hunter, and the seventh child of the family. His paternal great-grandfather was a younger son of Hunter of Hunterston, chief of the family of that name. At the age of fourteen he went to study at the University of Glasgow, where he remained five years. His father had designed him for the church, but he had an insuperable aversion to theological pursuits, and having the reputation of a good scholar, he sought to obtain the appointment of parochial schoolmaster in his native parish. To his great disappointment he was unsuccessful in his application. At this time, however, he formed an acquaintance with Cullen, afterwards the distinguished professor of Edinburgh, but who was then just established as a medical practitioner at Hamilton, and being thereby induced to enter the medical profession, went in 1737 to reside with him. After remaining with Cullen three years, it was agreed that they should enter into partnership, and Hunter should take the surgical part of the practice. Previously to completing this arrangement, Hunter was to study in London and Edinburgh, and on his return to take the entire charge of the practice, so as to afford Cullen similar advantages. A very different career was, however, marked out for them in the metropolis of the North and of England.

In pursuance of the plan laid down, William Hunter attended the lectures given in the medical faculty of the university during the session of 1740–41. Amongst the courses was that of Dr Alexander Monro. In the summer of 1741 he went to London, and took up his residence at the house of Dr Smellie, then an apothecary in Pall Mall. He brought with him a letter of introduction to Dr James Douglas from Mr Foulis, the famous printer of Glasgow, who had been useful to Hunter in procuring for him different editions of Horace's works. Douglas was then engaged on a work on the bones (which, however, he did not live to complete), and was seeking for a suitable person to employ as a dissector. Being pleased with William Hunter, he invited him to enter his family as tutor to his son, and assistant to himself. This invitation was accepted, and at the same time, by Douglas's friendly assistance, he entered as surgeon's pupil at St George's Hospital, under Mr James Wilkie, and as a dissecting pupil under Dr Frank Nichols, who was then one of the best anatomists of the day, and had formerly taught anatomy at Oxford. He likewise attended a course of experimental philosophy, delivered by Desaguliers.

Hunter, Dr William.

Before many months had elapsed William Hunter lost his friend and patron Douglas, who died in 1742, but he still continued to reside in the family, and act as tutor to the son. Before the death of Douglas he had made so much progress in his dissections that the former had had drawings of several of his preparations engraved. In the year following (1743) he communicated to the Royal Society an essay on the structure and diseases of articulating cartilages. To teach anatomy was now his plan of life, and he therefore began to collect preparations and take other steps to fit himself for the pursuit. It was at this time the foundation of his museum was laid. An opportunity of commencing the teaching of anatomy shortly offered. A society of naval surgeons had an apartment in Covent Garden, where they had engaged Sharpe, the eminent surgeon, to deliver a course of lectures on operative surgery. Sharpe continued to repeat the course until, finding it inconvenient, he declined the task in favour of William Hunter, who gave his hearers so much satisfaction that they engaged him to teach them anatomy.

William Hunter's first anatomical course was delivered to this society in 1746. Mr Watson, one of his earliest pupils, accompanied him home after the trying moment of his introductory discourse. He had just received seventy guineas as admission-fees, which he carried in a bag under his cloak, and remarked on the way to Watson that it was a larger sum than he had ever before possessed. The profits of his two first courses were considerable; but in consequence of too liberally relieving the wants of some friends, he had not money sufficient to defray the expense of the usual advertisements of the third course, and was obliged to defer the commencement of it for a fortnight. This embarrassment was an impressive lesson to him, and probably was one of the remote causes of the large fortune he accumulated.

In 1747 he was admitted a member of the Corporation of Surgeons of London; and in the spring of 1748 accompanied his pupil Douglas on a tour through Holland and France, returning in the autumn to commence his usual course of lectures. At Leyden he visited Albinus, whose beautiful injections of the blood-vessels strongly attracted his attention, and excited his emulation. In the autumn of this year his brother John came to him. William Hunter at first practised both surgery and midwifery; but, like his patron Douglas, he gave the preference to the latter department: consequently, in 1748, he took the appointment of surgeon-accoucher to the Middlesex Hospital, and, in 1749, to the British Lying-in Hospital. In 1750 he seems to have resolved to abandon the practice of surgery altogether, for in that year he became a graduate of the University of Glasgow. Previously to this he had left the family of Mrs Douglas, and taken a house in Jermyn Street.

Hunter, Dr William.

This was the crisis of William Hunter's career, and fortune aided his first commencement of practice. His rivals were moving away, or unable to compete with him for public favour. Smellie was unpleasing in his person and manners; William Hunter was his equal in acquirements, his superior in person and deportment. Sir Richard Manningham, one of the most eminent accoucheurs of the day, also died about this time; and Dr Sandys, who divided with him the practice of the fashionable world, retired within a few years to the country. William Hunter subsequently secured Sandys' large collection of anatomical preparations by purchase from Mr Bromfield for L.200.

In 1751 we find him devoting the whole of his energies to his professional labours and pursuits, and forming plans of great and varied extent and importance. In a letter to Cullen, he says, "I want to tell you many things about colleges, hospitals, professorships, chariots, wives, &c., &c. I'm busy in forming a plan for being an author. In short, my head is full of—a thousand things." His plans as to marriage were amongst those which he never completed. In this year he paid his first and only visit to his native country, where he found Cullen established at Glasgow, and in rising reputation both as a practitioner and lecturer, so that the two friends could congratulate each other on their mutual prosperity. In 1752 he demonstrated to his class his method of injecting the testis with mercury. In 1753 he had a long illness—"a strange sort of eruptive fever," as he describes it in a letter to Cullen. In 1754 he was elected a member of the Medical Society of London, and took his brother John into partnership; and in 1755 he succeeded Dr Layard as physician to the British Lying-in Hospital. In 1756 he was admitted a licentiate of the Royal College of Physicians in London. In 1757 his first contribution to the *Medical Observations and Inquiries* appeared in the first volume of that work; it was "The History of an Aneurism of the Aorta." Various papers on practical subjects from his pen appear in successive volumes of this work, *i.e.*, in the 2d, a history of an emphysema, and in the 4th, 5th, and 6th essays on varicose and other aneurisms, displacements of the uterus, and malconformations of the heart, the last illustrated by plates.

John Hunter having left his brother in 1759 to join the army, the latter engaged that distinguished anatomist, William Hewson, to take his place both as assistant and partner. The connexion between the two brothers had not been a happy one; William was irascible—John quarrelsome and vulgar. Indeed, the only inducement which led to its continuance on the part of William Hunter were his brother's extraordinary skill as a dissector, and the valuable contributions he was constantly making to the museum.

In 1762 Dr Hunter was consulted by the queen, then pregnant, and on the 12th August he writes to Cullen to announce the birth of the Duke of Cornwall. "I owe it to you," he adds, "and thank you from my heart for the great honour I now have, and have had for some time, though very few know anything of it,—I mean having the sole direction of her majesty's health, as a child-bearing lady." Two years afterwards he was appointed physician-extraordinary to the queen. In this year, also, he published the first part of his *Medical Commentaries*, proposing that the second should be constituted by his work on the Human Gravid Uterus. In this work he gave a summary of his controversy with the Monros in 1757—carried on at first in the pages of the *Critical Review*; and asserted his prior claim to the method of injecting the testis with mercury, and to the discovery of the uses of the lymphatics. He also endeavoured to set himself right as to his controversy with Pott, and defends his brother's views on congenital hernia.

When William Hunter began to practise midwifery, he was desirous of acquiring a fortune sufficient to place him in easy and independent circumstances. Before many years had elapsed, he found himself in possession of a sum adequate to his wishes in this respect; and this he set apart as a final resource whenever age or infirmities should oblige him to retire from business. As his wealth continued to accumulate, he formed a design of engaging in some scheme of public utility, and at first had it in contemplation to found an anatomical school in the metropolis. For this purpose, about the year 1765, during the administration of Mr Grenville, he presented a memorial to that minister, in which he requested the grant of a piece of ground in the Mews, for the site of an anatomical theatre. Dr Hunter undertook to expend L.7000 on the building, and to endow a professorship of anatomy in perpetuity. This scheme did not meet with the reception it deserved. In a conversation on this subject, which he had soon afterwards with the Earl of Shelburne, his lordship expressed a wish that the plan might be carried into execution by subscription, and very generously requested to have his name set down for 1000 guineas. Dr Hunter's feelings would not allow him to adopt this proposal. He chose rather to execute it at his own expense, and accordingly purchased a spot of ground in Great Windmill Street, where he erected a spacious house, to which, in 1768, he removed from Jermyn Street. In this building, besides a handsome amphitheatre and other convenient apartments for his lectures and dissections, there was one magnificent room appropriately fitted up as a museum. The cost of the whole was above L.8000. Of the magnitude and value of his anatomical collection some idea may be formed, when we consider the number of years he employed in making the anatomical preparations and in the dissection of morbid bodies, and the eagerness with which he procured additions from the collections of Sandys, Hewson, Falconer, Blackall, and others, that were at different times offered for sale in London. His specimens of rare diseases were likewise frequently increased by presents from his medical friends and pupils; who, when anything of this sort occurred to them, very justly thought they could not dispose of it more properly than by placing it in Dr Hunter's museum. Speaking of an acquisition in this way in one of his publications, he says, "I look upon everything of this kind which is given to me, as a present to the public; and consider myself as thereby called upon to serve the public with more diligence."

Hunter, Dr William.

Before his removal to Windmill Street, his collection chiefly illustrated human and comparative anatomy, and pathology; but now he extended his views to fossils, and to the promotion of classic and polite literature. In a short space of time he became possessed of a most magnificent collection of Greek and Latin books. A cabinet of ancient medals contributed likewise much to the richness of his museum. A description of part of the coins in this collection, struck by the Greek free cities, was afterwards published by his friend Mr Combe. In the preface some account is given of the progress of the collection, which had been formed since the year 1770, with singular taste, and at the expense of upwards of L.20,000. In 1781, the museum received a valuable addition of shells, corals, and other illustrations of natural history, which had been collected by the late Dr Fothergill, who gave directions by his will, that his collection should be appraised after his death, and that Dr Hunter should have the refusal of it at L.500 under the valuation. This was accordingly done, and Dr Hunter purchased it for the sum of L.1200.

By William Hunter's will, the use of his museum, under the direction of trustees, devolved to his nephew Dr Matthew Baillie, and in case of his death, to Mr Cruikshank, for the term of thirty years; at the end of which period the whole collection was bequeathed, with L.8000, to the university of Glasgow, where it is now deposited.

Hunter, Dr William Hunting.

In 1767 William Hunter was elected a fellow of the Royal Society, and in the year following communicated to its Transactions *Observations on the Bones found on the banks of the Ohio River*. In 1768 he became a fellow of the Society of Antiquaries, and in the same year was appointed by the king to be professor of anatomy to the Royal Academy of Arts, which he had recently founded. Hunter performed the duties of the new professorship with remarkable tact. The originality and soundness of his teaching, and his application of anatomical knowledge to painting and sculpture, evinced the greatness and versatility of his mind.

In 1770 the connection of William Hunter with Hewson ceased, in consequence of some disputes, and the latter was succeeded by Cruikshank, a name deservedly celebrated amongst anatomists. The *Anatomy of the Human Gravid Uterus* appeared in 1775, a work of classical value and importance, and which as such has lately been one of the works selected for republication by the Sydenham Society. Ten of the thirty-four plates which it contains had been completed so early as 1751; but the publication was retarded by Hunter's anxiety to render his work as perfect as possible. In the preface he fully acknowledges the assistance he had derived from his brother John in making the necessary dissections, thanking him for it, and passing a graceful compliment upon his skill. Five years afterwards (1780), John presented a paper to the Royal Society on the structure of the placenta, in which he claimed for himself the honour of discovering the true mode of union between this organ and the uterus,—a discovery which William Hunter claims as his own in this work. This led to a complete estrangement between the brothers, which continued until William was on his death-bed. A reconciliation then took place, but the latter did not, in consequence, alter that portion of his will by which he left the family estate in Scotland (he having succeeded to it) to his nephew, Dr Baillie, to the exclusion of his brother.

The engraver Strange (famous for his delicate execution) engraved two of the finest plates in the volume; and some of the others are remarkable for their beauty. William Hunter did not live to publish a work designed to illustrate the engravings and descriptive anatomy of the gravid uterus; but he left very ample materials for the purpose, which were edited in 1795 by Dr Baillie, and published in a thin quarto volume.

Dr John Fothergill having died, William Hunter succeeded him in January 1781, as president of the Medical Society. In the preceding year he had been elected one of the foreign associates of the Royal Medical Society of Paris; and in 1782 he received a similar mark of distinction from the Royal Academy of Sciences of Paris. In the following year he died.

Hunter, Dr William Hunting.

About ten years before his death, William Hunter found his health so much impaired, that he proposed to recruit it by residing in Scotland, and was about to complete the purchase of a considerable estate, when the project was abandoned in consequence of a defect in the title. This ended his rural plans, and he thenceforth remained in London, suffering from repeated attacks of gout; it was this disease which terminated his life, notwithstanding his abstemious regimen. On Saturday the 15th of March 1783, after having for several days experienced a return of a wandering gout, he complained of great headache and nausea. In this state he went to bed, and for several days felt more pain than usual, both in his stomach and limbs. On the Thursday following he found himself so much recovered, that he determined to give the introductory lecture to the operations of surgery. It was to no purpose that his friends urged on him the impropriety of such an attempt. He was determined to make the experiment, and accordingly delivered the lecture; but towards the conclusion his strength was so exhausted that he fainted away, and was obliged to be carried to bed by two servants. During the night and the following day his symptoms were such as indicated danger; and on Saturday morning, Mr Combe, who made him an early visit, was alarmed on being told by Dr Hunter himself, that during the night he had certainly had a paralytic stroke. As neither his speech nor his pulse were affected, and he was able to raise himself in bed, Mr Combe encouraged him to hope that he was mistaken. But the event proved that Hunter's idea of his own complaint was but too well founded. He died on Sunday the 30th of March 1783. Turning to his friend Combe in his latter moments, he observed, "If I had strength enough to hold a pen, I would write how easy and pleasant a thing it is to die."

William Hunter is described as being regularly shaped, slender, and rather below the middle height. He was an early riser, courteous, prudent, and economical. When he invited his younger friends to his table, they were seldom regaled with more than two dishes; when alone he rarely sat down to more than one; he would say, a man who cannot dine on this deserves to have no dinner. After the meal his servant (who was also the porter at the anatomical theatre), used to hand a single glass of wine to each of the guests. It was by the aid of such habits that William Hunter was enabled to devote L.70,000 to the advancement of medical science. (T. L.)

HUNTING.

One of the greatest compliments paid to the chase is, its having been considered as a theme worthy the pens of the ablest writers of the most refined periods of the world. Whilst Greece was the nursery and residence of every branch of polite literature, and of all the arts and sciences then known to mankind; whilst every study that depends on the powers of the imagination, or the faculties of the understanding, was there carried to the very summit of perfection, we find Xenophon composing his Κυνηγετικος, treating of every description of field-sports. He, according to the custom of the times, opens the subject with fable, and tells us that hunting, which he calls the gift of the gods, and the use of dogs, originated with Apollo and Diana, and that the invention was made a present of to Chiron, who took pupils in the art, each of whom was, in his turn, honoured by the gods (ἀπο θεων ἐτιμηθη). His real object, however, was to encourage in the youth of his country a taste for the pleasures of the chase, and other manly pastimes, as the best preparation for war, the senate, and the world. Whilst he condemns the effeminate man as shamefully useless to his country, he represents the well-trained sportsman as not only mighty in war, but ready to sacrifice his person and his wealth to the public good. As a preparation for war, and particularly the higher branches of the soldier's profession, we need not the testimony of Xenophon; for our own experience has shown us that, speaking generally, no man takes a view of a country, at first sight, with equal facility to a sportsman, particularly a sportsman who has been accustomed to follow hounds. Indeed, unless he have what is called in the field "a good eye to a country," he cannot ride with judgment after hounds in our inclosed or woodland districts; and when the chase is concluded, it is surprising to witness the rapidity with which an experienced fox-hunter sees the points of a country in

Hunting. which he is a stranger, that must lead him towards his wished-for home. With respect to the other advantages alluded to by Xenophon, he had very good authority for what he asserted of them. The Olympic games were established by the Greeks for two distinct purposes: first, to inspire their youth with a love of glory, as well as a taste for manly and invigorating exercises, conducive to contempt of danger, and coolness when exposed to it; and, secondly, with a view of drawing together the leading men of the different states of Greece, which gave them an opportunity of deliberating upon matters of general concern. As regarded the other various occupations of life which a gentleman is called upon to fulfil and do honour to, we may remark, that an irreproachable moral character was a necessary qualification for a competitor at those games or sports. Drawing something like a parallel here, then, we may add, that neither is a sportsman in our own country esteemed, how skilful soever he may be, if his character be tainted with fraud; and we are not unmindful of the advantages derived from the mixture of society in the hunting-field, or of the many valuable and lasting friendships that may be dated from accidental meetings by the cover side. But Xenophon wrote in praise of hunting rather perhaps as a soldier than a philosopher, giving it as his opinion, that the exercise of the chase formed the best soldiers in the world; that it habituated men to cold, heat, and fatigue; that it kindled courage, elevated the soul, and invigorated the body; that it retarded the effects of age, and rendered the senses more acute; and, finally, that the pleasure it afforded was a sovereign remedy against all mental uneasiness; in which latter sentiment he is seconded by a modern author of celebrity, who says that "the chase fortifies the heart as well as the body." Nor is Xenophon the only eminent soldier or philosopher of his renowned country who has written in commendation of hunting. Aristotle wrote a treatise on field-sports, by order of Alexander the Great; and Polybius, one of the greatest soldiers of any age, relates that Maximus restored discipline in the Roman legions, by often exercising them in hunting; and he even goes so far as to celebrate one individual sportsman, Ptolemy Epiphanes, for his dexterity in killing a wild bull. Amongst the poets of Greece, Oppian distinguished himself highly by his poems on hunting. So excellent, indeed, were they considered by his emperor, that he is said to have presented him with a piece of gold for every verse they contained, and thus they acquired the honourable appellation of "the golden verses of Oppian." Several of the most splendid similes of Homer are taken from hounds in chase, and in the manly disposition of Achilles we see the formation of the heroic character by the pursuits of the chase.

The Romans at one time discouraged hunting amongst the upper orders of society, from the fear of its becoming a passion which might divert them from their essential duties. But here they committed an error; for, aware of its beneficial effects in forming their people for war, they substituted public exhibitions of animals destroying each other in an amphitheatre, which could only have hardened the heart, without advantage to either body or mind. Yet we find many of their emperors encouraging hunting, and many of their best writers extolling it. The learned and polished Hadrian was so passionately addicted to hunting, and also to horses and dogs, that he erected monuments to the memory of the latter, and built a city on the spot on which he had killed a wild boar, after a desperate encounter with him, and which he called by a word which, being interpreted, signifies Hadrian's chase. Amongst the celebrated writers of the Augustan age, we may mention two, who, not being themselves sportsmen, could only have made sporting a subject for their pens from a sense of the benefits arising from it. Virgil makes his young Ascanius a sportsman as soon as he is able to sit his horse; and he also makes him, at a very early age, the first in the fight (*primum bello*), as he had been the first in the field. In the speech addressed to him by the bold Numanus, which cost that hero his life, we have the fittest contrast of the evils of effeminate habits with the benefits of manly pursuits, that the pen of a satirist could produce. The words, *O vere Phrygiæ, neque enim Phryges!* "Oh, worse than women in the shape of men," convey the severest rebuke a nation could receive for having made themselves contemptible to their enemies, by the effects of an effeminate life, and pursuits unworthy of men; whereas the advantages of the manly exercises of youth are finely set forth in the vaunting exclamation of this hardy Rutulian. Neither is Horace behind his contemporary poet in his disgust of an effeminate youth. In the twenty-fourth ode of his third book, he beautifully contrasts those softening pleasures which emasculate the mind and enervate the body, with the opposite effects of manly sports and exercises; and in his justly celebrated *Epistle* to Lollius, he recommends the chase, not only as a noble exercise, but as contributing to health and peace of mind. His *Carmen Sæculare* was also written in honour of manly exercises; and in another of his odes we find him upbraiding a young Roman for giving up the manly exercise of riding; and glancing at the destruction of Troy, and the feminine education of Achilles, seems to insinuate, that effeminacy was likely to destroy the energies of his own countrymen, as it had those of others. That his apprehensions were not unfounded, a few centuries proved; for the Romans, after the conquest of Persia and other distant kingdoms, participating in their luxurious habits, became as easy a prey to the Goths and Vandals, as the Grecians and other nations had before been to themselves; and, in the decline of the republic, the few victories which they gained were achieved but by the terror of their name. Minor poets have also made sporting their theme. Gratius wrote a poem on coursing. He was contemporary with Ovid, and a sportsman, as the knowledge of his subject denotes. Nemesianus also, three centuries afterwards, wrote some poems on hunting, though they have not been so highly esteemed. But the sports of the field are alluded to by innumerable classic writers, and made the groundwork of their most beautiful allegories and fables, both in verse and prose; and perhaps, after all, the greatest compliment that can be paid to them, as well as the best answer to the assertion that any man can make a sportsman, is to be found in the latter department of literature. We allude to the letters of that accomplished country gentleman and scholar, Pliny the consul, in which he speaks of his prowess in the chase. In one addressed to Tacitus the historian, boasting of a famous day's sport he had been enjoying, he also boasts of the good effect it had had on his mind, telling him that Minerva accompanied Diana on the hills; and in the eighteenth letter of the fifth book he goes a point beyond this: "As for myself," says he to his friend Macer, "I am employed at my Tuscan villa in hunting and studying, sometimes alternately, and sometimes both together; *but I am not yet able to determine in which of those pursuits it is most difficult to succeed.*"

Hunting.

It is not surprising that hunting should have been the theme of poets, as poetry then ceases to be the language of fiction; neither can the subject itself be deemed unpoetical, as it affords an opportunity to expatiate, not merely on the beauties, but also on the endowments of nature. That the feelings of nature have more of rapture in them than those which are excited through the medium of science, is a fact which cannot, we think, be denied; and thus do we account for the exhilarating passion of the chase. To describe a chase, however, is a task of no small difficulty, and perhaps more so in prose than in verse, as the imagination must be powerfully excited by the transporting scenes on which it has dwelt, and cannot well be restrained in a mere recital

Hunting. of facts. When the noise of the battle is over, powerful must be the pen that could revive the clang of arms. "The chase is done," sings Ossian; "and nothing is heard on Ardven but the torrent's roar."

Somerville's poem of *The Chase* will live to the end of time; for although it was not faultless in the eyes of the perhaps too rigid Johnson, it is written with the spirit and fire his subject demanded; and many of the instructions it conveys, when stripped of their poetical dress, are esteemed by sportsmen of the present day. "Manners," says Lord Kames, "are never painted *to the life* by any one to whom they are not familiar;" neither could a man have written the poem we speak of unless he had been himself a sportsman. Indeed his descriptions of hunting the hare, the stag, and the fox, place the objects clearly and beautifully before our eyes, and show that the poet had often witnessed with rapture the scenes to which he devoted his muse. The following passage, descriptive of the feelings of a master of hounds on a hunting morning, is not merely truly natural, but at the same time highly poetical:—

"Hail, gentle dawn! mild, blushing goddess, hail;
Rejoic'd I see thy purple mantle spread
O'er half the skies; gems pave thy radiant way,
And orient pearls from every shrub depend.
Farewell, Cleora! here, deep sunk in down,
Slumber secure, with happy dreams amused.
. . . . Me other joys invite;
The horn sonorous calls, the pack awak'd
Their matins chaunt, nor brook my long delay:
My courser hears their voice;—See there! with ears
And tail erect, neighing, he paws the ground:
Fierce rapture kindles in his redd'ning eyes,
And boils in ev'ry vein."

Although hunting *songs* are a species of ancient lyrics, of which the specimens are rare, and in our own country "the songs of the chase" do not appear to include any earlier than the middle of the seventeenth century, we have some of a more modern date that have been highly popular with the public, and no doubt have given the original impulse to many a good sportsman. The power and force of national songs have never been disputed in any age; and he who said that if he were allowed to compose the ballads of a nation, he would soon alter its form of government, uttered a boast not altogether unfounded in the principles of human nature. Compositions of this kind, then, that tend to encourage a love of manly pursuits and pastimes, and give a relish to a country life, should by no means be thought lightly of by a people who, like ourselves, have ever been conspicuous for our excellence in the one, and our fondness for the other; but which, in the opinion of some, appear to be on the wane, as the natural consequence of our present state of almost excessive refinement. This would be a real cause for regret. The fondness for rural life amongst the higher order of the English has hitherto had a great and salutary effect upon the natural character of their country; and there cannot be found a finer race of men than the country gentlemen of Great Britain. Instead of the softness and effeminacy which characterize the men of rank of most other nations, they exhibit a union of *natural* elegance and strength, a robustness of frame and freshness of complexion, which are to be attributed to their living so much in the open air, and pursuing so eagerly the invigorating recreations of a country life. Their hard exercise produces a healthy tone of mind and spirits, as well as of body, accompanied with a manliness and simplicity of manners, which even the follies of a town cannot easily pervert, and can never entirely destroy. Let us, however, hope that the fears on this head are groundless; let us hope that what Horace sighed for, what Cato, Plato, and Cicero recommended, what Bion eulogized, what all the best poets of antiquity sang the praises of (according to the poets, the golden age was spent in the country), and for which kings and emperors quitted their thrones, will never be ill suited to, or considered as beneath, the taste of a British country gentleman, in what circle soever he may move. That the sports of the field are classical, the authority of all ages will vouch for; neither is the man of fashion, or *haut ton*, by any means incompatible with the country gentleman and sportsman. On the contrary, how has the character of Paris been handed down to us by the poets? Was he not the finest gentleman, the greatest favourite of the female sex, the greatest beau of his day? Such he is represented to have been; but, although a prince, he had been bred a shepherd; and from the robust habits he had acquired in his youth, he was the only man who could stand up against the powerful arm of Dares, the great champion of his day. What was the all-accomplished Pliny, or Lollius, whose education Horace had superintended? Hunting.

Again; on the score of health, the chief felicity of man, were it not for the sports of the field, the softness and effeminacy of modern manners, in the higher walks of life, would soon exhibit their pernicious effects on forthcoming generations, by depriving them of their natural defence against diseases incident to our climate, by subjecting them to that morbid debility and sensibility of the nervous system which lays the foundation of most diseases, as also depriving them of the courage to support them. And who enjoys the blessing of health equally with the country gentleman and sportsman? Somerville says,

"In vain malignant steams and winter fogs
Load the dull air, and hover round our coasts;
The huntsman, ever gay, robust, and bold,
Defies the noxious vapour, and confides
In this delightful exercise to raise
His drooping head, and cheer his heart with joy."

Certain is it, the rough sports of the country have been known not only to cure diseases of long standing in the human frame; but the exercise of hunting, *with the temperance it enjoins*, absolutely steels the constitution, as the poet expresses himself, against the attacks of the most common of the diseases peculiar to this variable climate. Its effect on the mind, which he also alludes to, is of no less value; for, from the very exhilarating nature of the amusement, it relieves it from dwelling upon its anxieties, from which few persons are free; and it is one of the best cures for the heartache, or any of those shocks which our flesh is heir to:—

"Dona cano divum, *lætas venantibus artes*,
Auspicio, Diana, tuo,"

sang the poet Gratius; and Horace's description of a sportsman's return to his family, after the toils and perils of the day, is a true picture of a country life, replete with every possible enjoyment.

Objections have been made to encouraging youth in a love of our national field-sports, on the score of their engrossing too much of their time and attention, to the neglect of more necessary attainments. "It is true," says a Roman historian, "the masters in every branch of learning, whom the accomplished father of Commodus provided for his son, were heard with inattention and disgust; whilst the lessons of the Parthian, or the Moor, in the arts of the javelin and the bow, could not be too often repeated." But where is the pursuit that may not be carried to excess? and yet without zeal no person ever succeeded in field-sports of any kind, much less in hunting. "Whatever thy hand findeth to do, do it with all thy might," said Solomon; and had not Providence implanted this zeal in man's nature, he never would have been what man now is, but, comparatively a useless being. Objections are again made, that the sports of the field, hunting animals with dogs especially, are cruel; but the charge, if proved, does not altogether lie against man. The beasts and birds of the field have been given to him, as well as the way to procure them pointed

Hunting. out to him; or wherefore the almost unsearchable faculties of the dog? Some persons, however, have thought otherwise: "Is it a labour worthy of man," says a very celebrated English writer, "to watch from day to day, from night to night, the haunts of our fellow animals, that we may destroy them? To triumph over a poor mangled hare or hind, after we have harassed them up and down the country for many hours together with an army of dogs and men? Is it an exercise becoming the majesty of a rational spirit to run yawling with a parcel of hounds, perhaps a whole day together, after some timorous animal?" In answer to this it may be urged, that we knew no other method of availing ourselves of them when first they were given for our use; and it may be strongly urged, that the destruction of wild animals was never so speedily, and therefore humanely accomplished, as it is at the present day. A century or two ago, the fox lingered all night in a trap, and then too often was subjected to a lingering, if not an agonizing death. He is now killed by hounds, generally in a short time, if he cannot escape from what may be deemed his lawful pursuers. The buck in the forest of the king, or in the park of the nobleman, is now no longer hunted down by the slow but sure blood-hound, a race nearly extinct, but the unerring eye of the rifle-shot seals his doom on the spot. We agree with the poet, that

"Poor is the triumph o'er the timid hare;"

but she was given for our use, and must be taken, as Esau took the venison, *by hunting her;* and here likewise is an improvement. A hundred years back she was trailed up to her form, the operation perhaps of an hour, with the terror-striking notes of the hounds all that time in her ear; and then pursued for at least two hours more, by animals with not half her speed, but with a power of following her by the foot, which it was nearly impossible to evade. At the present day she is whipped out of her form, twenty minutes generally deciding her fate; and, in consequence of her being now pursued in the forenoon, instead of, as before, just on her return from her walk, she escapes oftener than she is killed. Animals destined to fall by the gun are now nearly certain of meeting with instant death. In addition to the increased skill of our marksmen, the improved formation of the gun enables it to carry destruction with a much surer hand, owing to the force and precision with which it carries its shot. Thus, if the game be stricken, it is stricken to instant death, not wounded and mangled by weak scattered shot. Another consideration presents itself in the discussion of this subject. Life is said to be "sweet;" but strip it of intellectual enjoyment, and its sweetness is very considerably abated. But we will go one step farther. The natural death of wild animals must generally be lingering, and often painful in the extreme; they have no relief to fly to, but perish as it were by inches. This being admitted, perhaps the hand that instantly deprives them of life may be deemed the hand of a friend.

No great satisfaction would arise from a reference to the practices of the ancients in the field, who, it appears from Virgil, hunted anything, from the wild ass to the stag; but, we have reason to believe, without much system, as far as their dogs had to do with it. We conceive the ancient Germans and Gauls to have been the best early sportsmen upon system; and the ancient Britons, who came originally from Gaul, and, according to Cæsar and Tacitus, were one of the widely-extended Celtic tribes, introduced, or rather brought with them from Gaul, that ardent passion for the chase for which Great Britain has ever since been remarkable. The Anglo-Norman and early English monarchs likewise all appear to have had a passion for the chase; and although a code of laws relative to hunting was formed by one of the Welsh princes in the twelfth century, containing a list of animals, climbing ones for example, which does not accord with the present idea of *hunting*, we hear nothing of fox-hounds *per se*, till we find them in the kennel of Edward I., and an item in his wardrobe book of L.21, 6s. as the annual expenses of his pack, consisting of six couples. Soon after this period, at all events in the course of the next king's reign, the diversion of hunting in England may be said to have been first reduced to something like a science; treatises having been written on the subject for the instruction of young sportsmen, as well as rules laid down for the observation and conduct of those who filled the various offices, in the forest, the kennel, and the stable. One of the most curious of these performances, is a manuscript written in the beginning of the fourteenth century, in Norman French, by William Twice, huntsman to Edward II., an ancient translation of which occurs amongst the Cottonian manuscripts. In it are enumerated and described the different beasts that were then objects of the chase in England; and, in the manner of a dialogue, the huntsman is informed how he should blow his horn at the different points of a chase. But the generally rude system of hunting in the earlier days of England had previously been in some measure improved and amended by William the Conqueror, of whom Somerville thus writes:— Hunting.

"Victorious William to more decent rules
Subdued our Saxon fathers; taught to speak
The proper dialect; with horn and voice
To cheer the busy hound, whose well-known cry
His list'ning peers approve with joint acclaim.
From him successive huntsmen learn'd to join
In bloody social leagues, the multitude
Dispers'd; to size, to sort, their warrior tribes,
To rear, feed, hunt, and discipline the pack."

Edward III. was a great stag-hunter; and even at the time he was engaged in war with France, and resident in that country, he had with him, attached to his army, sixty couples of stag-hounds, and an equal number of hare-hounds. We also learn from Froissart, that the Earl of Foix, a foreign nobleman, contemporary with King Edward, had 150 couples of hounds in his castle. But it does not appear that the fox was much in esteem for the chase by any of the Anglo-Norman sportsmen; for in Twice's *Treatise on the Craft of Hunting*, he is classed last of all the beasts of venery, excepting the martern and the roe; nor does Somerville in his poem treat him with the respect that he pays to the stag or the hare. The first public notice of him occurs in the reign of Richard II., who gave permission, by charter, to the Abbot of Peterborough, to hunt him. Hunting, however, in all its branches, appears to have advanced steadily till the last century, when it flourished greatly by the encouragement given to it by George III.; and as time improves every art, it has at length, we believe, attained perfection.

Whatever pastime mankind indulge in, their first endeavour should be to make themselves acquainted with the best means of pursuing it, which will greatly increase the pleasure derived from it. But as the philosopher was laughed at for his offer of teaching Alexander the Great the art of war, so the theory of no pastime is worth anything unless it be based on practice. And, perhaps, of all sports invented by reason for the use and amusement of mankind, there is none to which theory would avail so little as the noble and popular one of hunting. Indeed, the practical part of hunting, notwithstanding its popularity, is but little known, at least but little understood, from the perplexing difficulties that accompany it; and there is reason to believe it was still less understood before the appearance of a work in which the whole system is minutely and accurately detailed by an eminent sportsman, and master of fox-hounds, of the early part of this century. It is scarcely necessary to observe, that the work alluded to is Beckford's *Thoughts upon Hunting, in a series*

of familiar Letters to a Friend; of which it has been said, "they are so truly the effusions of sound judgment, and so replete with the useful remarks of an experienced sportsman, that there is no room for anything new or additional to be introduced upon the subject." It is true, this has been considered, and will continue to be considered, as a standard work amongst sportsmen; but as systems and habits change with time, and many of both have been materially changed since Beckford's day, another work on fox-hunting, also from a practical pen, made its appearance in 1826, and was well received by the sporting world, viz., *Observations on Fox-Hunting, and the Management of Hounds in the Kennel and the Field*, by Colonel Cook, several years a master of fox-hounds, hunting various English counties, but principally the Roothings of Essex, celebrated for the stoutness of its foxes.

It is only within a very short space of time that sportsmen have been given to communicate their thoughts, or the result of their experience in the field, to the public, unless under fictitious signatures. In proof, however, of the benefit derived from such contributions to the stock of sporting *science*, if such a term will be allowed; and likewise in confirmation of what has been advanced on the subject of change of systems and habits that occurs in the course of time, we will make a few comments on the practices of one of the most conspicuous sportsmen England ever gave birth to, the unrivalled Hugo Meynell, Esq. of Quorndon Hall, Leicestershire, and made partially known through the medium of a small pamphlet, entitled, *The Meynellian Science, or Fox-Hunting upon System*, by the late John Hawkes, Esq., a personal friend of Mr Meynell's. That Mr Meynell studied fox-hunting as a science, we believe no one will deny; and that his master-mind was quite equal to the task he imposed upon himself, is also an admitted fact; for he was a man of more than ordinary acuteness, coupled with a close and accurate observation of everything that passed under his eye; and all this with the benefit of an education perfected beyond the usual extent of that bestowed upon, or, perhaps we may say, submitted to, by young gentlemen of large fortune in his day, having studied nearly three years under a private tutor after he became of age. That he shone beyond all others who had preceded him, in the breeding and management of hounds, is a fact universally admitted, producing, as Mr Hawkes says of them, "the steadiest, best, and handsomest pack of fox-hounds in the kingdom;" adding also the emphatic remark, that his object was to combine strength with beauty, and steadiness with high mettle. His idea of perfect shape was, short backs, open bosoms, straight legs, and compact feet; and the first qualities of hounds he considered to be fine noses and stout runners, opinions which all found to hold good.

But there were peculiarities in Mr Meynell's system of hunting, to which, as detailed by Mr Hawkes, we scarcely know how to reconcile ourselves. For example, he tells us that his young hounds were broken in to *hare* in the spring of the year, "to find out their propensities, which, when at all flagrant, they early discovered, and he drafted them according to their defects;" and in the same page he adds, "after hare-hunting, they were, the remaining part of summer, daily walked amongst riot." Now we cannot approve of entering hounds to an animal they are not intended to hunt, and are at a loss to comprehend what is here meant by the word "riot," unless it be hares (as the term generally implies) or deer (which were never found wild in his country), which they had been previously instructed to hunt. Their "propensities," also, by which is here generally understood their steadiness or unsteadiness, must, under such circumstances, have been rather difficult to pronounce an opinion upon, with the exception of their promising to be true to the line, and not given to skirt. The goodness or badness of nose could of course have been discernible when hunting their own game (the fox), to which, in our opinion, all fox-hounds should be entered. Beckford, we remember, speaks of his huntsman letting his puppies enter to a cat; but we cannot approve of such a practice.

Early in the autumn Mr Meynell hunted his woodlands, Charnwood Forest chiefly, with his whole pack, and then divided them into "the old" and "the young pack;" but, to show the disadvantage of this system, Mr Hawkes says, the young hounds were hunted twice a-week, as much in woodlands as possible, and in the most unpopular districts." The present plan of mixing young and old hounds together is far preferable to this, not only as they can then take their turn in the good and popular "districts," but, by having the assistance of older hounds in chase, the younger ones are less likely to do wrong.

Mr Meynell's idea of *perfection* in hounds, in chase, Mr Hawkes says, "consisted of their being true guiders in hard running, and close and patient hunters in a cold scent, together with stoutness. Their imperfections, over-running the scent, and babbling, were considered their greatest faults." To all this every sportsman must assent.

The following passage contains perhaps rather more of enthusiasm than of fact, although a qualification is given to it in the concluding sentence. "Mr Meynell's hounds," says Mr Hawkes, "were criticised by himself and his friends in the most minute manner. Every hound had his peculiar talents, and was sure to have a fair opportunity of displaying them (!) Some had the remarkable faculty of finding a fox, which they would do, almost invariably, notwithstanding twenty or thirty couple were out in the same covert. Some had the propensity to hunt the doubles and short turns. Some were inclined to be hard runners. Some had a remarkable faculty of hunting the drag of a fox, which they would do very late in the day. And sometimes the hardest runners were the best hunters; and fortunate was the year when such excellencies prevailed."

"Mr Meynell," continues Mr Hawkes, "prided himself on the steadiness of his hounds, and their hunting through sheep and hares, which they did in a very superior manner. He seldom or never attempted to lift his hounds through sheep; and from habit, and the great flocks the hounds were accustomed to, they carried the scent on most correctly and expeditiously, much sooner than any lifting could accomplish." We are far from advocates for lifting hounds when it can be avoided; but knowing the so often insurmountable difficulties occasioned by flocks of sheep and herds of cattle in the country Mr Meynell hunted, in addition to a crowd of horsemen pressing upon the heels of the pack, we consider that if, under such circumstances, hounds do not almost instantly recover the scent, the assistance of the huntsman is called for. The "steadiness and docility" of Mr Meynell's pack, we have reason to believe, were remarkable, and are vouched for by other authority than Mr Hawkes'. "A most extraordinary instance of discipline in hounds," says Colonel Cook (p. 202), "occurs to me, which I ought to have mentioned when speaking of that unrivalled sportsman, the late Mr Meynell. He met in the Market-Harborough (Leicestershire) country, at a small patch of gorse on the side of a hill, in a very large pasture field: the hounds feathered as they went in, and found instantly. The covert being only about two acres, and open, Mr Meynell immediately saw that the fox was in danger of being chopped; he therefore called out to Jack Raven, the huntsman, "Jack, take the hounds away;" and at one of his usual *rates*, every hound stopped, and the pack were taken to the hedge side, when Mr Meynell called out three steady hounds, and threw them into the cover. The fox was so loth to break, that the three hounds kept hunting him for ten minutes, in the hearing of all the pack, who lay perfectly quiet at Raven's horse's feet, till the fox went

Hunting. away over the finest part of the country; and the moment Mr Meynell gave his most energetic, thrilling holloo (Mr Hawkes speaks of the power of Mr Meynell's cheering holloa, which, he says, "thrilled through the heart and nerve of every hearer"), every hound flew to him; the burst was the finest that any sportsman ever beheld, and after an hour and ten minutes they killed their fox." This is doubtless an astonishing instance of command of hounds with a scent before them, particularly so to those persons who are aware of the generally uncontrollable power of the impulse given to them by nature at that particular time; and were it not for the high reputation of the pack alluded to, we should, as we cannot doubt the fact, be inclined to say, it savoured a little of slackness, or, at all events, of a too severe discipline, bordering upon the annihilation of the distinguishing natural properties of the fox-hound, namely, high mettle and dash.

"Mr Meynell," adds Mr Hawkes, "was not fond of casting hounds; when once they were laid upon the line of scent he left it to them; he only encouraged them to take pains, and kept aloof, so that the steam of the horses could not interfere with the scent. It is true, hounds should not be cast, if they can do the work themselves; and if the authority of Mr Meynell could restrain a Leicestershire field of horsemen to keep aloof when his hounds were at check, more time may have been given them to make their own cast; but it must be recollected, that when the hounds are at fault, the fox is not." Again, "when his hounds came to a check, every encouragement was given to them to recover the scent, without the huntsman getting amongst them, or whippers-in driving them about, which is the common practice of most packs. The hounds were holloa'd back to the place where they brought the scent, and encouraged to try round in their own way, which they generally did successfully, avoiding the time lost in the mistaken practice of casting hounds at the heels of the huntsman. When the hounds were cast, it was in two or three different lots, by Mr Meynell, his huntsman, and whipper-in; and not driven together in a body, like a flock of sheep. They were allowed to spread, and use their own sagacity, at a very gentle pace; and not hurried about in a blustering manner. It was Mr Meynell's opinion, that a great noise, and scolding of hounds, made them wild. Correcting them in a quiet way was the most judicious method. Whippers-in also should turn hounds quietly, and not call after them in a noisy, disagreeable manner." In all the foregoing remarks we coincide with the opinions of these two celebrated sportsmen. We think a huntsman should never be nearer than from 60 to 100 yards of his hounds when they first check; nor can a whipper-in execute his office of turning or stopping a hound at this moment too quietly and discreetly; but no general line of conduct for either the one or the other can be laid down. Some hounds, and especially if they have been pressed upon by horsemen, will not turn to either horn or holloa, without a smack of the whip, or at all events a *rate;* nor will the body of the pack, if a little blown, or excited by a previous holloa, always try for their fox so well and *quickly* as they should do, if left quite to "themselves; or, as Mr Hawkes so properly expresses himself, if left to "their own sagacity." That a great noise makes hounds wild no one doubts, and the system of holloaing is every year on the decrease. As for the division of the pack into three lots when at fault, that perhaps originated with Mr Meynell: indeed we believe it did; but the practice is now become not uncommon, of its being divided into two, namely, one lot with the huntsman, and the other with the first whipper-in.

"When hounds are going to the cry," writes Mr Hawkes, "they should be encouraged in a pleasant way: not driven and rated, as if discord was a necessary ingredient in the sport and music of a fine cry of hounds. Whippers-in are too apt to think their own importance and consequence consist in shouting, holloaing, and unnecessary activity. When hounds can hear the cry, they get together sooner than any whipper-in can drive them. If any hound is conceited, and disinclined to go to cry, he should immediately be drafted." Hunting.

On the subject of blood, that is, killing and eating foxes, we entirely assent to the following remarks: "Blood was a thing Mr Meynell was more indifferent about than most masters of hounds. The wildest packs of hounds were known to kill the most foxes in cover, but very seldom showed good runs over a country. Hounds chopping foxes in cover is more a vice than a proof of their being good cover-hounds. Murdering foxes is a most absurd prodigality. Seasoned foxes are as necessary to sport as experienced hounds." Our own opinion of the value of blood to hounds perfectly accords with that which, it appears, was entertained by Mr Meynell; namely, that it is far from a *sine qua non* to the well-doing of fox-hounds, or any other hounds, as is apparent at once from the modern system of hunting the stag. If it be possible, the pack are not permitted to break his skin, much more to devour him; still, despite of the rating and flogging they get to prevent their injuring the object they are pursuing, they do pursue it to the last with all their might and main. But let it not be supposed that we set no value on what may be termed well-carried blood. On the contrary, we think the flesh and blood of a fox well found, and handsomely killed, by hounds in the moments of high excitement, must be very beneficial to them. But when chopped in a cover (generally the effect of accident, and not, as Mr Hawkes supposed, of vicious propensity in any individual hound), we consider a round of beef would be a more acceptable present to them; nor is the case much altered when a fox is dug out of an earth, after perhaps an hour's delay. We remember to have heard Mr Osbaldeston assert, that the best week's sport he ever had in Leicestershire when he hunted it, was after his hounds had been out nine days in succession without tasting a fox.

"Mr Meynell's natural taste," continues Mr Hawkes, "led him to admire large hounds; but his experience convinced him that small ones were generally the stoutest, soundest, and in every respect the most executive. His hounds had more good runs than any pack of his day. Two very extraordinary ones happened of a very rare description. One was a run of one hour and twenty minutes without a *check*, and killed their fox. The other was two hours and fifty minutes without a *cast*, and killed. The hounds in the first run kept well together, and only two horses performed it; the rest of the field were unequal to its fleetness. The other run alluded to was performed by the whole of the pack; and though all were up at the death, two or three slackened in their pace just at the last. One horse only went the whole of it."

Mr Hawkes thus speaks of the necessary qualifications of hounds to show sport:—"To obtain a good run, hounds should not only have good abilities, but they should be experienced, and well acquainted with each other. To guide a scent well over a country for a length of time, and through all the difficulties usually encountered, requires the best and most experienced abilities. A faulty hound, or injudicious rider, by one improper step, may defeat the most promising run." It is evident, from the above judicious observations, that an old established pack of hounds must have great advantages over one of an opposite character.

We shall finish our extracts from this little pamphlet, which was merely circulated privately amongst the author's friends, but valued as from the pen of so eminent a sportsman as the late Mr Hawkes proved himself to be, both in the field and on the race-course, where he shone conspicuously as one of the best gentleman jockeys of his day, with

Hunting. his judicious remark on the conduct of sportsmen who follow hounds. "Gentlemen, and every person who makes hunting his pursuit," says he, "should learn to ride judiciously to hounds. It is a contemplative amusement; and much good diversion might be promoted by a few regular precautions. The principal thing to attend to is, not to ride too near the hounds, and always as much as possible anticipate a check. By which means the leading men will pull their horses up in time, and afford the hounds fair opportunity to keep the line of scent unbroken. Sheep, cattle, teams at plough, and arable land, are all causes of checks. Thoughtless sportsmen are apt to press too much on hounds, particularly down a road. Every one should consider that every check operates against the hounds, and that scent is of a fleeting nature, soon lost, never again to be recovered."

The following is the concluding paragraph, affording a good specimen of the writer's enthusiastic love of fox-hunting, as also of a cultivated mind:—"Fox-hunting," he asserts, "is a manly and fine exercise, affording health to the body, and matter and food for a contemplative mind. In no situation are the faculties of man more displayed. Fortitude, good sense, and collectiveness of mind, have a wide field for exercise; and a sensible sportsman would be a respectable character in any situation in life. The field is a most agreeable coffee-house, and there is more real society to be met with there than in any other situation in life. It links all classes together, from the peer to the peasant. It is the Englishman's peculiar privilege. It is not to be found in any other part of the globe, but in England's true land of liberty; and may it flourish to the end of time!"

There is perhaps no part of the material of fox-hunting more interesting than the management of hounds in the kennel, which, we do not hesitate in saying, presents one of the most curious scenes that are anywhere displayed in the whole circle of the transactions of mankind with the inferior animal creation. To see sixty couples of those animals, all hungry as tigers, standing aloof in their yard (as is the practice in some kennels), and, without even hearing, much less feeling, the whip, not daring to move until the order is given to them to move. And what is the order given? why, at the words, "Come over, *Bitches*," or, "Come over, *Dogs*," every hound of each individual sex comes forward, as the sex it belongs to may be called for, leaving those of the other sex in their places; and then the act of drawing them to the feeding troughs is an exceedingly interesting sight. Often, with the door wide open, and the savoury meat in their view, the huntsman has no use for his whip, having nothing to do but to call each hound by his name, which of course he readily answers to. The expression of countenance, too, at this time, is well worthy of notice; and that of earnest solicitation, of entreaty, we might almost say of importunity, cannot be more forcibly displayed than in the face of a hungry hound awaiting his turn to be drawn. He appears absolutely to watch the lips of the huntsman, anticipating his own name. A view of a pack of fox-hounds likewise in their lodging-rooms, is a most agreeable sight to those who love to see animals in a high state of enjoyment, which no doubt hounds are when reposing on their well littered-down benches after a hard day's work, and with their bellies well filled. They absolutely appear to feel for each other's comforts, in placing themselves in situations that enable their fellow-creatures to repose parts of their bodies upon their own, to render their position for sleep and rest more agreeable to them.

The system of fox-hunting has been much changed since that sport commenced. Almost all foxes were once found by the drag, and the first challenge was loudly cheered in days when the game was scarce. A long drag, however, although a great test of *nose*, is by no means desirable, as, if it happens to be down wind, the fox takes the hint, and is off long before the hounds can hunt up to his kennel. It was nevertheless a fine feature in the sport, as the gradual increase of cry, the cheering holloas of the sportsmen, and the crash when the fox was unkennelled, contributed greatly to ennoble the scene, and created, as it were, two climaxes in a chase, when it ended in blood. But another disadvantage attended it. Hounds could not be depended upon, taking the average of scent, to hunt a drag that had become cold; so they were obliged to be out very early in the morning, which was not only disagreeable, as encroaching upon the sportsman's rest, but was coupled with the disadvantage, at all events with the risk, of finding a gorged fox, too full to run far, much less to run fast. The modern system does not require the drag, as woodland covers are comparatively small to what they used to be; gorse covers made for the purpose of holding foxes are easily accessible to hounds accustomed to draw them; and the game is in most countries so plentiful, that if a fox be not found in one cover, he is almost certain to be found in another, and that not far off. The consequence is, no more time is now lost in drawing two or three gorse covers, than the drag of one fox formerly occupied; neither did that always lead to a find. Moreover, at the present hour of finding, there is but little chance of unkennelling a gorged fox. Hunting.

It is by some asserted, that what are called woodland foxes are stouter runners than those bred in the artificial gorse and other covers, and we have good reason to believe they are so. But the great objection to large woodlands is the uncertainty of getting a run, from the difficulty of making foxes break from them, as they naturally hang to places which appear to afford them security; and it often happens that hounds, and the horses of the servants, have done a fair day's work before the run begins. On the other hand, we admit that a fox found in a wood of considerable extent is more likely to show a decidedly good day's sport, than one found in an artificial cover, and for this reason: he slips away unperceived, eight times out of ten, and consequently has time to look about him, and make his points, ere the chase commences: whereas a fox viewed away from a small gorse cover, within sight of a hundred or two of horsemen, is bullied, frightened, and soon blown, which occasions him to run short: and, of course, if the scent serves, and the hounds are good, he cannot live long, half an hour being as much as can be calculated upon under such circumstances. Gorse covers, however, if not too small,—not under three or four acres,—are indispensable in a hunting country, as foxes are very fond of them for their security against anything but fox-hounds; and another great advantage attending them is, that they can be placed wherever it may be thought desirable to place them.

The making of gorse covers requires no small attention, we had nearly said *skill*. The ground is all the better for being trenched to the depth of from a foot to a foot and a half, and it should be made as clean and in as good condition as if it were to be the seed-bed of turnips. The seed should be minutely examined, as it often fails from having lost its germinating properties; and it should be drilled in the ground, and hoed, after the manner of a turnip crop. By keeping it clean by the hoe, it will, if the seed be good, *and the land dry*, often hold a fox in the second year, but will seldom fail in the third. Some writers, Colonel Cook among the number, speak of broom being sown amongst gorse. This should never be, as all huntsmen who draw, or run through, broom covers, can vouch for their being decidedly inimical to scent. A novel description of fox-cover came into fashion a few years back in Leicestershire, but is not highly approved of, from the difficulty hounds experience in drawing it. Strong black thorn stakes are driven into the ground endways, at a small distance apart, and the rank grass and weeds growing rapidly over, and entwining with them, form a strong cover the first year; and it is found proof against a fall of snow,

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which gorse covers are not, and are often forsaken by foxes on that account. All artificially-made covers should be not nearer than half a mile at the least to any house or village; and if on a gently sloping bank, facing the south, foxes will like them better.

Some sportsmen object to many rides being cut through covers, as they are so often the cause of foxes being headed by the horsemen. The objection in part holds good; but a certain number of rides are necessary in all large covers, to enable the servants to get near their hounds, who might otherwise be disposed to run riot, as they soon discover when they are out of the reach of either rate or whip. Woodlands, with rides in them, are essential to the making of young hounds in all countries; and the finest in England are those of the Duke of Buccleuch, near Keltering, in Northamptonshire, within the limits of the Pytchley Hunt, with rides, or, speaking more properly, avenues in them, to the extent of upwards of fifty miles.

When speaking of the disadvantages of large woods, in which foxes are apt to "hang" or dwell, Colonel Cook recommends killing a fox, and letting the hounds eat him, in the middle of them; which we believe will generally have the desired effect. On the other hand, should a fox be killed in a small cover, he should, if possible, be carried out of it before the hounds break him up. One of the best gorse covers in the Dunchurch country did not hold for two or three seasons, because a dead fox was left in it.

The arrangement of earths, and the stopping of them, are matters of no small importance. Artificial ones are reckoned unhealthy for foxes; and the best are those made by badgers, which can always be commanded at pleasure, by turning out those animals in pairs. There are various methods of stopping earths, but none more secure than by a bunch of gorse, or furze, crammed well into the mouth of them, with the stalks pushed inwards. When earths are only slightly stopped, a fox will scratch his way into them; and as this very often happens, it shows the necessity of a careful and experienced earth-stopper; and it is better to pay for each day's stopping rather than annually in the lump, reserving the power to withhold payment in case of evident neglect. The expense of earth-stopping varies according to the nature of the soil, covers, &c.; but in certain countries it amounts to as much as L.200 per annum. It may also surprise some persons to hear, that the rent paid for covers in the Quorn Hunt amounts to upwards of L.2000 per annum. The multiplication of small artificial gorse covers has, however, sadly spoilt the breed of foxes, and converted many of them into mere "ringers;" while the cross with the small cowardly French fox has also done much towards destroying their dash. The only way to recruit a country is to bring cubs from Ireland or the Highlands, where the greyhound fox is still to be found in high perfection.

The following calculations of the expenses of a pack of fox-hounds are given by Colonel Cook, and admitted to be very near the mark; making allowance for the difference in the price of markets at the time he made them, and at others.

For Hounds hunting twice a-week :—	
Six horses, including groom and helpers	L.300
Hounds' food, for 25 couples	150
Firing	30
Taxes	80
Whipper-in and feeder	140
Earth-stopping	50
Saddlery	40
Farriery, shoeing, medicine, &c.	50
Young hounds purchased, and expenses at walks	60
Casualties	100
	L.1000
A second whipper-in, and two horses in addition	170
Total	L.1170

Expenses for three times a-week :—	
Twelve horses, groom, helpers, &c.	L.600
Food for forty couples of hounds	220
Firing	40
Taxes	100
Two whippers-in and feeder	210
Earth-stopping	65
Saddlery	80
Farriery, shoeing, &c.	80
Young hounds purchased, and expenses at walks	80
Casualties	150
Total	L.1625

Expenses for four times a-week :—	
Fourteen horses, &c.	L.700
Hounds' food for fifty couples	275
Firing	50
Taxes	120
Two whippers-in and feeder	210
Earth-stopping	80
Saddlery	100
Farriery, shoeing, &c.	100
Young hounds purchased, and expenses at walks	100
Casualties	200
Total	L.1935

"If you do not attend to the kennel department yourself," adds the Colonel, "but keep a huntsman, the expense will be at least L.300 more."

The only remark we have to offer on the foregoing calculations is, that the author does not allow a sufficient number of hounds for the several days' hunting in the week. For example, we venture to say, that no country could be hunted four times a-week with fifty couples of hounds; at all events, fifty couples of hounds equal to that work are very rarely to be found. We agree with the writer, that either four times a-week, or even twice, are preferable to three, for keeping hounds in regular work, when sound. But on the subject of expenses we have a word or two more to say. Knowing, as we do, that they generally, we believe we may say always, exceed the calculations made by Colonel Cook, and in some instances by double, we consider it rather inconceivable that either noblemen or private gentlemen should be expected or permitted to bear all the charge of hunting a country themselves, knowing, as we do, the great sacrifices of property and income that have already been made to a perseverance in keeping fox-hounds, unassisted by a subscription. The late Sir Richard Sutton, for instance, is supposed to have spent about L.8000 a-year over his stud and kennel, when he hunted the whole of the Quorn country at his own expense, with the exception of the rents of the covers. Hunting men are in fact becoming more and more anxious to have their sport at a master's expense; and too many do not subscribe at all, or what is worse, forget to pay up when they have put their names down. But this cannot go on much longer; nor indeed is it, with some exceptions, fit that it should; and, in support of our assertions, we will quote the sentiments of a writer on this subject, admirably well expressed, in an old number of the *New Sporting Magazine*, which equally applies to the present day.

After hinting at the probable decline of a sport, from this cause alone, which Mr Burke described as "one of the balances of the constitution," he thus proceeds:—"As to the total abolition of the sport, we anticipate no such event. It is the favourite sport of Englishmen; and that which a man likes best he will relinquish last. Still, with the exception of countries that boast their Clevelands, their Yarboroughs and Suttons, their Graftons, Beauforts, Rutlands, Fitzwilliams, Segraves, Middletons (his lordship is since dead), and Harewoods—their great and sporting noblemen, in fact—we feel assured that, unless something be speedily arranged, half the packs in England must either be curtailed of their fair proportion of sport, or abolished altogether. This is not as it should be. Men are as fond of

Hunting. hunting, at least of riding to hounds, as ever; but though we feel that we may be telling a disagreeable truth to many, the fact is, that most men want to hunt for nothing. The day for this, however, is fast drawing to a close. The breed of country gentlemen who keep hounds—the Ralph Lambtons, the Farquharsons, the Assheton Smiths, the Villebois, and Osbaldestons—are fast disappearing, in all probability never to be renewed. True that it is a fine, a proud sight, to see an English country gentleman spending his income on his native soil, and affording happiness and amusement to his neighbours, receiving their respect and esteem in return; but we cannot help feeling, that unless a man has one of those overwhelming incomes that are more frequently read of than enjoyed, it is hardly fair that the expenses of a sport which affords health and recreation to hundreds should fall upon his individual shoulders. Heirs at law will not be hindered by the remoteness of relationship from impugning the conduct of their ancestors; nor will it be any consolation to a son, on coming into possession of an overburdened estate, to know that the difficulties which oppress him were incurred for the purpose of keeping a pack of fox-hounds, by which his father afforded amusement to the country."

Fox-hunting is a sort of prescriptive right, which England has claimed from a very early period; and, more than this, it has long been considered that the common law allowed persons to enter the lands of another in pursuit of a fox, the destruction of which was presumed to be a public benefit. This opinion was founded on the celebrated case Grundy *v.* Feltham (1, *Term. Reports*, p. 334); but in that of Earl of Essex *v.* Capel, Summer Assizes, 1809, the legality of hunting foxes over the land of another is rendered very questionable. This being the case, it is a great compliment to the sport, as no doubt injury of land to a certain amount, though small, is occasioned by it, that it is permitted to the extent to which we see it, in every county in Great Britain; and that an action of trespass is an unusual occurrence, must be considered as still more creditable to the yeomanry and tenantry who live by the occupation of land. On the other hand, however, it must be remembered, that the produce of land is very considerably enhanced by the great demand, as well as extra prices given, for hay, corn, and straw, as likewise by the encouragement to breeding horses; and that, wherever there is a colony of fox-hunters, it is accompanied by a great influx of money, which is expended in the immediate neighbourhood. Cecil, in his admirable *Records of the Chase*, gives it as his opinion that about 15,300 hunters are kept in England and Wales alone, and that, taking the average for the keep of each horse at L.40, no less than L.612,000 is circulated through the medium of horse and hound annually. The United Kingdom contains about 105 packs of fox and stag hounds, and about 90 of harriers, otter-hounds, and beagles. By far the largest number of packs is kept in Devonshire, but although every one there goes a hunting, it is the worst hunting ground in England, not excepting the Craven, where John Warde considered that "he was sent as a punishment for his sins."

There were formerly three established classes of hunting in Great Britain, each of which had advocates, as it may have been suitable to situation, fortune, time of life, &c.; and although the struggle for superiority has ended in favour of that of the fox, we have reason to believe, that since what are termed "*packs of hounds*" have been established, hunting the stag or buck claims precedence of the hare; the hare of the fox; the otter, perhaps, of all. We will then offer a few more remarks upon them, as we have ranked them here.

Since the stag has ceased to be drawn for, and found in his native majesty, and hunted as a wild animal, "stag-hunting" has lost all its interest with the sportsman; and when we say that the chase of no other animal is, after all, from first to last, so full of interest as that of the stag, the sportsman has some cause for regret. But wild-stag hunting could not have remained one of the popular diversions of Great Britain, for two sufficient reasons. First, from the country being so generally cleared of wood there would have been a great scarcity of game; and, secondly, from the circumstance of the stag being, by his nature, unfit to be hunted during some of the months that sportsmen like to be on the field. The act of harbouring the deer, however, must be considered as amongst the very highest branches of the sportsman's art, and one which none but a well-practised sportsman could perform. Neither was the hunting to death of the wild stag by any means so easy a task as might be supposed, from the bulk of the animal, which it must be proportionally difficult for him to conceal. On the contrary, like the harts of Meandros, flying from the terrible cry of Diana's hounds, the "wise hart," or *cerf sage*, as he is termed in ancient hunting, knows how to foil hounds perhaps as well as, or better than, most other wild animals, and is allowed to consult the wind in his course more than any of them. It is also said of him, that he will, when pursued, rouse other deer from their lair, to induce the hounds to run counter, or change; and his device of taking soil, with nothing but the nose to be seen above the water, or, running down a stream, and seeking for a hard and dry road when pressed, are facts too well established to require comment. There is not a nobler sight in nature than that of a full-headed stag roused from his lair by hounds, and majestically trotting before them, snuffing the air as he goes, and appearing to care little for his pursuers, from confidence in his natural powers. That these powers are great, all modern stag-hunters are satisfied of; and those of endurance, when chased, are allegorized in the fable of the Mænalæan stag, the running down of which is said to have occupied Hercules for a year, and was in consequence counted amongst the labours of that hero. That deer are superiorly winded animals, is apparent by the immense height they can leap, just before they die from bodily exhaustion. A popular error has attributed this to the existence of the *fossa lacrymalis*, which was supposed to furnish a breathing place at the corner of each eye. Oppian must have supposed, by the following line, that they had *four*;—

"Τετραδύμοι ῥῖνες, πίσυρες πνοιῇσι διαύλοι,"

which was a mistake of the sporting bard; and some writers have made Aristotle say, that goats breathed at their ears, whereas he directly asserts the contrary. The classic writers, however, as well as our own poets, have taken some of their most beautiful similes from the chase of the deer; for example, Virgil's comparing the flight of Turnus to a stag trying to escape from the toils; and the death of the favourite hind by the hand of the young Iulus, a masterpiece of pastoral poetry. But the death of the stag has been a favourite theme of our own poets; and both Shakspeare and Thomson have been equally happy in their description of the last moments of the antlered monarch of the forest; the latter particularly:

. . . . . "He stands at bay,
And puts his last weak refuge in despair.
The big round tears run down his dappled face:
He groans in anguish; whilst the growling pack,
Blood-happy, hang at his fair jutting chest,
And mark his beauteous chequer'd sides with gore."

A kind of technological dictionary is required to almost all sports of flood and field. Of the technical terms in deer-hunting Nimrod thus speaks:—"What we fox-hunters call the ball or pad of a fox on foot, they term the 'slot.' We drag up to a fox; they draw on the slot, or walk up a deer. We find, or unkennel a fox; they rouse, or unharbour a deer. A fox runs up and down a cover; a

Hunting. deer beats up or down a covert, or a stream. With us, a fox is headed (turned back, or driven from his point); with them, a deer is blanched. We say, a fox stops or hangs in a cover, in a run; they say, their game sinks. We recover our fox; they fresh find their deer. We run into (kill) our fox; they set up the deer. The fox is worried; the deer is broken up. The fox goes a clicketing; the deer goes to rut. The fox barks; the stag bellows. The billiting (excrement) of the one is termed the feument or feumishing of the other. The brush of the fox is the single of the deer. The mask of the fox is the snout or nose of the deer. The view, the foil, the tally-ho, and who-whoop, are common, I believe, to all; but 'currant jelly' and 'sweet sauce' are not in the fox-hunter's vocabulary." "There are some expressions here," continues Nimrod, "which require farther explanation than I am able to afford them; and it is almost presumptuous in me, without any assistance at hand, to attempt giving an opinion on the subject. The word 'harbour,' however, is one of common acceptation, and implies a place of refuge. To unharbour a deer has long since been settled by Pliny,—'*Excutere feram cubili.*' The expression is clear, and falls smoothly on the ear. Not so with 'taking soil:' it savours of filth, and is only applicable, in this sense, to a hog delighting, in the summer months, to wallow in mud or dirty water, previously to going to his bed. To 'beat up and down' is only another way of expressing to run to and fro, and is found in Terence, in the word *cursito.* The deer being 'set up,' can only be in allusion to his having his throat cut; for Cicero speaks of a man being 'set up' to have that pleasant operation performed,—'*In cervicibus* imponere *dominum.*' The stag roused from his lair has certainly a great superiority over unkennelling the fox. The latter is tame and puny, whereas the former is bold and classical, and quite in association with the wildness of the forest, of which this animal is the monarch. The lair is but another word for the den; as we read in Virgil's celebrated contrast of a town and country life, in which he so beautifully describes the manly pursuits of the latter; and likewise in the hunting scene with Dido and Æneas. The word feument I never heard before, but conclude it is derived from the Greek word φύρμα, *recrementum.*"

The following is Nimrod's description of a full-headed deer:—"A perfect head, I find, consists of brow, bay, tray, and three on top of each horn; but some have brow, bay, tray, and five on each horn, though these are rare."

Of the powers of endurance of a deer before hounds, as also of his subtlety in foiling them, the same writer thus speaks:—"When we reflect on the powers of a stag, and look at his qualities for speed, we cannot be surprised that, when not overladen with flesh, or a 'heavy deer,' as he is then called in Devonshire, he should afford some extraordinary chases. The following well-authenticated facts will speak to their powers of locomotion: 'When Sir Thomas Acland kept the hounds, a farmer in the neighbourhood of Holnicote House, saw a stag one evening in his fields, with a particular spot on his side. The next morning he met this same stag running in great distress, with the hounds close at his haunches, and he soon afterwards sank before them. On his asking Sir Thomas where he had found him, he learnt that it was 25 miles, as the crow flies, from the place where he was killed. He must therefore have travelled that distance in the course of the previous night.'" Again, on the power of leaping, which we have already noticed, and particularly in allusion to their wind, when otherwise much distressed, we find the following remark:—"On my return from hunting on the preceding Tuesday's hunting," says Nimrod, "I was shown a leap, in Lord Fortescue's park, which a hind had taken last season before this pack, after a long run, and not ten minutes before she sank before them. What makes it more extraordinary is, that, on being paunched, a calf was taken from her almost able to stand. The fence was a stone wall, with a rail on the top of it, not to be broken; and your readers may judge of its height from the following statement, having had no other means of measuring it: My own height is 5 feet 9 inches; the horse I rode is 15 hands 2 inches high; the top of the fence was upwards of 2 feet above the crown of my hat; and it was up a steep bank that she approached it. The stag we ran went up to this fence, but did not attempt to leap it." Hunting

From the adverse circumstances attending it in a country like Great Britain, so generally free from large tracts of woodlands, which the red deer delights in, and also so much intersected with streams, real stag-hunting can never be again reckoned amongst the popular diversions in England, a good substitute for it is found in the turning out deer before fox-hounds in the neighbourhood of the metropolis, which has the advantage of affording a certainty of something in the shape of a run, and frequently very long ones, to persons whose time is precious, as well as the opportunity of, in a great measure, selecting the country best suited to the habits and propensities of the game. There are a number of stag-hunting establishments in England, and there has been a royal establishment of this nature throughout several successive reigns. In that of George III. stag-hunting was in high repute amongst the nobility and gentry forming the court, as well as of others residing in its neighbourhood. Mr Beckford said little about it, because he knew little: the reason he himself gives; but the following expression in his book relating to it made a deep impression on fox-hunters, who reluctantly acknowledge its truth:—"Could a fox-hound," says Mr Beckford, "distinguish a hunted fox, as the deer-hound does the deer that is blown, fox-hunting would be complete."

The roe-buck has partaken of the same respite from the chase as the wild red deer, although by the old laws of the forest he was not considered as venison until hunted; and, according to Cæsar, the Britons did not eat this animal at all. The fact is, the roe-buck runs so short, after the first ring, that he is said to hunt the hounds, instead of the hounds hunting him; an artifice by which he hopes to elude his pursuers, as, of course, it must produce a confusion of scents. Neither does his cunning end here. When closely pursued in a thick wood, he will bound to one side of a path by a sudden spring, and, lying close down upon his belly, permit the hounds to pass by him without offering to stir. But the beauty of form and elegance of motion of the "favourite roe" ought to protect it from the chase. There has been only one pack of roe-buck hounds kept in Great Britain, and that was by a gentleman of the name of Pleydell, of Whatcombe House, near Blandford, Dorsetshire, lately deceased, in whose covers these animals abounded, as they also do in various parts of Scotland.

Hunting the *otter* was a sport much thought of in England, and is of very early date, chiefly perhaps for the great value set on fresh-water fish. The system of hunting the otter is this: The sportsmen go on each side of the river, beating the banks and sedges with the hounds. If there be an otter near, his "seal" (foot) is soon traced on the shore; and, when found, he is attacked by the sportsmen with spears, when he "vents," that is, comes to the surface of the water to breathe. If he be not soon found by the river side, it is conjectured he is gone to "couch" inland, for he will occasionally go some distance from his river to feed. He is traced by the foot, as the deer is; and when found, and wounded in the water, he makes directly for the shore, where he maintains an obstinate defence. He bites most severely, and does not readily quit his hold; on the contrary, if he seizes a dog in the water, he will dive with him to the bottom of the river, and will never yield to him whilst he has life. This sport is still pursued in the few

Hunting. fenny and watery districts that now remain in England, and has for a long time been confined principally to those parts where, from local circumstances, the other more noble and exhilarating distinctions of the chase cannot be conveniently enjoyed. An attempt, however, was at one time made to revive it, by an Oxfordshire sportsman, Mr Peyton, only son of Sir Henry Peyton, Bart., of which an account may be found in the *Oxford Journal*. By this, two facts were established; the one, that otter-hunting spiritedly pursued is not a tame diversion; and the other, that the charge against this animal of destroying young lambs and poultry, is not altogether unfounded.

The otter-hound is not a distinct kind of hound, the strong rough-haired harrier answering the purpose best, provided he will hunt a low scent, as the game shows no small sagacity, as well as circumspection, in guarding against assault from man or dog. In 1796, on the River Worse, near Bridgenorth, Shropshire, four otters were killed, one of which stood three, another four hours before the hounds; and in 1804 the otter-hounds of Mr Coleman of Leominster, Herefordshire, killed an otter in a mill pond, which is said to have weighed thirty-four pounds and a half; supposed to have been eight years old, and to have consumed a ton of fish or flesh annually, for the last five years. They often destroy much more than they consume, for they will go on killing when their prey is plentiful, eating only a small portion of each fish. Mr John Dixon lately imported some Durham otter-hounds to Canada, and we hear that they are generally considered to be better adapted for bear-hunting than any description of dog which has yet been sent over.

Hare-hunting claims precedence of fox-hunting in the sporting chronology of Great Britain, and we believe of all other countries, inasmuch as a hare has always been esteemed excellent eating, and a fox the rankest of carrion. We gather from Xenophon that it was practised before his day, and he wrote fully upon it above three centuries before Christ; both hounds and nets being then used in the pursuit. Neither can we marvel at hare-hunting being the favourite diversion in all nations given to sporting where the use of the horse in the field had not become common. But we will go a point farther than this, and assert that, how inferior soever may be the estimation in which hunting the hare is held in comparison with hunting the fox, no animal of the chase affords so much true hunting as she does, which was the opinion of the renowned Mr Beckford.

In our description of the modern harrier (see article Hound), we have termed him the fox-hound in miniature; and we may apply the simile to hare-hunting, which now, as long as the chase lasts, greatly resembles fox-hunting, only on a minor scale. In the modern system there is no tracking to the seat with the one, any more than dragging up to the kennel with the other; but both animals are now chiefly stumbled upon by accident, and instantly fly for their lives. With the system of hunting also has the kind of hound been altered; there being now no longer occasion for that nice distinction of scent which was wanting to be a match for the windings and doublings a hare was able to make in her course when hunted by the slow and fastidious southern hound, and which was essential to the finding her at all, in countries where hares were scarce, by the perplexing means of a very cold trail.

In proof of our assertion, that there is more of true hunting with harriers than with any other description of hounds, we shall point out a few of the difficulties which they have to overcome. In the first place, a hare, when found, generally describes a circle in her course, which is in itself not only more difficult to follow, but it naturally brings her upon her foil, which is the greatest trial for hounds. Secondly, the scent of the hare is weaker than that of any other animal we hunt; and, unlike some, it is always the worse the nearer she is to her end; which accounts for its being better, and lasting longer, when going to her seat. than when running Hunting. There is scarcely any scent from a hare until she is in motion; therefore hounds constantly draw over her; and, of course, according to the length of time she has been gone to her seat after feeding, will be the difficulty of hunting her by the trail. In fact, at the most distant part of her previous night or morning's walk, the most tender-nosed hound in a pack will be scarcely able to own the scent at all. But the grand puzzler of all is, when hounds get upon the counter trail, about the middle of a hare's work, and the scent lies so equal that it is most difficult to distinguish heel from chase. No such difficulty as this can occur in any other description of hunting, and can only be obviated by the skill and experience of the huntsman in his notice of the working of his hounds. But although this difficulty is alluded to by almost all writers on the chase, we know not where to look for directions to the huntsman at the critical moment. It is true, Mr Daniel, in his *Rural Sports*, says, "To find out this, see if your hounds challenge counter; if they double and carry it on counter, they will soon signify their error by opening singly." We conceive there is some reason in this remark, but it will not always avail. Hounds, harriers in particular, are fond of a scent; and if they cannot carry it forward, they will turn and hunt it heel; and here it is that the judgment of a huntsman turns to account. One with a keen eye, and *a perfect knowledge of his hounds*, may be able to unravel this mystery perhaps six times out of ten; but it is in no man's power to be sure of doing it. His chief guide is in the cry of his pack at this time, which will slacken instead of getting fuller if the scent be heel, as the experience of old hounds adds to their natural instinct the faculty of judging whether it is leading them to their prey or from it.

The great perfection of modern harriers is the head they carry over a country, the result of the pains now taken in breeding them of the same size and character; whereas, upon the old system, which was all for *the pot*, the chief dependence was upon a few couples out of the whole pack, the rest being wheresoever they liked or were able to be in the chase. On the other hand, it may be said modern harriers have not the nose and patience of the old sort, which perhaps they have not; but what they may lose in those respects they more than gain in another, viz., by being nearer to their game in chase, and, by pressing her, not allowing her to make more than half the work she was able to do when pursued by slow hounds. In fact, the want of speed, and tedious exactness, of the southern hound, rendered the warmest scent, after a short time, cold; which may be proved from the fact of an hour being the average time of killing a hare, in former days, with a good scent; and from three to four with what is called a "fair," a "holding," or a "half scent." For our own part, speaking as fox-hunters, yet abandoning all prejudices against a sport it is too much the fashion to hold cheap, we consider that, to any man who is a real lover of *hunting*, that is, of seeing hounds do their work, and do that work well, a twenty minutes burst over a good country, with a well-bred pack of harriers of the *present* stamp and fashion, affords a high treat. To see them to advantage, however, it should be over a country in which the fields are large, and the fences stone walls, like those of Oxfordshire or Gloucestershire; for harriers, being for the most part obliged to *meuse*, strong hedges prevent their carrying a head in chase, which is the chief beauty in all hunting.

Somerville has these appropriate lines on the adaptation of hounds to their game:—

> "A different hound for every chase
> Select with judgment; nor the timorous hare
> O'ermatched, destroy; but leave that vile offence
> To the mean, murderous, coursing crew, intent on blood and spoil."

Harriers should not be too large, certainly not more than

Hunting. 18 inches high, or, by their speed, and, if good withal, they will much overmatch their game; but in a good and open country there should never be less than from eighteen to twenty couples in the field. A strong pack not only adds to the respectability of the thing (at all events, a small one greatly detracts from it), but, in our opinion, more hounds are wanting to pursue an animal that runs short, than one which, like the fox, generally makes for a distant point. The opinion of Mr Beckford is in opposition to us here. He says, "the fewer hounds you have, the less you foil the ground, which you will find a great hindrance to your hunting;" but it must here be remarked, that in the preceding sentence this eminent sportsman speaks of the difficulty of getting a strong pack of harriers to run well together, a difficulty which no doubt existed in his day, but is totally overcome in the best hare-hunting establishments of ours. Indeed, we once heard a sportsman declare, and he was a sportsman who had hunted in all the best countries in England, that he had never seen a chase quite complete from end to end, not a single hound being out of place, until he saw it with a pack of harriers over the Cotswold Hills.

The following passage from Beckford is worthy of his pen, and should be strictly observed by all masters of harriers:—"Harriers, to be good, must be kept to their own game. If you run fox with them, you spoil them. Hounds cannot be perfect unless used to one scent and to one style of hunting. Harriers run fox in so different a style from hare, that it is of great disservice to them when they return to hare again. It makes them wild, and teaches them to skirt. The high scent which a fox leaves, the straightness of his running, the eagerness of the pursuit, and the noise that generally accompanies it, all contribute to spoil a harrier." We conclude that the writer here alludes to hunting wild foxes, which is now very rarely done with a pack of harriers, at least in a country near to which fox-hounds are kept. No master of harriers would do it, who wishes his pack to be perfect: and there are other reasons for his not doing it, which it is unnecessary to mention. But the very best understanding now generally exists between masters of fox-hounds and masters of harriers; and it is a common practice of such of the latter as reside in a fox-hunting district, to await the publishing of the fox-hunting fixtures before they make their own.

The following hints may be useful in hunting the hare. First, respecting the hare herself:—Hares breed from February to the end of harvest, and are said to live seven years. The buck affords the best sport, particularly *in the spring*, when, after one or two rings, he often goes straight on end for several miles. Hence the proverb, "as wild as a March hare." Some persons pretend to distinguish the sex upon the seat; at all events, the head of the buck is shorter, the shoulders redder, and the ears redder, than those of a doe; he is also larger, and his hind parts are of a lighter colour. If the claws are smooth and sharp, and the ears tear easily, the hare is young.

The difficulty of finding a hare by the eye is well known. It is an art greatly facilitated by experience, although not one person in ten who attempts it succeeds in it. But here we recognise the Hand that furnished her with such means for her security; as, from the delicacy of her flesh, she is the prey of every carnivorous animal, and her means of defence are confined only to her flight. In going to her form, she consults the weather, especially the wind, lying always, when she can, with her head to face it. After harvest, hares are found in all situations; in stubble fields, hedgerows, woods, and brakes; but when the leaves fall, they prefer lying upon open ground, and particularly on a stale fallow, that is, one which has been some time ploughed; as likewise after frost, and towards the spring of the year. In furze or gorse, they lie so close as to allow themselves nearly to be trodden upon, rather than quit their form. The down or upland bred hare shows best sport; that bred in a wet, marshy district, the worst, although the scent from the latter may be the stronger. If a hare, when not viewed away, runs slowly at first, it is generally a sign that she is an old one, and likely to afford sport; but hares never run so well as when they do not know where they are. Thus, trapped hares, turned out before hounds, almost invariably run straight on end, and generally till they can run no longer; and they generally go straight in a fog. Hunting.

The chase of the hare has been altered, and rendered less difficult in some degree, by the improvement of the hound used in it. In the first place, she is now so pressed by the pace at which she is hunted, that she has not time, when first started, to visit the works of the preceding night; nor is she, from the same cause, so likely to run her foil. But when making out her foil, hounds are not let to puzzle over it now as formerly, but, if it be not quickly done, are rated forward by a whipper-in, to make good the head, and if that do not succeed, to make it good round the fences. Formerly, when hounds were at fault, the cast was made in a small circle to begin with, and then their huntsman tried wide; whereas they now generally, and especially if the game is supposed to be not far before them, make a wide cast at first, and then contract the circle if the wide cast fails. There is reason in this; for if the hare is on, the wide cast will cross her; and if she is not, she has most likely squatted. The old system was, "avoid a view, if possible." The modern one rather encourages a view, but no halloaing: for as hares regulate their speed in great measure by the cry of hounds, they are less apt to have recourse to shifts when the cry bursts upon them at once. In fact, to suit the taste of the day, which is to have every thing that moves fast, it was necessary that the greater part of the system of hunting the hare should be changed. It used to be insisted upon, that harriers should never be lifted as long as they can possibly carry a scent; and Beckford says, "a hare is not fairly hunted unless the pack be left almost entirely to themselves; that they should follow her every step she takes, as well over greasy fallows as through large flocks of sheep; nor should they be cast but when nothing can be done without it." This may have been all very well when gentlemen followed hounds on foot, or were content to be some hours killing one hare; or for Mr Beckford himself, who (although he admits having bred an infinity of harriers before he could get a pack to please him) thought hare-hunting should be taken as a ride after breakfast, to get an appetite to dinner.

But we have reason to believe, if a master of harriers of the present day wished to show his pack to advantage, and could have a choice of a run to display them, he would say, "Give me twenty-five minutes *in all*; the first fifteen a severe burst; then a fault, well hit off; and the remaining ten without a turn." But, it may be asked, wherefore the fault? We reply, because, although the speed of well-bred harriers, for a certain time, if not quite equal to that of fox-hounds, is too much for most hares, as well as for most horses that follow them, yet, after that certain time, say fifteen minutes, wind and power begin to fail, and a short check is useful. Besides, the ability of a pack, in quickly recovering a fault, is more than a counterbalance to their coming to a fault at all, which, with a short running animal, as the hare is, it is often difficult to avoid, nay, rather to be looked for indeed in every field.

The difference in the terms used in hare-hunting and fox-hunting is comprised in a few words:—Harriers are cast off in the morning; fox-hounds throw off. The hare is found by the quest or trail; the fox by the drag. The hare is on her form or seat; the fox in his kennel. The young hare is a leveret; a fox a year old is a cub. The view holloa of the hare is, "Gone away;" of a fox "Tally-ho." The hare doubles in chase; the fox heads back, or

Hunting. is headed. The harrier is at fault; the fox-hound at check. The hare is pricked by the foot; the fox is balled or padded. The hare squats; the fox lies down, stops, or hangs in cover; the "who-whoop" signifies the death of each.

Our ideas of a complete pack of fox-hounds are very soon expressed. For four days' hunting in the week there should be not much less than sixty couples of working hounds; nor do we think more are necessary, as hounds, like horses, are always better and sounder when in regular work. For three days in the week, forty couples are enough. They should have at their head not only a huntsman, but also a master, each of whom knows his business, and one *clever* whipper-in, and another as clever as you can get him. It is not necessary, because it is not feasible, that they should all be good drawers of covers; but it is absolutely necessary to perfection that they should all get to work as soon as a fox is found, and prove themselves true on the line their game has gone. As to their being quite free from riot on all days, and on all occasions, the man is not yet born *who can say with truth*, "my hounds *never* run riot." Nature is seldom extinguished; and as Æsop's damsel, turned to a woman from a cat, behaved herself very well till the mouse appeared, so will hounds occasionally break away upon riot, particularly when out of sight of the servants, in large covers, or when disappointed by a long blank draw. We conceive a pack of fox-hounds entitled to be called "steady from riot," if they will bear being put to the following test:—If, when at fault for their fox, in the middle of a large field, a hare gets up in view, and not a hound stirs, nor attempts to break away after her; and this without a word being said to caution them. But it is in chase, with only a holding scent, that a pack of fox-hounds display their excellence. In such a case as this there must be checks; and it being ten to one against their fox running straight, because they cannot press him, now is the time to see them work. Do they carry a good head when the scent is a-head, and serves them well? Are they cautious when it does not? And do they turn short when the game has turned right or left, or is gone back? Are they careful not to overrun the scent, and will they stand pressing to a certain degree by the horsemen? But having overrun it, do they stop directly, and make their own cast? Should that fail, do they come quickly to horn or holloa—to their huntsman's cast? Do they fling for a scent when their huntsman lifts them to points, and not attempt to *flash*, or break away, without a scent? When the scent serves well, do they not only carry a good head over a country, but, as their game is sinking, does the head become better? If they do all this, and have speed and stoutness withal, they are equal to any fox in any country, and are worth a thousand sovereigns to a sportsman.

The number of fox-hounds taken into the field depends chiefly upon country; more being required in that which is woodland, than for an open champaign, or for our inclosed grass districts, such as Leicestershire. Eighteen couples are generally considered as sufficient for the latter; and the strongest woodlands do not require more than from twenty-two to twenty-five couples; and we consider the latter the more common number, in the field, of any pack in any country.

The average speed of fox-hounds is estimated at ten miles, point blank, over a country, with a good scent, in one hour; that is to say, making allowance for deviations from the straight line, hounds seldom go more than ten miles, from point to point, in that space of time. Mr Beckford has a very judicious remark on this part of his subject. "That pack," he writes, "may be said to go the fastest that can run ten miles the soonest, notwithstanding the hounds separately may not run so fast as many others. A pack of hounds, considered in a collective body, go fast in proportion to the excellence of their noses and the head they carry; as that traveller gets soonest to his journey's end who stops least upon the road. Some hounds that I have hunted with would creep all through the same hole, though they might have leaped the hedge; and would follow one another in a string, as true as a team of cart-horses. I had rather see them, like the horses of the sun, *all abreast*."

Hunting.

There is nothing in the history of our domestic sports and pastimes to inform us correctly as to the date of the first regularly-established pack of fox-hounds kept in England. Neither the holy prioress of St Alban's, Dame Juliana Berners, Markham, nor any of the very old writers on such subjects, are able to satisfy us on this point; but, on the authority of the Rev. William Chafin, in his *Anecdotes respecting Cranbourn Chase*, the first real steady pack of fox-hounds established in the western part of England was by Thomas Fownes, Esq. of Stepleton, in Dorsetshire, about the year 1730. "They were," says the author, who wrote in 1818, "as handsome, and fully as complete in every respect, as the most celebrated packs of the present day. The owner, meeting with some worldly disappointments, was obliged to dispose of them; and they were sold to Mr Bowes, in Yorkshire, the father of the late Lady Strathmore, at an immense price for those days. This pack was probably the progenitors of the very fine ones now in the north. Before this pack was raised in Dorsetshire, the hounds which hunted in the chase hunted all the animals promiscuously, except the deer, from which they were necessarily made steady, otherwise they would not have been suffered to hunt at all in it." Lord Yarborough's fox-hounds, at Brocklesby Hall, Lincolnshire, have been established for upwards of 170 years, and the Smitts have hunted them for several generations.

The Fox.

The fox makes a conspicuous figure in the natural history of animals; still, in some respects, his character has been overrated and exaggerated. He is a native of all temperate regions; and although we read of the cur, the greyhound, and the mastiff fox, we consider a fox as a fox, the difference in size, colour, &c., being dependent on either climate or food. It is true, they are larger in some particular parts of England than in others; and it is generally believed, that such as are what sportsmen call "stub-bred foxes," that is, bred above, and not below ground, are the largest. It is in this sole instance that the habits of the fox differ from those of the wolf, to whose genus he belongs; the she wolf never bringing forth her young, as the fox does, under ground. But although the general conformation of the fox is the same as that of the wolf, his external form has a greater resemblance to the dog, with whose character also he closely assimilates, when domesticated, in expressions of affection, of anger, or of fear. When minutely examined, and particularly in relation to his predatory life, and, consequently, the dangers to which he is exposed, he will be found to be abundantly endowed by nature with the instinctive faculties requisite for such a life, in addition to the most elegant form an animal of his size is capable of. Foxes copulate in the winter months, and of course bring forth in the spring, on an average perhaps half a dozen cubs at a litter, born blind like the dog; but the period of each depends on the mildness or severity of the winter. Excepting during the season of sexual desire, the fox is a solitary, not a gregarious animal, for the most part passing the day in sleep, and the night in prowling after food.

The food of the fox is extremely variable; indeed, very few things that have or have had life come amiss to him; but we have reason to believe that rabbits, hares, poultry, partridges, and pheasants, with their eggs, are his favourite repasts; and when these are not to be had, he contents

Hunting. himself with field-mice, black-beetles, snails, and frogs. That he can even exist solely on the latter, was proved a few years ago, by the circumstance of a fox-hound and a fox having been found at the bottom of a dry well, into which they had fallen; the hound had perished from hunger, but the fox had supported his life on frogs. Of those animals and birds which we call game they are without doubt destroyers—of pheasants, it is asserted, twenty-five per cent.; but how it happens that they have been charged with feeding on grapes, we are, as far as our own experience directs us, quite at a loss to determine. The fact, however, is stated by several accredited writers, and has given birth to the fable of the fox and the grapes, the moral of which is a severe rebuke to an envious person who "hates the excellence he cannot reach." Aristophanes, in his *Equites*, compares soldiers devastating a country to foxes destroying a vineyard; and Galen (*De Aliment.*, lib. iii., c. 2) tells us, that hunters ate the flesh of foxes in autumn, because they were grown fat with feeding on grapes. There are also two lines in Theocritus (*Idyl.* E. v. 112) which admit of the following version:—

> I hate those brush-tailed foxes, that each night
> Spoil Micon's vineyards with their deadly bite.

He is likewise accused of eating human flesh, and, we have reason to believe, accused justly. In addition to the sentence pronounced by David, in the sixty-third psalm, that the enemies of God and himself should be "a portion for foxes," we have the following interesting historical anecdote. When the famous Messenian general Aristomenes was thrown into the Cæadas (a deep chasm into which criminals were hurled) by the Lacedæmonians, his life is said to have been preserved by following a fox that was feeding on a dead body, to the aperture at which he had entered, and through which, after enlarging it with his hands, he himself escaped.

But although the subtlety of the fox has been proverbial from the earliest times; so much so, that our Saviour himself called the tetrarch Herod "a fox," by way of signifying the refinement of his policy; we do not perceive that, with the exception of a timid prudence on breaking cover, he shows more sagacity in his endeavours to baffle his pursuers than the hare is known to do, if indeed so much. To "catch a weasel asleep," is a typical designation of an impossiblity; but foxes are frequently surprised in their naps by hounds drawing upon them, up wind, particularly when gorged with food. In the faculty of natural instinct, however, they are equal to the dog; there being well-attested instances of their being sent, *marked*, upwards of fifty miles in a bag, and, having escaped being killed by hounds before which they were turned out, being retaken in their native woods. One was marked and sent down from Whittlebury Forest behind the venison-cart, when the Duke of Grafton's hounds were kept at Croydon, and it found his way back the seventy miles, no less than three times, before it was run into. But it is in his last moments, when seized by hounds, that the superiority of character in the fox over the hare exhibits itself. He dies in silence; but he sells his life dearly; for, revengefully seizing upon the first hound that approaches him, he only relinquishes his hold with the last gasp.

When first the fox was hunted in Great Britain, he was considered merely as a beast of prey, and killed in any way in which he could be got at, generally by being caught in nets and pitfalls, or killed at earth by terriers; his scent not being considered favourable to hounds by our forefathers. Although they admitted it to be hotter at hand than that of the hare, their favourite object of pursuit, they believed it to be sooner dissipated; but perhaps the real cause of their objection was, in the general inequality of speed and endurance in the hounds of their days and in a really wild fox; and foxes then were undoubtedly stouter, and able to run much greater distances from point to point, than they now do, when they have comparatively so short a distance to travel for their food, as well as being often over-fed. These animals, then, being always destroyed when an opportunity offered, were of course generally scarce; which, added to the great extent of woods and other fastnesses with which England then abounded, accounts for the fact of hunting the fox, unless as a beast of prey, not being in vogue until these objections were removed. But the fox was ever considered as a mischievous animal, and, in one signal instance, is said to have been made an engine of mischief to a vast extent, in carrying fire and flame into the standing corn of the rebellious Philistines. Hunting.

As the preservation of the fox is now more an object in Great Britain than his destruction, it may not be amiss to observe, that a few links of an iron chain, such as an old plough-trace, or a small piece of red cloth, suspended near to the spot on which a hen-pheasant sits, is a certain protection from foxes, of herself, her eggs, or her brood, independently of her losing her scent, by a wise provision of Providence, during the incubation.

It is also asserted by sportsmen of experience, that the scent of foxes varies with the animal; and that a vixen fox which has laid up (brought forth) her cubs is nearly devoid of scent.

Huntsman.

"A good huntsman," says Beckford, "should be young, strong, active, and bold; fond of the diversion, and indefatigable in the pursuit of it; he should be sensible and good tempered; he ought also to be sober; he should be exact, civil, and cleanly; he should be a good horseman, and a good groom; his voice should be strong and clear, and he should have an eye so quick as to perceive which of his hounds carries the scent, when all are running; and should have so excellent an ear, as always to distinguish the foremost hounds when he does not see them. He should be quiet, patient, and without conceit. He should let his hounds alone *when they can hunt*, and he should have genius to assist them *when they cannot*." It is scarcely necessary to observe, that Mr Beckford is here speaking of a huntsman to fox-hounds, his demands on the hare-hunter being somewhat more moderate; and yet the difficulties he has to combat with are more than obscurely acknowledged. Aware that practice is the key to excellence in every art, and that experience is the great mistress of all human knowledge, he requires age, with its experience, to fit the hare-huntsman for his office, and to be a match for the wiles of the hare; very ludicrously adding, that, "for patience, he should be a very Grizzel."

We do not think we exaggerate when we say, that the picture here drawn of a clever huntsman may, in one degree (of bodily endowments at least), be termed a near approach to human perfection; nor do we hesitate in adding our conviction, that if to the attributes here given him are joined a comprehensive mind and a humane heart, nothing is wanting to make it complete. As the chase is said to be the image of war, "but without its guilt," let us suppose Mr Beckford had been drawing the character of a soldier, and not a huntsman. Could he have given him higher qualifications than a clear head, nice observation, a good constitution, undaunted courage, a powerful voice, an accurate ear, and a lynx's eye, together with a quick perception, endowed with quick impulses for acting, so necessary to each? That he should be "fond of his profession," and "indefatigable in the pursuit of it;" "sober" and "exact," "sensible and good tempered?" It is not necessary that either a huntsman or a soldier should be a man of letters; some of the best among the former have been scarcely

Hunting. able to read; and there have been but few Cæsars who could fight and write; but a good understanding is put to the test by both the one and the other; and although we do not mean to place the servile situation of a huntsman on a level with the honourable profession of the soldier, each requires, in a high degree, a good, sound understanding, and a manly exertion of talent.

But the office of huntsman to fox-hounds is not always intrusted to servile hands. It has long been the ambition of masters of packs to hunt their own hounds; and although the fashion has become more prevalent within the last thirty years than it was in the earlier days of fox-hunting, yet we could bring forward some instances of what are called gentlemen-huntsmen of pretty long standing. His Grace the Duke of Cleveland, and Sir Richard Puleston, Bart., each hunted his own hounds for nearly forty years; and the late William Leche, Esq. of Carden-Hall, Cheshire, was his own huntsman for an equally long period. Coming next to them in chronological order, stand Messrs Ralf Lambton, Musters, Thomas Assheton Smith, Lord Fitzhardinge, Sir Bellingham Graham, Bart., Mr Osbaldeston, Mr Nicoll, the Earl of Kintore, Mr Smith, late of the Craven, Sir Richard Sutton, Mr Baker, Mr Arkwright, the Honourable Grantley Berkeley, and several others. There can be no doubt that no man enjoys hunting to perfection equally with him who hunts his own hounds; nor can there be any reason assigned why an educated gentleman should not excel, in any ardent and highly scientific pursuit, an uneducated servant; nevertheless, we do not think that, throughout the fox-hunting world in general, gentlemen huntsmen have been so popular as might have been expected; and in some countries that are hunted by subscription, an exception is taken against the master of the pack being the huntsman. That it is a very laborious office when efficiently executed, both in the kennel and the field, is well known to those who have filled it; but, *labor ipse voluptas*, we have seen a painstaking zeal displayed in the master which we have too often seen wanting in the servant; and we could name a nobleman who used frequently to tell his huntsman, when drawing for his second fox, that he was "thinking more of his dinner than of hunting."

In the earliest days of English hunting, gentlemen huntsmen were in high estimation; and a reference to *Domesday Book* will show that Waleran, huntsman to William the Conqueror, possessed no less than fifteen manors in Wiltshire, eight in Dorsetshire, together with several in Hampshire; and his name occurs on the list of tenants *in capite* in other counties. The same venerable record of antiquity describes the extensive possessions of other huntsmen, bearing the names of Croc, Godwin, Willielmus, gentlemen of consideration in those times, in which, according to Froissart, the ardour of the chase was carried to a pitch since unequalled by the Norman lords, some of them having kept sixteen hundred dogs, and a proportionable number of horses for the chase.[1] But we may go still farther back, to a very barbarous age, for the respect in which huntsmen have been held by kings and legislators. The temperate but brave Agesilaus, and even the luxury-destroying Lycurgus, provided for the bountiful entertainment of their huntsmen on their return from the chase; a pursuit which they believed to be so agreeable to the gods, that they offered the first fruits of their sports to Diana.

The Duties of a Huntsman.

The situation of huntsman to a pack of fox-hounds is one of great responsibility, and, if the breeding as well as hunting of them be left to him, a very arduous undertaking. Nor does it end here. There is great call for judg- Hunting. ment in feeding hounds to answer every purpose, such as long draws, severe days, and at the same time to go the pace without showing distress, and to come home at night with their sterns up, and looking fresh. Here variety of constitution increases the difficulty; for, to please the eye, hounds should look level in their condition, as well as even in point of size. One hound will not bear to have his belly more than half filled; another will not fill his when he may; and still each must be made equal in strength and wind to the other, to stand hard work and go the pace without distress. A huntsman must have a very watchful eye over their condition, which will be effected by work and weather; and he must be pathologist enough to foresee and provide against the alterations which such circumstances produce. He has need also to be a physiologist, to enable him to exercise a sound judgment in breeding his hounds after a certain form and fashion, which are absolutely essential to their doing well, and at the same time pleasing the eye. Then look at him in the field, with a hundred eyes upon him, and a hundred tongues to canvass all his acts. Here he should be a philosopher.

In the Field.

A huntsman is expected to bring his hounds to the cover side in a high state of condition, at all seasons of the year. They should be seen quietly grouped about his horse's heels, when he is waiting for the hour of throwing off, without a whip stirring, or even an angry word said to them. This is a time when they are often subject to the inspection of strangers, and a first impression goes a great way. When the master gives the word to draw, they should approach the cover at a gentle trot, one whipper-in riding in their front; and when within about a stone's throw, they may dash into it with as much spirit as they like. Not a word need be said by way of caution, unless it appears to be especially called for, when "gently, there," by the first whipper-in, and one smack of his whip, will generally have the desired effect. But we like to see the huntsman alive at this moment, as well as his hounds. Homer compares hounds cheered by their huntsman, to troops encouraged by a skilful general; and doubtless there is a similarity in the effect. Putting hounds out of the question, there is something very cheering to the field in the "cheering holloa" of a huntsman, when encouraging his hounds to draw; and it also answers two good purposes. Should a hound get wide off the pack, or hang behind in the cover, or should any of the field be at a loss, which often happens in woodlands, the "pipe" of the huntsman is an unerring guide to all. How necessary is it, then, at all events how desirable, that, like Ajax, he should be *βοὴν ἀγαθός*, "renowned for the strength of his voice," and, we may add, for the melodiousness of it. He should likewise blow a horn well; and if he varies the blast, to make himself more intelligible to his hounds, he will find his advantage in it. We wonder this is not more practised than it is. Independently of the common *recheat*, why not have the "view horn" as well as the "view holloa?" But too much horn, like *vox et prætereа nihil*, is bad, making hounds apt to disregard it; yet a huntsman would be sadly at a loss without it, not only in getting hounds away from cover and in chase, but in drawing large covers, in which they will occasionally get wide. Here a twang of the horn saves a huntsman's voice in bringing them over to him. One short blast is sufficient.

. . . . "He gave his bugle-horn a blast,
That through the woodlands echoed far and wide."

[1] See *Froissart*, tom. iv., c. 27.

Hunting. The following observations on holloaing are from the pen of an old sportsman. They contain hints that it would often be advisable to profit by; and they apply not only to huntsmen, but to the field. "A general rule as to *hallooing* is, never to halloo unless you can give a good reason for so doing. A constant and indiscriminate use of the voice is blameable in a huntsman; his hounds, by constantly hearing his voice, will soon learn to pay no more attention to it than they do to the singing of the lark, and they will not come to him when they are called. Some huntsmen, in making a cast, try that part of the ground where they can most conveniently ride, instead of that where it is most likely the fox is gone. Others ride on hallooing, without regarding their hounds, while making their cast; their own noise then prevents them from hearing their hounds, who often take the scent without their being aware of it."

"No person should halloo that is not well forward. It signifies little what words you use, as a hound's knowledge of language is confined to a view halloo, a call, and a rate; it is the tone of the voice, and not the words, that they understand; and hounds will always draw to the voice, if it be not a rate. This shows the impropriety of hallooing behind hounds. In running with good scent, if you are up with the pack, a cheering halloo does no harm; the hounds will not attend to it, and it is expressive of the pleasure of the hallooer. Never cap hounds with loud halloos to a bad scent; capping makes them wild and eager, and should never be done but when the scent is high. Hounds should be brought up gently to a cold scent." Holloaing to hounds is often necessary, and highly useful when done with judgment; but the word "tallyho" loses many a good run; as, unless a fox is gone clear away from his cover, it occasions him to turn back often into the mouth of the hounds.

Dog Language.

It is true, no correspondence can subsist between beings whose natures are separated by a chasm so wide as that between rational and irrational animals; and it is with a view of adapting our meaning to the level of their understandings, that we generally address or converse with brutes in a silly unmeaning manner; which gave rise to the remark, that children, or men who act like children, have animals more immediately under their control than the philosopher who is replete with wisdom. But we may look farther into the subject than this. If the Almighty had not manifested some portion of his attributes by means which are on a level with the capacity of the human race, man must have remained for ever ignorant of his Maker. The power of language, however, between man and man, is prodigiously increased by the tone in which it is conveyed. The vagrant when he begs, the soldier when he gives the word of command, the senator when he delivers an oration, and the lover when he whispers a gentle tale to his mistress, all differ in the key in which they speak; and it is thus that huntsmen and whippers-in make themselves intelligible to hounds. They do not speak to them in an unmeaning manner, or after the manner of children; but in short and pithy sentences, every word of which is law. The method of doing this, however, admits of several degrees of excellence; but the huntsman who is endowed by nature with a clear, sonorous voice, in a well-pitched key, and knows when to use it with effect, contributes greatly to the enthusiasm of fox-hunting, and no doubt to the success of it. Gelert, in his *Hounds of England*, speaks of the master of Langilly hounds (Mr J. Williams) as one whose "dog language in cover-drawing is particularly good and melodious;" and it is notorious that there is a wonderful difference between huntsmen in this respect.

Without entering again into the wide range of hunting, we cannot do more than add a few maxims which may be observed by a huntsmen in the field. In drawing for your fox, don't be persuaded always to draw up wind. In the first place, you are in danger of chopping him; secondly, he is sure then to go down wind at starting; and, thirdly, you may drive him into a worse country, or from his point. When found, get after him as quickly as possible if you have a body of hounds with you; if not, you will have a better chance of sport if you can wait till the body come up. This is easily done by a twang of the horn, or a false holloa, if hounds are under good command, and the convenient opportunity be seized upon. Keep near to them in chase, with your eye on *the body* of the pack, as well as on such hounds as may be leading; the body are more certain to be right. Next to knowing where a fox is gone, is knowing where he is not gone; therefore, in your cast, always make good the head. This you will do for your satisfaction; but hounds are seldom at fault for the scent a-head, when the chase has been at all warm, that is, on a fair scenting day; for if the fox be gone forward, wherefore the fault? Good hounds will seldom or never leave a scent a-head, unless the ground be stained by sheep or cattle, or when the chase leads over dry ploughed land, hard and dry roads, &c. It is high odds that your fox has turned to the right or to the left; but although his point may be back, he cannot well run his foil, from the number of horsemen that are generally in the rear of fox-hounds. Recollect your first check is generally the most fatal to sport, and for these reasons: Your hounds are fresh, and perchance a little eager; they may have overrun the scent for some distance, owing to their being pressed by the horses, which are also at this time fresh; nor will they always get their heads down as soon as they should do, from the same exciting causes. Again, your check now generally arises from a short turn, the fox having been previously driven from his point, which he now resolves to make; and he will make it at all hazard at certain times. When your hounds first "throw up" (*i. e.* check), leave them alone if they can hunt; but, disregarding what the "old ones" say on this subject, as inapplicable to these fast times, don't be long before you take hold of them, and assist them, if they cannot. We would not go from scent to view; yet hounds in these days that will not bear lifting are not worth having. But do all this quietly as well as quickly. Turn your horse's head towards the line you think your fox is gone; and the first moment you see all their heads up, that is, if they do not hit him off, put your horn to your mouth for one blast or two, and trot away to still more likely points. If your pack will divide when casting, so much the better; but if they are good for anything, they will be making their own cast whilst you are making yours, by not keeping at your horse's heels, but spreading as they go.

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When you have hit upon his point, if a single hound goes off with a good scent, get the body to him as quickly as you can; but not so if the scent be not warm. In the latter case, your hounds will be in expectation of a fresh fox, and will be in a hurry; the hound that is forward will be lifted, and in all probability you will have to seek for the scent again. Go gently, and your hounds, if steady, settle to it. Likewise, if, when at check, you are holloaed to a spot where a fox has been viewed, ***stand still***, and say nothing at the moment the first two or three hounds throw their tongues. If you hurry the body on immediately, the scent will often be lost if the fox has been a few minutes gone. If it can be done, give your hounds the wind at a crisis like this. Again, when a fox has been viewed, and you go directly to holloa, do not take your hounds to the extreme distant point at which he was viewed, but a hundred yards behind it; and for this reason: If you take them to the extreme point, and they do not take up

Hunting. the scent at once, you have then to make your cast at a venture; whereas, if you lay them on at that distance behind it, you have somewhat of a guide to that extent, as to the line towards which you should draw them.

The following further hints may be serviceable, or at all events they relate to hounds at check. In trying back, hounds have this advantage. It is evident the fox has come the line, up to the point where the check occurred; and he must be gone either to the right or the left of it, or back. We make this observation, because so much has been said about the straight running of foxes, which is far from true; and the necessity of persevering in the cast a-head with the fox, and back, on the foil, with the hare. The more hounds spread, within reason, in this backward cast, the better will be the chance of making the check a short one. Again, if at check on a road, or foot-path (the latter not often run over by foxes), when you observe some of your best hounds failing to make it good, on one side of either, it is reasonable to suppose the fox is gone on the other. If your hounds check in a cover in the middle of a run, and the fox is viewed away from it, try and get your hounds together as much as you can in the short time that can be allowed for it, *before you cap them to the scent.* It generally ensures a good finish, from two obvious causes: First, hounds get fresh wind; and, secondly, they will have a better chance to carry a good head, which generally ends in blood, and in blood well earned; for the fox is more likely to stand longer, and go straighter, for not having been viewed by hounds when he broke. But the most difficult point for a huntsman to decide upon promptly is, when his pack divides, which division is on the hunted fox. If it happen in cover, his ear is his surest guide, as the cry is louder and stronger on a fresh found fox, than on one which has been for some time on foot. If when out of cover your pack should split on two separate scents, you should get as near as you can to what you imagine to be the chase, giving view holloas every yard you go; also sending one of your whippers-in to stop the other hounds. Your choice will doubtless be directed by several circumstances. You will first look for your truest and best line-hunting hounds, and next, to the points your first fox would be likely to make for; and if your choice fall upon the lot that are going furthest up the wind, the other will be more likely to hear them running; and, should they come to a check, to join cry again perhaps before a whipper-in can get to stop them.

It was once justly observed, that those who seek pleasure from the chase must ask permission of heaven; and the case still remains the same. Hounds without a scent resemble a man running in the dark; neither can make head against such fearful obstructions; and on stormy days, with a very high wind, if you have influence with your master, persuade him to let you go home after the first failure. It is not generally known what mischief even one such day does to some hounds. Don't set too high a value on blood, unless well earned; it is the result of want of reflection alone that has set any value whatever upon it, when otherwise obtained. Mob a bad fox in a cover if you like; but never dig out a good one, unless your hounds have almost viewed him into a spout, and you can bolt him before the excitement subsides. Never break ground in a country belonging to another pack of hounds, nor dig for a fox in a moin earth in your own. Many a bitch fox, heavy with young, has been killed by this means in the spring, instead of the one that was hunted and marked to ground; and be assured that sportsmen in general do not estimate the goodness of a pack of hounds by the noses nailed against the kennel door. Lastly, keep your field back from pressing on your hounds in chase, and still more so when in difficulties, as well as you can; but don't suffer your zeal to carry you too far on this point. Remember the apostolic precept, "BE COURTEOUS." Hunting.

The modern annals of sporting contain the names and characters of several very eminent huntsmen, whose conduct and abilities would have done credit to any other situation of life to which it might have been their lot to have been called. Considering the responsibility of their office, the severity of their work, and the risks they run, they are not supposed to be too highly paid in wages, say on the average L.150 per annum, besides their board; but, from perquisites, such as annual presents from gentlemen who attend the hounds which they hunt, and drafted hounds sold to other packs, they may realize the like sum in addition.

The office of whipper-in is, in our opinion, thought more lightly of by the sporting world in general than it deserves to be; and, as we shall show, we have the great Beckford on our side. We never saw a steady pack of hounds without at least one good whipper-in, and we are quite sure we never shall; but we have seen many of these red-coated youths who might have been better employed at the plough-tail—who, like Cicero's lawyer, belonged rather to the profession than the science. "If he has genius," says Beckford, "he may show it in various ways; he may clap forward to any great earth that may by chance be open; he may sink the wind to halloo, or mob a fox when the scent fails; he may keep him off his foil; he may stop the tail hounds, and get them forward; and has it frequently in his power to assist the hounds without doing them any hurt, provided he has sense to distinguish where he is wanted most. Besides, the most essential part of fox hunting, *the making and keeping the pack steady,* depends entirely upon him, as a huntsman should seldom rate, and never flog a hound. In short, I consider the first whipper-in as a second huntsman; and, to be perfect, he should be as capable of hunting the hounds as the huntsman himself. He should not be conceited, but contented to act an under part, except when circumstances may require that he should act otherwise; and the moment they cease, he must not fail to resume his former station."

To the above excellent remarks we have very little to add. We only recommend, when a huntsman is casting his hounds, that a whipper-in should turn them to him always as gently as he can, and with little noise; by which means they will *draw* towards him, trying for the scent as they go; whereas loud and repeated rates and cracks of the whip make hounds fly to their huntsman at this time with their heads up. When they are drawing properly towards him, not a word should be said; a whipper-in riding outside of them will be sufficient.

It is scarcely necessary to say, a whipper-in, to be perfect, should be an accomplished horseman, as nothing requires a much firmer and nicer hand than the act of following a hound over open ground to flog him. A whipper-in, however, should always hit a hound first, and rate him afterwards, and be able to hit hard when occasion requires it. A riotous fox-hound cannot be trifled with, if he is to be cured of his evil ways; and let the lash fall heavily when necessary, but at no other time. Above all, let the whipper-in have an eye to a skirter: skirting is the least pardonable fault a hound can possess, because he is then deviating from his nature, and has not the force of impulse to plead, which the hound that runs riot has. (C. A.) (W. H. L—Y.)

Huntingdon || Huntingdonshire.

HUNTINGDON, Selina, *Countess of*, was the daughter of Washington Shirley, Earl of Ferrers, and was born in 1707. At the age of twenty-one she was married to Theophilus Hastings, Earl of Huntingdon, a man of distinguished piety and religious zeal. With him she lived a happy and useful life till his death, which took place very suddenly in 1746. Of the numerous family which she bore her husband, four died in the bloom of youth. It was about this time that the religious revival set on foot by Wesley, and taken up by Whitfield, had begun to influence English society. Until about the year 1748 the revivalists had acted in unity, but after that date the tenets of Whitfield becoming daily more Calvinistic, and those of Wesley more Arminian, they separated, and Whitfield became private chaplain to the Countess of Huntingdon. By his advice she assumed a sort of leadership of the Calvinistic Methodists of England, or as they came to be called from her "the Countess of Huntingdon's connexion." As her means were large and her personal expenses very small she was able to devote large sums of money to the maintenance and propagation of her views. She built chapels, and engaged preachers to officiate in them, and established a college at Trevecca, in South Wales, for the education of Calvinistic preachers. After her death, which took place, June 17, 1791, the college was removed by her trustees from Trevecca to Cheshunt in Herts, where it now is. The number of chapels mentioned in the census of 1851 as belonging to the Countess of Huntingdon's connexion was 109, accommodating 38,727 hearers. Although the name of "connexion" is still in use among this sect, there is no combined or federal form of church government. The congregational polity is practically adopted; and of late years several of the congregations have become, in name as well as virtually, congregational churches.

HUNTINGDON, a municipal and parliamentary borough and market-town of England, and capital of Huntingdonshire, stands on the left bank of the Ouse, on the line of the Great Northern Railway, 58 miles N. of London. It is connected with the old borough of Godmanchester, on the right bank of the river, by a causeway with three bridges, the largest of which has six arches. The town consists of a long street with lanes branching off. Of 15 churches that were once in Huntingdon, there now remain only two, with three Dissenting chapels. There are two public schools, with a grammar and green-coat school. The commerce is inconsiderable; the chief articles of trade being wool and grain, and of manufacture, bricks and tiles. It is governed by a mayor, four aldermen, and a common council. Two members are returned to parliament by the united boroughs of Huntingdon and Godmanchester. It was here that Oliver Cromwell was born, April 25, 1599, and his grandfather's house, Hinchinbrook, is about a mile distant from the town. Pop. (1851) 3882.

HUNTINGDONSHIRE, an inland county of England, bounded on the N. and E. by Cambridgeshire, on the N.W. by Northamptonshire, and on the S. by Bedfordshire, with two outlying parishes, viz., Swinestead in Bedfordshire, and Everton, between Bedfordshire and Cambridgeshire. The county is 29 miles long from N. to S., and 23 miles broad from E. to W. In size it is the third smallest of the English counties; Rutland and Middlesex being the least. The county is divided into 4 hundreds, and 107 parishes, and forms an archdeaconry in the diocese of Ely.

The surface of the county is generally flat. There are, however, two low ridges of hills, one entering the county from the S. near Potton Beds, and terminating in the Ouse Valley near Huntingdon; the other, coming E. from the borders of Cambridgeshire, crosses the county by Huntingdon to Wansford. Along the banks of the Ouse and the Nen, there are beautiful and fertile meadows; in the S.E. is an extensive plain of rich meadow-land; the centre and upland part of the country is highly cultivated, though much of it is still uninclosed. The latter was anciently a forest tract, appropriated to the chase. It was disforested, however, by Henry II. and Edward I., and is now very bare of trees, few being grown in the hedgerows, while woods and coppices are very rare. The north-eastern part of Huntingdonshire, comprising 50,000 acres, or one-fifth of its whole extent, belongs to the great "Fen" district, extending throughout the counties of Cambridge, Lincoln, Northampton, Norfolk, and Suffolk. See Bedford Level.

Huntingdonshire.

In Huntingdon, as well as in the other counties, these marshes are intersected by numerous artificial channels, by means of which they have been effectually drained and converted into a fertile region. Willows too have been planted of late years in this part of the county, and have been of considerable use in absorbing the superabundant moisture, and consolidating the soil. Situated in the Huntingdon Fen are three sheets of water, respectively named, Whittlesea, Karnsey, and Ugg-meres. The first is 1550 acres in extent, and the second is about half as large. Projects have been formed for draining both, as the water is shallow and the soil very rich.

Whittlesea-mere was a favourite resort of sportsmen, both fish and wild fowl being abundant. The water of the low parts of the shire, although plentiful, is not generally good for drinking. The climate, it need scarcely be added, is not very good where there is so much fenny land and so little pure water. Consumption and other diseases of the respiratory organs are common causes of death amongst the inhabitants.

The upper substratum of the county is formed of a bed of Oxford clay nearly 700 feet thick. The south-eastern district is occupied by ferruginous sand which rises into low hills, and is covered with the diluvial debris of the neighbouring chalk range. The high ground overhanging the valley of the Nen, on the borders of Northamptonshire, is composed of stone brash or forest marble. The rest of the county, with the exception of the Fens, is occupied by the Oxford clay. The soil lies in patches of gravel, sand, and clay; the latter, which predominates, is intermixed with muddy alluvial earth. Peat exists in many parts of the county, and is used for fuel.

The rivers of the county are the Ouse and the Nen, with their tributaries. The Ouse enters the county from Bedfordshire, near St Neots, and flows by Huntingdon and St Ives into Cambridgeshire, on its way to the Wash. It is navigable for barges in its whole course through Huntingdonshire, and thus forms an important means of communication for the agricultural produce of the county. The Nen divides the northern part of the county from Northamptonshire, and quits it at Peterborough; it is also navigable. The river has changed its bed, and the waters in the old channel run into Whittlesea and Ugg-meres. The other means of navigation in the county are a navigable cut from the old channel of the Nen at Standground sluice to the navigable channel of the Nen at Ramsey; and Vermuiden's, or the Forty-foot Drain, a cut from the old Nen near Ramsey to the Old Bedford River in Cambridgeshire. The Great Northern Railway traverses the county throughout its whole length, while it is connected with the Eastern Counties' Railway by a branch line from St Ives to Huntingdon.

Agriculture is the only pursuit in the county; and the chief trade is that in corn, cattle, and wool. The main produce of the county is wheat, oats, and beans, with some barley, hemp, mustard seed, and hops; rape is also grown in the Fens, and turnips in the drier soils. The fen lands have been much over-cropped, and, in consequence, the average produce of the county is low. A large number of horses are bred for sale in the Fens, though they are not generally good.

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The sheep of the county are a mixed race, composed of crosses of the Lincolnshire and Leicestershire breeds with the native kinds. They are without horns, and of very imperfect shape, but are found profitable from the quantity of wool they produce, their fleeces usually weighing from seven to eight pounds each. The sheep of the original race of the county are much inferior to those produced by the crossing with the better kinds; many of these are still found in the open commons, and their fleeces seldom exceed four pounds in weight. The cattle, like the sheep, are a mixed breed, being in great measure the refuse of the Lancashire, Leicestershire, and Derbyshire races. The dairy cows are mostly Durham and Yorkshire short-horns; but dairy farming is not much followed; and though Stilton, in this county, has given a name to the celebrated cheese, that is now made exclusively in the counties of Lincoln and Leicester. Instead of using the milk for churning, a large number of calves are reared to supply the metropolis with veal. The farms are generally large, although, for the most part, they are inconveniently situated, sites having been chosen more with regard to dryness than the economy of labour. Of persons connected with agriculture in the county there were in 1851—961 farmers, 15 corn merchants, 102 brewers, and 36 maltsters. The only other trade of the shire is brick and tile making, commenced a few years ago. Of persons engaged in the manufacture of clay there were 235 in 1851.

Huntingdon was originally inhabited by the British tribe Iceni, and during the Roman occupation was included in the province of Flavia Cæsariensis. The Saxons called the county Hunlandunscyre, and in their time it first formed part of East Anglia, and afterwards of Mercia. Huntingdonshire has given the title of earl since the days of William the Conqueror; this title, originally conferred on Waltheof, brother-in-law of William, passed to David, king of Scotland, and is now borne by a member of the Hastings family. There is also a popular tradition that the outlaw Robin Hood was Earl of Huntingdon.

The antiquities of the county are neither numerous nor remarkable. It was traversed by two Roman roads, the Ermin Street and the Via Devana. Traces of ancient encampments remain at Dornford, Stangrund, and St Neots, and some Roman pottery at Holywell, near St Ives. Kimbolton Castle, the seat of the dukes of Manchester, was the residence of Catherine of Aragon after her divorce from Henry VIII. A great part of the county having belonged to the monks, they erected abbeys at Ramsey and Sacotry, and priories at Huntingdon, St Ives, St Neots, and Hinchinbrook. A ruined gateway at Ramsey, a rich specimen of decorated English architecture, and a dove-house and barn at St Ives, are the only remarkable remains of these edifices.

Huntingdonshire returns four members to parliament, two for the county and two for the boroughs of Huntingdon. The polling places for the county are Stilton and Huntingdon, the number of electors being 3047. Owing to the small size of the county, it is associated with Cambridgeshire in the choice of high sheriff, and is required to supply that officer only once in three years. The county courts are held at Huntingdon and St Neots.

There were in Huntingdonshire in 1851, 91 Established ministers, and 37 Dissenting ministers. According to the religious census of the same year there were 196 churches in the county; 96 of these belong to the Church of England; 46 to the Methodists; 30 to the Baptists; 7 to the Independents; and 17 to various minor denominations. The educational census gives 95 public day schools, with 6631 scholars; and 135 private day schools, with 2552 scholars.

The population of the county was in 1821, 48,946; 1831, 53,192; 1841, 58,549; 1851, 64,183. Of towns with more than 2000 inhabitants there were in 1851—Huntingdon, 3882; St Ives, 3522; St Neots, 2951; Ramsey, 2641; Godmanchester, 2337. The area of Huntingdonshire is, in statute acres, 230,865.

Huntly ‖ Hurdwar.

HUNTLY, a burgh of barony and market-town of Scotland, Aberdeenshire, near the junction of the rivers Bogie and Deveron, and 39 miles N.W. of Aberdeen, with which it is connected by railway. It consists of two principal streets, crossing each other at right angles, with a market-place at the point of intersection. An ancient bridge of a single arch crosses the Deveron, and a modern one of three arches spans the Bogie. Besides the parish church, there is a Free Church, and chapels for United Presbyterians, Independents, Episcopalians, and Roman Catholics. In the neighbourhood are the ruins of Huntly Castle (destroyed in 1594), and Huntly Lodge, the seat of the Duke of Richmond. Pop. (1851) 3131.

HURD, Richard, D.D., bishop of Worcester, and the friend and biographer of Warburton, was born in 1720, at Congreve, in the parish of Penkrich, Staffordshire. He was the second son of John and Hannah Hurd, whom he describes as "plain, honest, and good people, farmers, but of a turn of mind that might have honoured any rank and any condition." Their farm was not far from the grammar-school of Brerewood, at that time one of the best conducted schools in the midland counties of England. At this seminary their son was trained with such ability and skill, that at the age of fifteen he was ready for the university. Entering Emmanuel College, Cambridge, he took the usual degrees in their ordinary course, and in 1742 was chosen a fellow of his college. He continued to reside at Cambridge till 1756, occupying his time in literary labour, of which the results were given to the public from time to time. In one of his works—a Commentary on the *Ars Poetica* of Horace—he had alluded in flattering terms to Warburton; and, though he is not believed to have had any selfish aim in view when he did so, he could not have devised a more effectual means for advancing his interests. In 1756 he was appointed rector of Thurcaston, where he resided for eight years, and where he wrote his *Dialogues*, his *Letters on Chivalry and Romance*, and some of those controversial pamphlets in which he was constantly vindicating the opinions and character of his idol Warburton. In 1765 he was chosen preacher of Lincoln's Inn; and, two years later, was promoted to the archdeaconry of Gloucester, of which Warburton was bishop. In 1775 he was promoted, by Lord Mansfield, to the bishopric of Lichfield and Coventry; whence, in 1781, he was transferred to that of Worcester. Two years later, on the death of Dr Cornwallis, he was offered the see of Canterbury, which, however, he declined, as "a charge not suited to his temper and talents, and much too heavy for him to sustain in these times." The remainder of his life he spent in studious retirement. He died in 1808, in the eighty-ninth year of his age.

HURDWAR, or Haredwara, a town of Hindustan, in the British district of Saharumpore, under the lieutenant-governorship of the N.W. provinces; a great mart of commerce, and a celebrated place of Hindu pilgrimage, situated on the W. side of the Ganges, where it issues from the northern hills. The town is not large, having only one street about 15 feet in breadth, and one furlong and a half in length. Pilgrims of both sexes resort annually thither from all parts of India to perform their ablutions in the sacred Ganges. The month of April is the time appointed for this concourse of pilgrims; and great numbers of merchants also attending, one of the largest fairs known in Hindustan is held here. It is calculated that in general about 300,000 persons are collected on this occasion; but, once in twelve years, when particular ceremonies are observed, the number is increased to a million. In April 1809, it was computed that two millions of strangers were

Huron || Husband and Wife.

assembled. The chief articles brought thither for sale are horses, mules, camels, tobacco, antimony, assafœtida; dried fruits from Cabul, Candahar, Moultan, and the Punjab; shawls, cloaks, &c., from Cashmere and Amritsir; spotted turbans, looking-glasses, toys, with various manufactures in brass and ivory, from Jeypoor; shields from Rohilcund, Lucknow, and Silhet; bows and arrows from Moultan and the Doab; rock-salt from Lahore; baftas and piece-goods from Rahn, a large city in the Punjab; many camels, and a species of flannel, from the Marwar country; and from the Company's provinces, Kharwa muslins, sarsnet, cocoa-nuts, and woollen cloths of a coarse quality. The merchants who frequent this fair travel in large caravans, and are frequently infested on the roads by freebooters, who watch their opportunity, and cut off stragglers. During the Mahratta dominion, a poll tax and heavy duties were imposed on all the cattle. But these have all been repealed by the British, and every encouragement is now held out to merchants. In such a vast concourse of people from all quarters, disputes were formerly very frequent. But owing to the strict police maintained by the British, these fairs have lately ended without bloodshed, to the surprise and satisfaction of the vast multitude, who were accustomed to see bloody quarrels at the Hurdwar fair. The stream divides itself into three channels at Hurdwar, the principal of which is on the western side, running along a bank named Chandnee Ghaut. The travelling distance from Calcutta by Moorshedabad is 1080 miles, by Birbhoom 975 miles, from Delhi 117 miles, and from Lucknow 311 miles. E. Long. 78. 14., N. Lat. 29. 57. (E. T.)

HURON, LAKE. See CANADA.

HURREEANAH, a British district in Hindustan, within the jurisdiction of the lieutenant-governor of the N.W. provinces; comprehending an area of 3300 square miles, with a comparatively scanty amount of population, consisting of Hindus and Mohammedans. The district is intersected by the canal originally constructed by Feroz Toghluk, the renowned king of Delhi. This watercourse having become nearly obliterated, was cleared out about thirty years ago, by order of the British government, and made available for the purposes of irrigation. Towards the close of the last century, George Thomas, an Irish adventurer, made a bold attempt to establish an independent principality in Hurreeanah under his own rule. He fortified the principal town, collected troops, cast cannon, and coined money bearing his own name; but being attacked by a superior native force under the command of the French adventurer Perron, he was overpowered and forced to retire. The principal towns are Hissar and Hansee. (E. T.)

HURRUR, or HARRAR, a large commercial town of Eastern Africa, said to be about 192 miles E. of Ankobar, and 150 S.S.W. of Zeyla. It is surrounded by a mud-and-stone wall, 12 feet high and 3 feet thick, and is about two hours quiet walking in circumference. The wall is in good repair, and has five gates. There are many large and well-built houses of mud and stone, but the majority of the people live in huts made of mats and reeds, with a thorn fence round them. The soil in the vicinity is very rich, producing coffee, wheat, barley, jowarie, &c., in great profusion. Coffee is the most important export. The seaport is Zeyla. The inhabitants are rigid Mohammedans, and Christians are strictly prohibited from entering the town. (*London Geographical Journal*, vols. xviii., xix., &c.)

HUSBAND AND WIFE. In civilized countries some solemnities are usually employed to mark the constitution of this relationship. The Council of Trent made it a religious ceremony. In Lord Stowell's opinion it was not necessarily so in England prior to the Act of Geo. II.; and it certainly has not necessarily been so in Scotland since the Reformation. Into the past history of the subject we do not propose to enter. At present the marriage law of England is regulated chiefly by two statutes—the 4th Geo. IV. c. 76, and 6th and 7th Will. IV. c. 85. By the last of these it is enacted, that after the 1st March 1837, all the rules prescribed by the *Rubrick* should continue to be duly observed by every person in holy orders of the Church of England who should solemnize any marriage in England (the right of the Archbishop of Canterbury, or other person having authority to grant licences to marry at any convenient time and place, being reserved); while Quakers and Jews are allowed to contract marriage according to their respective usages, provided both the contracting parties be Quakers, or both profess the Jewish religion. One of the parties must give notice of their intention to the superintendent registrar of the district within which they have dwelt for seven preceding days, or if they have dwelt in the districts of different superintendent registrars, the like notice must be given to each. These officers are then required to preserve and enter a copy of the notices in the "marriage notice book," which is open to the public without charge; and after seven days, if the marriage is to be solemnized by licence, or after twenty-one days, if without licence, a certificate is issued authorizing the marriage, one of the parties having first made oath or affirmation of belief that there is not any lawful hindrance, and that the statements contained in the notice are correct.

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Any person, duly authorized, may forbid the issue of the certificate by writing the word "forbidden" opposite the entry in the marriage notice book; in which event the superintendent registrar can issue no certificate until he be satisfied that the objection is unfounded. If he have doubt, the matter is referred to the registrar-general, who has power to decide; or if the superintendent refuses to grant licence, there is an appeal to the registrar-general, who either confirms the refusal, or directs the licence to be issued.

Without attention to these particulars no marriage can be solemnized in England. If not celebrated within three months after the notice, the notice, entry, and certificate must be renewed. The certificate of the superintendent, or where the parties live in different districts, the certificate of the superintendent of each, is delivered to the officiating minister if the marriage is to be solemnized according to the rites of the Church of England; or to the registering officer of the Quakers, or officer of a synagogue, who may solemnize the marriage in the registered building mentioned in the notice. When parties choose, they may dispense with a clergyman, and be married according to any form they please, provided the marriage take place between 8 and 12 o'clock in the forenoon, in presence of a registrar and witnesses, and provided each of the parties in some part of the ceremony declare that they do not know any impediment to their union, and expressly call upon the persons present to witness the proceedings. The parties may also be married in this manner, after the proper notice and certificate, in the office and presence of the superintendent registrar; and they have always the option of the parish church of either of them. It is further enacted that "every person who shall knowingly and wilfully solemnize any marriage in England, except by special licence, in any other place than a church or chapel in which marriages may be solemnized according to the rites of the Church of England, or than the registered building or office specified in the notice and certificate as aforesaid, shall be guilty of felony" (except in the case of a marriage between two Quakers, or two persons of the Jewish religion); "and every person who, in any such registered building or office, shall knowingly and wilfully solemnize any marriage in the absence of a registrar of the district in which such registered building or office is situated, shall be guilty of felony; and every person who shall knowingly and wilfully solemnize any marriage in England (except by licence) within twenty-one days after the entry of the notice to the superintendent registrar, as

aforesaid, or if the marriage is by licence within seven days after such entry, or after three calendar months after such entry, shall be guilty of felony." And any marriage solemnized in disregard of the statute is null and void; and in the case of a fraudulent marriage, the guilty party forfeits all the property that would otherwise have accrued to such party by the marriage. After the ceremony the marriage must be registered.

In Scotland, since the Reformation, a regular marriage is constituted by a proclamation of banns in the churches of the parishes in which the parties reside, of which a register is kept, and by the acceptance by the parties of each other before a clergyman, who pronounces the nuptial benediction in presence of witnesses. Till comparatively a late period, none but the Episcopal clergy, by 10th Anne, c. 7, could celebrate a marriage in Scotland, other than a minister of the Established Church. By 4th and 5th Will. IV. c. 28, this privilege was extended to "any person in holy orders, of whatever communion he may be," after proclamation of banns. If any other party celebrate a marriage, or if a clergyman do so without proclamation of banns, unless he appear to have been deceived, he is liable by the act 1661, c. 34, to banishment from Scotland, and by 1698, c. 6, to fine and imprisonment. Parties may go before a justice of peace to effect a marriage, but he is only entitled to certify that they declared themselves in his presence to be married; if he proceed further, and assume the ministerial office by pronouncing the nuptial benediction, he is liable in the penalties of the statute. By the statute 17th and 18th Vict., c. 80, it is provided that in all cases of regular marriage, the certificates of proclamation of banns, accompanied by a copy of a schedule given in the statute, shall be delivered to the officiating minister, or person solemnizing a marriage according to the rites of Jews and Quakers, to be filled up with the particulars required for registration, and signed by the contracting parties, minister or other person officiating, and witnesses; and within three days afterwards this schedule must be transmitted, under a penalty, for registration to the registrar of the parish within which the marriage was solemnized. If requested, the registrar is bound, on payment of a small fee, to attend at any place within his parish, for the purpose of making the entries, or seeing that they are properly made; and the marriage may be celebrated by the minister or pastor of a Christian congregation of any denomination. There is a provision in the statute for registering a marriage in the case of persons convicted before any justice of peace or magistrate of having contracted an irregular one; as well as a marriage declared by the sentence of any competent court, such registration being made in the parish where the conviction occurs, or of the domicile of the parties; but by an omission the act makes no provision for the registration of those irregular marriages, numerous in Scotland, of which there is neither any conviction before a magistrate, nor any decree of declarator.

As this statute expressly declares that the Scotch law of marriage shall not be affected by it, it is necessary to notice as briefly as possible what is essential to the constitution of marriage in Scotland. In doing so we may premise, that in order to be binding, and to secure all the rights of a legal marriage, it is not necessary that it should be what is called a regular one. By a long unbroken series of decisions confirmed by the House of Peers, it is established that the simple acceptance of the parties as husband and wife, without the prescribed ecclesiastical solemnities, and without any ceremony whatever, constitutes a legal marriage. That acceptance may be proved in various ways;—1. By express words; 2. By a promise to marry, followed by sexual intercourse; or, 3. By conjugal cohabitation and acknowledgment.

The acceptance must be given seriously and voluntarily by legally qualified persons. Pupils (that is, boys under 14, and girls under 12 years of age), idiots, and persons in a state of intoxication, are incapable of giving consent; persons within the forbidden degrees, impotent, or bound by a previous and existing marriage, are legally disqualified; and the most express acceptance, though followed by consummation, if extorted by force or fear, is unavailing. Even when consent is apparently free from all objections, and expressed in the most regular manner, the law still views it in connection with every circumstance in the conduct of the parties which may explain or throw light on its true meaning. Accordingly, the acceptance contained in an antenuptial contract of marriage, wherever it is accompanied by the usual clause binding the parties to solemnize the marriage in a formal manner, is construed as amounting only to a promise which cannot be enforced, though it may be the foundation of an action of damages. Some objections, well founded at the time, may be removed by subsequent voluntary cohabitation. For example, parties going through a form of marriage in pupilarity, or under compulsion, will be bound by it if they voluntarily continue the cohabitation after passing pupilarity, or regaining unrestrained freedom. The subsequent discovery of previous profligacy, or error as to rank, name, temper, legitimacy, religion, or deception as to fortune, or non-consent of parents or guardians, will not invalidate a Scotch marriage. Indeed, nothing short of an absolute mistake as to identity will have that effect; and even then, cohabitation after the mistake is discovered will render the marriage irrevocable.

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In regard to the evidence that a *de præsenti* consent was interchanged, we may observe—

1. That it may be proved directly—(1.) by witnesses swearing to the formal and serious verbal acceptance before a clergyman or friends; or by deliberate and explicit verbal acknowledgment of the parties that they were at some former period married to each other. (2.) It may be proved by writing, followed by delivery, provided the writing be either holograph of the parties, or be executed before witnesses, like other important documents; or at least that it be proved that the writing or subscription is genuine. And, (3.) It may be proved judicially, by the one party referring to the oath of the other, who either fails to deny it, or declines to swear. And it is of no consequence that the consent was secretly exchanged, if there be nothing else to discredit it. In some Scotch burghs the discreditable practice exists of presenting a complaint to the magistrates, praying that the parties be fined for having contracted an irregular marriage. The parties (who are the collusive promoters of the complaint) then confess the charge, and are fined in a nominal sum; and this procedure forms legal evidence that they were married. The equally discreditable Gretna Green marriage rests on the same acknowledgment.

As showing how completely the mere interchange of present consent, without any particular ceremony, constitutes in Scotland a valid marriage, we may mention that in a Scotch case, holograph and signed documents, "I hereby declare that Johanna Gordon is my lawful wife," and "I hereby acknowledge John Dalrymple as my lawful husband," were sustained in the House of Peers; Lord Stowell declaring that such a contract, without consummation, "does *ipso facto et ipso jure* constitute the relation of man and wife." As the most explicit declaration of marriage must be mutual, a document found in the repositories of either to which the other was no party is obviously worthless, unless connected with other circumstances. Thus a letter, containing on its envelope, "not to be opened till after the decease of George Fullarton," found in his repositories after his death, was disregarded, in respect that it was revocable while undelivered. A similar letter delivered to a third party, and connected with other circumstances implying the woman's recognition of it in her husband's lifetime, was

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sustained, the delivery being held to have been for her behoof. A course of letters between the parties, which commenced "dear wife," and "dear husband," and ended "your affectionate husband," or "wife," although they contained no explicit declaration of marriage, were found by the House of Peers to be equally conclusive. In the case of *M'Adam*, affirmed in the House of Peers in 1809, it was found sufficient, that the man called four servants and declared to them verbally that the woman was his wife, and that his children by her were legitimate; on which she gave him her hand, and curtsied; though in a few hours afterwards he committed suicide. As there was no evidence of insanity, Lord Eldon remarked that no subsequent repentance, however bitter, could affect a marriage once constituted. A different judgment is given wherever circumstances warrant the opinion expressed by the House of Peers in the case of *Taylor*, 1787, that what the parties did "was not intended, or understood to be final," as was most remarkably illustrated in the case of *M'Gregor* and *Jolly*, where the House of Peers disregarded a formal ceremony of marriage before a clergyman, on the ground that, looking to all the circumstances in "the conduct of the parties, both before and after the 23d May 1816" (the date of the ceremony), they did not "voluntarily and deliberately express that real and mutual consent," which is required. Some of these circumstances were, that M'Gregor never claimed the woman as his wife till many years afterwards, when she succeeded to a fortune, he having in the interval approved of her marriage with another, by whom she had children, and visited and acknowledged them as husband and wife.

2. The requisite consent may be proved inferentially—by a promise to marry, followed by sexual intercourse. Intercourse may be proved by witnesses, but the promise can only be proved by "writ or oath." It was at one time held that circumstances inferring that a promise had been given—such as an open courtship—might be proved by witnesses; but that doctrine is now exploded, and nothing short of a distinct promise can be founded on. Most conditions added to a promise—such as, "I will marry you when my circumstances permit"—are held to be discharged by the subsequent intercourse. The general rule is, that conditions of such a nature as cannot be fulfilled until *after* the copula,—as, for example, "I promise to marry you, provided an heir be born of our connexion,"—will not constitute marriage; while, if they might be fulfilled *before* the copula,—as "I promise to marry you when I am rich enough,"—the law will presume that they were either fulfilled or discharged at the date of the copula. Either party may pursue an action to have such a marriage declared. It is no objection to it that the intercourse existed prior as well as subsequent to the promise; because a party may have resolved to discontinue an unlawful course of life, and so have obtained the promise. Undoubtedly, if the interval between it and the subsequent intercourse be very long, or if circumstances indicate that the promise was renounced (such as the unchaste conduct with others of the party founding on it), it will be disregarded; and, generally speaking, whatever is sufficient to warrant a dissolution of a regular marriage, will elide a presumptive one. It has been found by the House of Peers that a woman's ignorance of the fact that the intercourse following on a promise constituted marriage, did not destroy her legal rights. Such a marriage is unquestionably valid, if circumstances do not create a sufficient presumption against it. Lord Kames, in his *Elucidations*, inquires whether it should be sustained in competition with a subsequent regular marriage? In an old case, the late Commissary Court of Scotland decided that question in the negative, but it was not carried to the higher court, and it is regarded as an erroneous judgment. No doubt parties contracting a regular marriage are exposed to most fearful and obvious hazards from collusion and perjury; and it may well be asked, if that judgment be erroneous, whether there is any use in going through a regular marriage after proclamation of banns. But while the principle of the law that the prior marriage, however informally contracted, is preferred to the most regular subsequent one, it will in most cases be held that any presumption in its favour is destroyed by the still stronger presumption arising from the conduct of parties and its undue concealment. But wherever there is no doubt of the promise, and of the intercourse following on it, if there be nothing to warrant the presumption that the promise was disregarded, a marriage so constituted is sustained.

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3. The requisite consent may be proved inferentially—by conjugal cohabitation, and being reputed married persons by friends and neighbours. This is supposed to have been first introduced by the Scotch statute 1503, which declared that where a woman was reputed to be the wife till the man's death, she should be entitled to her rights as his widow till it be proved that she was not his wife. Where the cohabitation was of considerable duration, and the parties openly mingled in society as acknowledged married parties (for both cohabitation and repute must co-exist), the presumption that the requisite consent, which the law allows to be given secretly, was really interchanged, is not an unreasonable one. But wherever it appears that such cohabitation was assumed merely from respect to public decency, the effect of it is destroyed. In judging of its true character, therefore, it is of importance not merely to ascertain whether it occurred within the natural sphere of the parties, but also how it commenced. Lord Eldon said, that "wherever it clearly appeared that it was at first illicit, it was likely to continue illicit;" and Lord Redesdale concurring, said, "that to raise the presumption of marriage, the repute must be general, and not such as might be created by statements or conduct designed to induce lodging-keepers to admit the parties into houses of respectability." The complaint of a woman claiming the rank of a wife, that the man had taken advantage of her by not introducing her to his friends, led another judge to remark, that "that complaint destroyed the very foundation of a plea of repute; and that wherever the connection was originally illicit, the law required some decided and unequivocal act to mark the change." This desideratum was supplied in M'Adam's case by what passed before his servants; and it was also supplied in another case, after some length of illicit cohabitation, by a meeting of friends being purposely called, at which the parties were drank to and bedded as married persons.

We may here observe, as applicable to all sorts of marriage recognised by the law of Scotland, that the circumstances inferring its constitution must occur either in Scotland or in a country where the same inference would be drawn from the like circumstances. This rests on the principle that the conduct of parties must be tried according to the law of the country where it occurred. In the case of the Countess of Strathmore in 1750, a proof of matrimonial cohabitation and repute in a foreign country was allowed, because a marriage was understood to be so constituted in that country; while, in another case, in 1811, an offer to prove that a promise and subsequent copula occurred in England, was disregarded, because no such mode of constituting marriage was then recognised in England. It makes no difference in such cases that the parties are Scotch by birth. These rules of judgment are followed in England even in the case of English parties. Lord Stowel said, "the validity of Miss Gordon's marriage rights must be tried by reference to the laws of the country where, if they exist at all, they had their origin." The same principle received effect in England in 1748, where, in reference to a marriage of English parties contracted in France, Lord Hardwick said, "that a marriage established by the sentence of a foreign court, having proper jurisdiction, is conclusive by the

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law of nations." In 1819, such a judgment was repeated in England with reference to a marriage of English parties in Sicily.

On the marriage being constituted the parties are bound to adhere with fidelity to each other; and the husband must support his wife according to his circumstances, unless she have property of her own sufficient for her support, with which her husband cannot interfere. The moveable property of both, including the fruits of the wife's heritable subjects, the interests of her bonds, and even the profits of her personal labour and skill, become the property of the husband. The marriage operates like a deed of assignation, so that the husband can sue for the recovery of these rights of his wife in his own name and without her concurrence; and any attempt on her part to defeat him, occurring after the proclamation of banns, is held to be fraudulent. The common moveable property of the parties is sometimes called the goods *in communion;* and yet the wife during the marriage has truly only the hope of getting a share of it—her right in it not being indefeasible till the death of her husband. The husband's right is called his *jus mariti*. In virtue of this right he may sell, gift, or waste the common property at his pleasure, and his creditors may attach it for his debts. The wife's paraphernalia, comprehending her personal attire and ornaments, and such articles of a kind used by either party as the husband may have gifted to her before the marriage, are excepted. Besides having this right to her moveables, the husband on the marriage becomes her legal guardian. He may, however, renounce both his *jus mariti* and his right of administration; and where he does so, the wife can act in reference to her own estate independently of her husband, and altogether as fully and freely as if she were unmarried—leasing, feuing, selling, or burdening her property, or appointing factors to manage it, though in opposition to her husband's will. But the husband may renounce his *jus mariti* and yet retain his curatorial powers, in which last case she can only act with his concurrence. Third parties may convey property to a wife conditionally, and so as to exclude all the rights both of the husband and his creditors; as, by declaring the conveyance to be purely alimentary, and exclusive of these rights; or by conveying to trustees for her behoof, with a similar exclusion of the husband and his creditors. A wife, by her own antenuptial contract, may reserve all the rights which she possessed as a single woman. After, however, a marriage is entered into, a husband cannot renounce his *jus mariti* to the prejudice of his creditors: and even when the renunciation is not to their prejudice, it seems to be in the nature of donations between husband and wife, which are revocable at pleasure during the existence of the marriage. In law the husband is liable, so long as she remains alive, for all the personal debts contracted by his wife prior to the marriage; but this liability terminates on her death, unless his estate were attached by "complete legal diligence," during the marriage; or unless he was a gainer by the marriage to the extent of something beyond a reasonable tocher. Even when made liable, on the ground of having received some excessive advantage, it is only in the event of the wife's separate estate being found insufficient, that he becomes personally liable. If he be imprisoned for a prior debt of his wife, for which his own separate estate has not been attached, and if she die, he is no longer liable in payment. During the marriage the husband and not the wife is liable for all domestic furnishings which she may order; and such furnishings may be proved against him by her attestation or evidence. In other respects she is not received in evidence against her husband, except in the case of assault committed by him against herself. For furnishings unsuitable to his condition in life made on the order of a wife, the husband is not liable; neither is he liable for any fine in which she may be subjected by a court of law as the punishment of her crimes. In this last case, however, so entirely is a wife's person exempted from imprisonment during marriage (except in a few instances now to be noticed), that where a fine is awarded against her on account of her crimes, it cannot be enforced by her imprisonment until the death of her husband. Indeed, even for her apparent crimes she may be relieved of all consequences, if it clearly appear that she acted under the compulsion of her husband. When, however, she voluntarily acts on her own account, or in concert with him, in the commission of crime, she is liable in criminal punishment.

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In England, as Justice Coleridge remarked, a husband may compel his wife to cohabit with him; adding, however, that the moment compulsion becomes unnecessary "for keeping her in the path of duty, it becomes illegal." In Scotland the same end is generally effected by the husband being entitled to withhold all alimentary support if she withdraw from his society, unless on sufficient cause. It has been found that a husband may, without any reason, debar his wife from his house, and assign her a separate, if it be not an unsuitable, residence. She takes his rank and precedence, unless these are merely official. She cannot sue at law, either in England or Scotland, without his concurrence, unless he have renounced all his rights, including that of guardianship; neither can she be sued in civil actions, unless her husband be called as a defender. All voluntary deeds of separation are revocable at pleasure, unless it appear that the revocation is merely for the purpose of obtaining an increase of aliment. The bills, bonds, and cautionary obligations of a married woman are null, so that she cannot be sued on them even after her husband's death; yet, like a minor, she may insist on other parties, who may have contracted with her in the knowledge that she was a married woman, fulfilling their contracts with her, wherever it is her interest to do so, provided she is ready to perform the counter part incumbent on her. Contracts, however, gone into by a married woman, are binding against her separate estate wherever they are clearly beneficial, such as for improvements on her separate property, just as the expense of managing or recovering her separate estate forms a good charge against it. Necessary furnishings for clothing, or aliment for herself, as well as for the domestic consumption, do not form the ground of a charge against her, but only against her husband. If a married woman fraudulently holds herself out as a single woman, and deceives parties into contracts with her, her separate estate will be liable in all consequences. Where a husband becomes insane, the disabilities under which a wife lies, equally with his curatorial powers or guardianship, are at an end, and she is entitled to manage, and probably to alienate, her estate, and do every act of a rational character; though even then it is not understood that she can be imprisoned for civil debts. If the married pair be judicially separated, a wife's creditors may attach her allowance for necessary furnishings made to her. Where the husband is abroad, a wife's obligations for necessaries are effectual; and if, in order to procure a livelihood while her husband is abroad, she engage in trade, she then becomes, even during his life, liable to imprisonment for her debts. There is nothing to prevent a married woman making a settlement of her separate estate, without the consent of her husband, to take effect after her death; and there is no reason why, if she please, the party to be benefited by such a deed should not be her husband. She is also liable to be imprisoned in order to compel her to subscribe necessary deeds which the Court has found her to be under a legal obligation to grant. Where she pursues an action at law, she must have her husband's concurrence, unless he have renounced his *jus mariti* and right of guardianship; and if he improperly withhold his concurrence, the Court will appoint a curator to her for the occasion. When an action is raised against

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her, the husband must be called for his interest; and if he refuse to appear, which he may when the action may have a prejudicial effect on himself, the Court, on being satisfied of the propriety of doing so, will appoint a curator for her, to aid her in the defence.

The law of England and of Scotland are alike to the disadvantage of the wife, in this respect, that marriage operates like a formal deed of assignation to the husband of all the wife's moveable estate, unless she is protected by an antenuptial contract, or by special clauses in conveyances by third parties for her behoof. She cannot otherwise acquire and hold money, or other moveable property. The husband is no doubt bound, as the holder of the goods in communion, to give to her a reasonable sum for her support; but then he may give that sum actually out of the proceeds of her own labour, as an author or an actress, a trader, or a needlewoman, and spend or misspend the surplus according to his own pleasure. The laws of both countries certainly relieve the wife from all responsibility, even for the necessary furnishings required for her own consumption; and where her personal gains are less than what is required by both her and her husband, she may have nothing to complain of. But when a husband altogether fails to support his wife, and squanders his time and means in utter profligacy, leaving to her only the alternative of labour or starvation, it is well worth the consideration of parliament whether the law should permit him to keep his wife constantly in poverty, by periodically pouncing on the fruits of her industry, and dishonestly wasting it, without even paying to her out of it what is required for her support. If this cannot be restrained, as we think on a husband's failure to do his duty it easily might, it may well be questioned whether a wife does not purchase exemption from personal responsibility at too great a price.

Marriage is dissolved by divorce or death. In Scotland there are two grounds of divorce—malicious desertion, and adultery. Neither of these necessarily dissolve the marriage, but only afford a plea, which may either be abandoned or rendered available by an action at law. If either party die during the dependence of the action, and before final judgment of divorce is pronounced, the rights of the survivor and of the heirs of the deceased must be tried on the footing of the marriage having been dissolved only by death.

1. *Desertion.*—By the Scotch statute 1573, c. 55, it is enacted, that where any of the "spouses shall divert frae the other without sufficient grounds, and shall remain in his or her malicious obstinacy for four years," the injured party may take certain steps to bring about a dissolution of the marriage. The first is the action of adherence, which may be raised after one year's desertion. If the desertion have not lasted for a year, or if it occurred in the course of necessary and lawful business, this action is useless as a step in the divorce. If the defender have broken up his Scotch domicile, and withdrawn himself from the jurisdiction of the courts of Scotland, leaving his wife behind, it seems hard to deprive her of her legal remedy by his own unlawful act; and therefore such an action in Scotland, provided the husband received notice of it, has been often sustained, though the legality of doing so is now seriously questioned. Where the wife is the deserter, and the husband remains in Scotland, there is no difficulty, as her domicile is in law held to be that of her husband. The action of adherence will be sustained in the face of an agreement to separate, because such an agreement is contrary to the first duty of marriage. Maltreatment or adultery furnishes a good defence against this action. On the decree of adherence being pronounced, the next step is to raise letters of horning and charge the defender to adhere. If recusant, the defender is denounced rebel, and application is made to the presbytery to admonish, and, if necessary, to excommunicate. In practice, presbyteries decline to interfere, whereupon the pursuer protests for remedy at law, and, on the expiry of four years from the desertion, raises the action of divorce. It is then too late for the defender to offer to adhere. On its appearing that the steps now alluded to were regularly gone through, decree of divorce is pronounced. The act 1573, c. 55, provides that the defender shall "tyne and lose" the tocher and the *donationes propter nuptias*, by which is understood all provisions, either by law or paction. If the husband be the offending party, he must restore the tocher, and pay to the wife all the provisions in her favour, legal or conventional; and if the wife be the offending party, she forfeits the tocher and all the right that would have belonged to her if she had survived, such as *terce*, *jus relictæ*, &c. If the offending wife be an heiress, the husband has right to the courtesy of her estate, if there were an heir of their marriage. An estate devolving to either party subsequent to a divorce, is free from all claim at the instance of the other party, as the divorce terminates all relationship between them. It is an error to suppose that any desertion, however protracted, by either of the married pair, unless followed by a decree of divorce, will warrant the other in entering into a second marriage in the lifetime of the party who deserted, or furnish a defence against a criminal prosecution.

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2. *Adultery.*—By the canon law adultery entitled the innocent party only to separation from bed and board. By the Scotch law, it does not dissolve marriage unless the aggrieved party shall bring the proper action requiring the dissolution; and the offender may be pardoned at the pleasure of the injured party. Pardon, which may be inferred from the conduct of the parties, or being accessory to the defender's guilt, is a bar to divorce. When divorce is pronounced, both parties are free to marry, as if they had never been married to each other, with this exception, that by the statute 1600, c. 20, the guilty party is prohibited from marrying the person with whom the adultery was committed. The prohibition, however, fails if the person with whom the adultery was committed be not judicially ascertained and named in the decree of divorce, or if the divorce were pronounced by a foreign judicature, as the statute refers only to divorces pronounced by the "ordinar judge," meaning a judge in Scotland. On raising the action, the pursuer must swear that it is believed to be well founded, and that it was not raised, either directly or indirectly, in collusion with the defender. Both the date of the marriage and of the guilt of the defender must then be proved, so that it may be ascertained that the latter did not occur prior to the former.

Sometimes it is pleaded in defence that the domicile of the defender is beyond the jurisdiction of the Scotch courts. Some years ago this defence was disregarded wherever the marriage was Scotch, and the defender was cited edictally. It is now otherwise. Where the wife is the defender, and her husband is domiciled in Scotland, she is held, on being cited edictally, and getting notarial intimation of the action, to be amenable to the Scotch court wherever she is resident, on the ground that her husband's domicile is hers. As against the husband, however, there must either be, at the date of the action, his actual domicile in Scotland, or the presumption of such a domicile, founded on residence of forty days within Scotland. When such domicile on the part of the husband exists, an action will be sustained against either party, even though English by birth, and though the marriage was contracted in England; and it will be sustained against the wife even although she be still resident there. This has led to a painful collision with the law of England. In the case of Lolly, the husband had contracted an English marriage, and he was divorced by the Scotch court on the ground of adultery committed while on a visit to Scotland of a duration sufficient to found jurisdiction. He then returned to England, and having there married

another woman, he was tried at the Lancaster assizes for bigamy, and received sentence of transportation—not because of insufficiency of the residence in Scotland to subject him to the law of Scotland, but because an English marriage being indissoluble in England, except by act of parliament, it was held that it could not be disturbed by the law of another country, to which the parties could not be supposed to have had reference at the time of their marriage. The sentence of transportation against Lolly has had no effect whatever in altering the Scotch practice in this particular; and there can be no doubt that if Lolly had remained and married in Scotland, even the House of Peers would have sustained the validity of his second marriage, to the effect of finding its issue entitled to succeed to his property in Scotland. Another question yet remains. While domicile creates jurisdiction, must the Scotch court decide all questions arising from marriage, according to the law of the place where the marriage was contracted, and thus refuse divorce to parties domiciled in Scotland who were married where such a mode of dissolution is not permitted? This question is in Scotland uniformly answered in the negative, otherwise the supremacy of the law of Scotland within its own territory would be compromised. The legality of the marriage itself, however, like all other contracts, is determined according to the law of the place where it is said to have been contracted. Analogous to this is the rule existing both in England and Scotland by which the goods in communion are divided according to the law of the domicile, without regard to the place of the marriage. In the comparatively recent case of Duntz, 1816, the parties were English by birth, and married in England in 1810. In 1813 the husband came with his wife to Scotland, where his domicile was established, after which he raised an action of divorce. In the course of the process the opinions of the Judges of the Court of Session were taken on this question, "Is it a valid defence against an action of divorce in Scotland on account of adultery committed there, that the marriage had been celebrated in England?" and they unanimously concurred in saying that it is not. In a similar case, *Edmonston*, 1816, with this variation, that the parties were Scotch, the defence was urged that the action should be restricted to separation from bed and board, but it met the same fate. On this subject Lord Robertson expressed with great clearness views which were recognised as correct by Mr Justice Storey, when he said, "marriage is merely a personal consensual contract;" and it may be "thought that the *lex loci* must be resorted to in expounding every question that arises relative to it;" but it "is a contract *sui generis*," and "it differs from other contracts in this, that the rights, obligations, or duties, arising from it, are not entirely left to be regulated by the agreement of parties, but are to a certain extent matters of municipal regulation, over which the parties have no control. It confers the status of legitimacy, &c. Unlike other contracts it cannot, in general amongst civilized nations, be dissolved by mutual consent, and subsists in full force even though one of the parties should be for ever rendered incapable, as in the case of incurable insanity or the like, from performing his part of the mutual contract." It is no defence after domicile is established that the adultery is committed only out of Scotland; but it is a good defence to either party in an English marriage that it was committed abroad, before the Scotch domicile was acquired. The following seem to be the results of the above and some other decisions:—1. Adultery abroad, where the law does not on that account dissolve marriage, and prior to the Scotch domicile, will not warrant a divorce in Scotland. 2. But the instant that a forty days' domicile is acquired by the husband in Scotland, divorce will be pronounced by the Scotch court against either husband or wife on account of adultery committed anywhere after or in the course of acquiring such domicile, no matter where the marriage was contracted, or where the parties have been born. 3. If before the action of divorce is raised, the husband have left Scotland and established a foreign domicile, the courts of Scotland cease to have jurisdiction. 4. The circumstance of both or either of the parties being Scotch by birth, or having estates in Scotland, will not, independent of the husband's domicile, confer jurisdiction on the Scotch court. These results rest on the principle that when parties break up their old domicile, and enter and acquire a domicile in a new territory, they voluntarily subject their future conduct to its laws.

In regard to the defences against an action of divorce—

1. Collusion, if proved, between the parties, affords to the repentant defender a good defence against divorce; but though it should appear that the defender intentionally gave ground for the suit so openly that detection was inevitable, and expressly to provoke the other party to bring the suit, divorce will be granted, if the pursuer was not accessory to the misconduct.

2. Forgiveness, or the plea of *remissio injuriæ*, as it is called, when established, is fatal to the divorce. As adultery operates only as a plea for divorce on the necessary action being raised, it follows that the injured party may forgive, or abstain from suing for redress. The forgiveness may be proved directly, by words or writing, or inferentially, from cohabitation after the guilt is known. As, generally speaking, a wife cannot so easily withdraw from the husband as the husband from the wife, Lord Stowell remarked, "that though the husband is bound to take prompt notice of the infidelity of the wife, yet this doctrine is not to be pressed against a wife, except in particular circumstances." It is a plea in bar of process, but to be successful it must apply to the specific guilt charged, and not to other offences which may not have been either known or pardoned. Facts inferring forgiveness can only be regarded when it appears that the guilt was certainly known. The raising of the suit infers certain knowledge; but not the conducting of a preliminary precognition. It may be proved by a reference to oath. A written discharge of all and any offences committed prior to a certain date is available.

3. Lenocinium, or a party's either directly or indirectly encouraging, countenancing, or instigating the other's guilt, or purposely throwing temptation in the way, affords an available defence; as no one is entitled to take advantage of his own improper conduct.

4. Recrimination, or the plea that the pursuer has been guilty as well as the defender, seems at one time in Scotland to have been an available defence; but it is not so now. If the defender bring a counter action, and both parties are successful in proving each other's guilt, mutual divorces will be pronounced, producing patrimonial consequences.

5. Further, it is a good defence against decree of divorce being finally pronounced that either party have died in the course of the process, no matter how plainly the guilt may have been proved in the lifetime; and the guilty party, or the heirs of the guilty party, cannot then be deprived of those patrimonial rights which may open on the dissolution by death.

It is competent to creditors interested to prevent a decree of divorce going out against their debtor, to sist themselves as defenders, and propone all defences competent to their debtor; as, for example, that the guilt was pardoned; or that the action is carried on collusively, to injure the defender's civil rights, and defeat the chance of the creditors recovering their claims. It has been decided by the House of Peers that it is too late for the trustee for the husband's creditor to appear and offer to prove collusion after the pursuer had both deponed that there was none, and had also proved her husband's guilt.

In regard to the proof, the only general rule that can be

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laid down is, that the circumstances in evidence must be such as lead the discretion of reasonable men to the conclusion of guilt. The paramour is not bound to criminate himself; but his declining to answer is not to be overlooked in considering the other evidence, though by itself it is of no consequence.

1. As to the consequences of the dissolution of marriage by death. We shall advert to those as they stand, irrespective of the recent statute 18th Vict., c. 23; and then mention the changes introduced by that statute. Where marriage subsists for a year and day, or where a living child has been born, the surviving wife succeeds to her terce, being the liferent of the third of her husband's heritage (excluding burgage property) in which he died infeft, and to the half or third of the goods in communion, called *jus relictæ*, according as a child has or has not survived; or otherwise, where she has conventional claims, sometimes granted in lieu of her legal rights, these conventional rights are secured to her. In regard to the husband, if he survive, and the marriage have subsisted for a year and day, he becomes the irrevocable proprietor of the tocher, and of the half of the goods in communion, or two-thirds if children be alive, subject to their claim of legitim. His conventional rights are secured to him. If a child of the marriage was heard to cry, the husband succeeds to his courtesy, being the liferent of the deceased wife's heritage, which fell to her by succession, and in which she died infeft. If the wife had a living child by a former marriage, who succeeds to her heritage, the last and surviving husband has no right to the courtesy. If the marriage be dissolved within a year and day, without there having been a living child, the parties are reinstated in the condition in which they were before the marriage, in so far as practicable, and the tocher must be returned, in so far as unconsumed. The surviving party, whether husband or wife, loses all right in the other's estate. Even contracts between the parties are annulled, unless they contain a provision to the contrary. If there be no children born of an irregular marriage, the year and day are counted from the date of the acknowledgment. Where children were previously born it draws back to the birth.

It must now be kept in view, that by the recent statute, 18th Vict., c. 23, § 6, it is enacted, "that where a wife shall predecease her husband, the next of kin, executors, or other representative of such wife, whether testate or intestate, shall have no right to any share of the goods in communion; nor shall any legacy or bequest, or testamentary disposition thereof, by such wife, affect or attach to the said goods or any portion thereof." And farther, by § 7, that "where a marriage shall be dissolved before the lapse of a year and day from its date, by the death of one of the spouses, the whole right of the survivor, and of the representatives of the predecessor, shall be the same *as if the marriage had subsisted for the period aforesaid;*" and by the 3d and 4th sections of that statute, it is provided that where any person dying intestate shall predecease his father, without leaving lawful issue, his father shall have right to one-half of his moveable estate; and where such person dying intestate, whose father has predeceased him, shall be survived by his mother, she shall have right to one-third of his moveable estate. These, it is believed, are the only alterations of the prior law of Scotland introduced by that statute, affecting the dissolution of marriage by death.

2. As to the consequences of the dissolution of marriage by divorce on the ground of adultery. If the wife be the divorced party, she is considered, in reference to all patrimonial rights, to be dead, and therefore can claim no provision of any sort, either legal or conventional; and the husband has right to the courtesy. If she made a donation to her husband during the subsistence of the marriage, she can now no longer revoke it; and no right can pass to those who would have been her executors for a share of the goods in communion. If the husband be the divorced party, the wife has immediate right, exactly as if he were dead, to her terce and *jus relictæ*, or to her jointure; in a word, to all her rights, legal, or conventional, as if he were naturally dead. All rights in the husband flowing from the wife, and all his power of administration of her estate are at an end. He forfeits his right of courtesy. He can no longer draw his wife's rents, or revoke gifts which he may have made to her. He is not, however, called on to restore the tocher; for justice does not require that the woman should be placed in a better situation by the divorce than she would have been by the husband's death. Neither party has any interest in the rights which may accrue to the other after divorce. This last point was fixed by a judgment in a case at the instance of the Earl of Elgin in 1827.

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Where a ceremony of marriage has been gone through by parties disqualified to marry, such as idiots, impotent persons, or persons already married, the action of divorce is inapplicable. The proper remedy is an action concluding for a decree, declaring the ceremony void and null, and that the defender has no interest in the pursuer's estate. In some circumstances the defender may be liable in damages to the pursuer, as if, for example, where the defender had previously been married to a party alive at the date of the second ceremony.

In the direct line marriage is forbidden *in infinitum*. First cousins, and all of remoter degrees, may lawfully marry. A man after his wife's death cannot marry any of her kindred nearer in blood to her, than he may of his own, nor *vice versa;* but as relationship by affinity properly exists only between the husband and the wife's relations, or between the wife and the husband's relations, there is nothing to hinder brothers from marrying sisters, or a father and son from marrying a mother and daugher.

Though maltreatment is not a ground of divorce, it warrants a decree of separation. By maltreatment, less than personal violence is meant. If a man, particularly in the better ranks, ill uses his wife by threats, degrading restraints, and licentious conduct, a decree of separation will be pronounced. Lord Stowell remarked in an English case—*Evans*, 1790—that, in general, when married people "understand that they must live together, except for a very few reasons known to the law, they learn to soften by mutual accommodation that yoke which they know they cannot shake off." "Mere austerity of temper, petulance of manners, rudeness of language, want of civil attention, even occasional sallies of passion, if they do not threaten bodily harm, do not amount to legal cruelty." "There must be proof of a reasonable apprehension of bodily hurt. I say an apprehension, because assuredly the court will not wait till the hurt is actually done; but the apprehension must be reasonable. It must not be an apprehension arising merely from an exquisite and diseased sensibility." In the case of *Waring*, in 1813, Lord Stowell said, it must be kept in view "that a wife may, by provocations, have brought upon herself the ill treatment complained of. When that appears she is not entitled to demand relief." "It is a difficult task to return blows, let them come from where they may, with words only. Force may be opposed, and in some cases must be opposed, with force." The adultery of either party entitles the other, by the laws of England and Scotland, to a separation; and even for maltreatment it will be awarded in favour of the husband as well as the wife, though it will require stronger grounds. This kind of action draws after it none of the consequences resulting from death or divorce. It only entitles the wife to obtain from a husband a suitable allowance for her separate support during their joint lives, a right which she possesses, even where the separation has been decreed against her at his instance; in respect that he is the possessor and administrator of the

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goods in communion. But the grounds of such an action, and the decree itself may be discharged by the pursuer at pleasure. Where there are children, if the mother be the successful pursuer, she is allowed to have the custody of female children till twelve, and males till seven years of age, with a suitable allowance for them. The court has a discretionary power to dispose of the children, according to circumstances, but it is not exercised except in extreme cases. After the parties are judicially separated, the husband is no longer liable for the debts which the wife may contract, provided he pay to her the sum awarded by the court for her support.

From what has been stated above, it will be seen that the leading differences between the law of England and Scotland on the subject of marriage, are to be found both in its constitution and dissolution. Certain forms are required in England in order to constitute marriage, which are not essential in Scotland, provided the consent of parties is given clearly and seriously. To avoid the strictness of England, her subjects sometimes cross the border to contract an irregular marriage, which may be effected in Scotland in a few minutes. This may be prevented by the legislature enacting that such a marriage should not be binding, unless preceded by the residence for a certain length of time of the English parties in Scotland; and a bill is at present before parliament to accomplish that object, which will be adverted to in conclusion, if it be passed into a law before the publication of this volume. In regard to the dissolution of marriage by divorce, a woman cannot, except in extraordinary circumstances, sue in England for such a remedy; and even the husband cannot, in that country, obtain it, except on the single ground of his wife's infidelity, nor until he obtain a verdict for damages against her seducer; after which he may procure an act of parliament dissolving the marriage. The expense of this procedure is so great as to exclude the remedy of divorce from husbands in the lower ranks of England. The practical exclusion of the English wife from such a remedy, rests on the ground that her husband's infidelity does not involve a family in calamities so great as those occasioned by the infidelity of the wife. In Scotland, malicious and obstinately continued desertion is regarded equally with infidelity as a violation of the marriage vow; and the husband, as well as the wife, having undertaken that vow, is equally with her liable in the consequences of its violation; while the remedy of divorce can be obtained by all ranks, even as a matter of right, and in *forma pauperis* if necessary. Marriage may thus be said to be more easily constituted, and more easily dissolved in Scotland than in England; and yet Scotland is not particularly remarkable for rash and inconsiderate marriages; neither do the number of divorces pronounced in that country lead to the inference, that the facility with which they are obtained tends to increase their number. Indeed, the number of Scotch divorces is very small; those at the instance of the wife not exceeding twenty annually; showing that divorce is a remedy not usually sought for by a wife, until her wrongs have become intolerable.

The Bill referred to in the last paragraph has now been passed into a law; by which it is enacted that after the 31st day of December 1856, no irregular marriages contracted in Scotland shall be valid, unless one of the parties had at the date thereof his or her usual place of residence there, or had lived in Scotland for twenty-one days next preceding such marriage; while, if any parties contracting an irregular marriage shall, within three months thereafter, present a joint application for a warrant to register such marriage to the sheriff, the sheriff shall, on evidence, direct it to be registered, provided that one of the parties had lived in Scotland for twenty-one days next preceding such marriage, or had his or her usual residence in Scotland at the date thereof; and it is now no longer lawful to convict any parties of having irregularly contracted marriage, unless there shall be adduced sufficient proof other than the acknowledgment of such parties, that one of them had at the date thereof his or her usual residence in Scotland, or had lived in Scotland for twenty-one days next preceding such marriage. See PARENT AND CHILD. (M. L.)

Huskisson || Huss.

HUSKISSON, WILLIAM, an able financier and statesman, was born in 1770, at Birch-Moreton, in Worcestershire. After an excellent education at home, he went to Paris to study medicine, which he had chosen as his profession. Accident, however, made him acquainted with Lord Gower, English ambassador in that city, and Huskisson, abandoning medicine, became his private secretary. Connecting himself on his return to England with the Tory party, he held various offices under government, to which he made himself valuable, and indeed indispensable, from his knowledge of business, especially in the department of finance. After the death of Pitt he attached himself to the party of Canning, and distinguished himself by the part he took in the celebrated Bullion Committee, in which he supported and enforced the views of Horner for an immediate resumption of cash-payments by the banks. In 1822 he succeeded Canning as secretary of state. For the remainder of his public history see art. BRITAIN. His death, which took place September 15, 1830, was accidental. At the opening of the Manchester and Liverpool Railway, he was run over by a train, and so severely injured, that he survived but a very short time. A collective edition of his speeches appeared in 1831. They do not exhibit any great eloquence strictly so called; but are distinguished for clear statement, lucid order, close reasoning, and a great mastery of details. The views, without being new or brilliant, are sound and comprehensive, and evidently the result of mature thought and study. The conscientious fulness of the details makes them both instructive and interesting, even to readers of the present day.

HUSS, JOHN, the Bohemian reformer, was born at a village called Hussinecz, situated in that part of Bohemia which borders on Bavaria, on the 6th of July 1369. His parents were in humble circumstances, and he was in early life subjected to both toil and privation—a discipline which was probably not without its use in preparing him for his subsequent career. After passing through the initiatory branches of education, he entered the university of Prague, where he studied philosophy and theology under Stanislaus of Znaim, a man of liberal tendencies, and from whom Huss probably received the first impulse towards those opinions and efforts to which he owes his fame and his place in the history of the Church. Huss took his master's degree in 1396, and in 1398 he began to lecture. In 1400 he was appointed confessor to Sophia, queen of Bohemia; in 1401 he became president of the theological faculty in the university; and in 1402 he was selected to fill the office of preacher at the Bethlehem Chapel, an edifice which had been erected and endowed by John of Milheim, one of the royal councillors, and a wealthy citizen of Prague named Creutz, for the express purpose of facilitating the preaching to the people in the Bohemian tongue (verbum Dei communi populo civitatis in vulgari Bohemico ad prædicandum.) These appointments show in what respect Huss, though as yet but a young man, was held. His chaplaincy at the Bethlehem was especially important to him, as it afforded scope for the exercise of those peculiar powers of popular address which he possessed, and gave him opportunity of employing these in the promotion of those measures of reform on which his heart was already set.

Whilst yet a student at the university, Huss's earnest and religious mind had been grieved by the prevailing levity and immorality of the clergy, as well as the gross superstition, ignorance, and vice of the body of the people. The

Huss. times in which he appeared were those of the deepest mediæval darkness, when boundless corruption reigned throughout the Church, when anarchy and discord were threatening her with ruin, and when almost every man in whose bosom a regard for the interests of religion and morality remained, was compelled to assume the position of a censurer and a reformer. Mosheim observes, that "no teacher or writer of any eminence in this century (the fifteenth), can be named, who does not plainly and greatly lament the miserable state of the Christian Church, and anticipate its ruin, unless God should interpose for its rescue."[1] Several had already appeared in Bohemia, who had uttered energetic testimony against the prevailing corruptions. Milicz of Kremsia, Conrad of Waldhausen, John of Steikna, and Matthias of Janow, had formed a succession of witnesses whose unwearied and vehement denunciations alike of the misconduct of the clergy and the corruptions of the populace, had been gradually leavening the minds of the community with sentiments favourable to a better state of things. In the footsteps of these men, Huss, deeply imbued with their spirit, and familiar with their opinions, enthusiastically followed, and by his eloquent, empassioned, and fearless discourses at the Bethlehem Chapel, greatly extended the movement they had commenced. At first, indeed, he confined himself to topics affecting only the laity, but from these he advanced boldly to attack the sensual and vicious habits of the clergy. The result was, that he drew around him a small but attached and congenial community from among the former, while he incurred the bitter hatred and opposition of the latter.

It is true, that at first his efforts for reform seemed to be conducted under the sanction of his ecclesiastical superiors. A young nobleman, Sbynko, or Zbynek, of Hasenburg, was at that time archbishop of Prague; and being disposed to introduce order into his diocese, and to discourage the gross superstitions that were bewildering the people, he availed himself of the knowledge, influence, and zeal of Huss for this purpose. For some time, therefore, the latter worked under the protection and with the approval of his diocesan; but the motives, designs, and the spirit of the two men were so different, that it was not possible they should continue very long to pursue a common course. Zbynek was a man of the world, whose tastes were more for military operations than for ecclesiastical or spiritual functions, and whose desire for reform in his diocese was kindled by no higher feeling than that which prompts a general to enforce order among his soldiers. Huss was a man fired with religious zeal, caring little for secular interests, devoted to the service of morality and piety, and whom nothing could satisfy but a return to such a state of things as the high standard of spiritual Christianity sanctioned. Between two such men there was hardly anything in common; and though peculiar circumstances might impel them in a common direction for a season, no sooner would the influence of these be removed, than their paths must necessarily diverge ever more and more widely from each other. As it happened, hardly seven years had elapsed when their relations were completely changed; the patron had become the persecutor, and the humble priest was agitating a reform which not only roused the indignation of the archbishop of Prague, but occupied the attention, and perplexed the counsels of the supreme Pontiff himself.

Several circumstances conspired to push Huss forward in the career on which he had entered. Already imbued with principles derived from the study of the sacred Scriptures, the writings of Augustine, and those of Milicz and Matthias of Janow, his mind received a still more decisive impulse in the direction of reform from the perusal of the writings of Wycliffe. With some of these he had become acquainted as early as 1391; but it would appear that it was not till a later period that he experienced the full amount of their influence on his mind. By the perusal of them he was completely won over to the views of the Realists in philosophy; and though he did not embrace all Wycliffe's theological opinions, he undoubtedly owed to him much spiritual enlightenment,—a benefit which he was prompt publicly to acknowledge whilst preaching, commending them to the people as full of truth, and frequently declaring that he wished his soul after death to go to the same place whither that of Wycliffe had gone.[2] It was as a defender of Wycliffe that Huss first came into collision with Archbishop Zbynek. In 1406, the latter began to institute proceedings for the suppression of the Wycliffite heresy in his diocese, and even went the length of banishing or committing to the flames some who refused to recant the opinions they had embraced from the teaching of the English reformer. Against this cruelty Huss, though not himself prepared to concur in all the opinions for which these men suffered, indignantly protested. "What sort of thing is this," he wrote to the archbishop, "that men guilty of incest and every kind of crime pass with impunity, whilst humble priests, plucking out the thorns of sin, fulfilling their duty, well affected towards your rule, not following avarice, but gratuitously, for God's sake, labouring in the gospel, are cast into prison as heretics, and suffer banishment for preaching the gospel itself?"[3] To these remonstrances Zbynek seems at first to have listened; at least he did not at this time pursue his persecution of the Wycliffites, nor does Huss appear to have incurred his displeasure by the zeal he had shown on their behalf. A more serious cause of quarrel arose out of the part which Huss took in the disputes which were then agitating Christendom, in consequence of the Papal schism. The archbishop had espoused the side of Gregory XII. in opposition to Wenceslaus, the king of Bohemia, and Huss, taking the same side as the king, employed his influence in securing support for his cause. Not long before this an event had occurred, very much through Huss's efforts, which greatly increased his power of serving the king in such an emergency. The university of Prague had hitherto numbered among its students a large body of Germans, who indeed formed the majority, and to whom had been conceded the privilege of three votes in all questions affecting the interests of the university, whilst the native Bohemians possessed only one. Against this, as an act of injustice, Huss, supported by his friend Jerome of Prague, and by the patriotic feeling of many of their countrymen, had at length successfully struggled: by an edict of the king in 1409, the relative weight of the parties was reversed, three votes being given to the Bohemians, and only one to the Germans. In consequence of this the latter seceded in a body, to the number, according to the lowest estimate, of 5000. Huss was immediately after elevated to the post of rector of the university; but whilst he was thus enabled to serve the side of the king in his contest with the archbishop and clergy more efficiently, the part he had taken in the measures which resulted in the secession of the Germans, materially contributed to his own subsequent injury. He had thereby not only given mortal offence to the archbishop and the clergy of Bohemia, but he had multiplied enemies in every place to which the dispersed students and professors betook themselves; whilst, at home, the loss occasioned to the city by the withdrawal of so large a number of its inhabitants turned from him the favour of the citizens, and facilitated the attempts of his enemies to stir up a party against him.

The archbishop now resolved to proceed vigorously for

[1] *Cent.* 15, ch. 2.

[2] *Æneas Sylvii Hist. Bohem.*, c. 35; *Herr von der Hardt, Act. Conc.* iv., 314.

[3] *Palacky Gesch. von Bohemia*, bd. iii., § 223, cited by Neander, vol. ix., p. 341, Torrey's Transl.

Huss. the suppression of the reformers. In 1410 he procured from the pope, Alexander V., full powers to prohibit preaching in private chapels, and to consign the writings of Wycliffe to the flames. Huss, in the face of this, boldly continued to preach as before at the Bethlehem Chapel, where he was still listened to by admiring crowds. This provoked the archbishop to accuse him to the pope of heresy; in consequence of which he was summoned to appear at Bologna, before Cardinal Otto of Colonna, to answer for himself; and, on his failing to appear, was excommunicated. This sentence was renewed by Cardinal Brancas, to whom the case had been referred for reconsideration; but, though Zbynek endeavoured to carry it into effect, the influence of Huss with the king and the people of Bohemia was still so great that he was compelled to relinquish the attempt, and even to recal his accusation of heresy, and request the pope to remove the ban under which Huss had been laid.

Archbishop Zbynek died in 1411, and was succeeded by Alric of Unitzow, a man wholly uninterested in religious disputes, and devoted to the interests of the king. Under his sway Huss might have remained unmolested, had it not been that events occurred which compelled him to assume even a still more decided posture of opposition to the corruptions of the Papacy than he had hitherto assumed. In 1412 the pope issued a bull commanding a crusade against King Ladislaus of Naples, and proclaiming full indulgence to all who should take arms in this crusade, or furnish money for carrying it on. This roused Huss's indignation, and he attacked the bull both with voice and pen. In this he was seconded only too zealously by his friend Jerome, who, not content with exerting his fiery eloquence on the subject, proceeded to parade the papal rescript through the streets suspended to the neck of a common strumpet, after which it was publicly burnt. These proceedings called forth, as might be expected, the anger of the pope; they were even too much for the king; and, accordingly, when Huss was again placed under the papal ban he was obliged to yield. He left Prague in 1413, and retired to Hussinecz, having first appealed from the pope to Christ himself, and defended his views in a work entitled *De Ecclesia*. At Hussinecz he employed himself in writing letters to his friends, in composing some additional expositions of his opinions, and in occasionally preaching to the peasantry in the open fields.

In the meanwhile his enemies had not forgotten him, or relinquished their determination to destroy him. In 1414 the council of Constance was opened, and thither Huss was summoned by the Emperor Sigismund to answer on a charge of heresy. Though knowing that he was about to appear before "numerous and mortal enemies," he went without fear, having confided himself wholly to God and to his Saviour, from whom he besought wisdom and prudence, that he might answer his accusers, and stand firm for the truth.[1] Before leaving Prague, however, he sought to fortify his innocence by submitting to an examination before the papal inquisitor, who gave him a certificate that he found nothing heretical in him. He also secured from the emperor a letter of safe-conduct, and from the pope the strongest assurances of protection. Accompanied by several Bohemian noblemen, he left Prague on the 11th of October, and reached Constance on the 3d of November. For the first four weeks after his arrival nothing was done or said touching his case. Expecting to be allowed to address the council, he employed the interval in preparing his defence. But his enemies had no intention of allowing him such an advantage. On the 28th of November he was seized and imprisoned in a loathsome dungeon. In consequence of the interference of the emperor, he was some weeks after transferred thence to a more salubrious apartment, where he remained a close prisoner till the 24th of March. After this he was, in spite of the remonstrances of the Bohemian barons, removed to the Castle of Gottleben, where he was treated with the utmost severity, under which his health, already greatly enfeebled, completely sank. At length, emaciated by sickness and exhausted by suffering, he was brought before the council, but it was only to be treated as one already condemned. At his first appearance, which took place on the 5th of June, whenever he attempted to speak in his own defence, he was assailed by violent outcries, amidst which not a syllable he uttered could be heard. At his second and third hearing, which took place on the 7th and 8th of June, the presence of the emperor prevented the tumultuous proceedings which had disgraced the former assembly, but Huss was still rather harassed by his assailants than allowed freely and fairly to answer for himself. The council persisted in imputing to him errors which he repeatedly declared he never held, and they would hear of nothing but that he should solemnly recant and abjure them. In vain did he ask "How can I abjure what I never held?" The council was inexorable, and he was remanded to prison, there to make up his mind between recantation and death. Repeated efforts were made by emissaries of the council to induce him to the former; but the spirit of the martyr rose within him as he saw his end approaching, and he stedfastly refused to swerve from the path of consistency and truth. "I write this," says he in a letter to his friends at Prague, "in prison and in chains, expecting to-morrow to receive sentence of death, full of hope in God that I shall not swerve from the truth, nor abjure errors imputed to me by false witnesses." The sentence he expected was pronounced on him on the 6th July, in the presence of the emperor and the council. When it was read to him he fell on his knees and said, "Lord Jesus! forgive my enemies; as Thou knowest that I have been falsely accused by them, and that they have used against me false testimony and calumnies; forgive them for the sake of Thy great mercy." Loud laughter rang through the hall, from the assembled prelates, as this prayer went up for them to heaven. They then proceeded to degrade Huss from his sacerdotal rank. For this purpose he was dressed in the robes of a priest, the different parts of which were then successively taken off him, with set forms of expression. When this was over, and the tonsure had been obliterated from him, a cap painted with figures of demons was placed on his head, and the bishops said, "Now we devote thy soul to the infernal devils." "But I," exclaimed Huss, raising his eyes to heaven, "commend my soul, redeemed by Thee, into Thy hands, O Lord Jesus Christ!" He was then led to the place of execution. When fastened to the stake he said, "I willingly wear these chains for Christ's sake, who wore still more grievous ones." Once more he was admonished to recant, but his reply was, "What error should I recant when I am conscious of none? The chief aim of my preaching was to teach men repentance and the forgiveness of sins, according to the truth of the gospel of Jesus Christ, and the expositions of the holy fathers; therefore am I prepared to die with a joyful heart." The fire was then kindled. As its smoke and flames rose around him, Huss began to shout, "Jesus, son of the living God, have mercy on me." Twice did he utter this, but before he could finish it a third time, his voice was stifled in the flames which the wind drove towards him. Still his lips moved as in prayer, and the calm bearing of the dauntless confessor of Christ continued to mark his countenance to the last. When the flames had done their office, his ashes were collected and cast into the Rhine, that no relics of him might remain. "But the miserable precaution was without any effect, since his disciples tore up the earth from the spot of his martyr-

[1] See his letter addressed to the Bohemians before commencing his journey. Bonnechose *Lettres de Jean Hus*, p. 82.

Hussars || Hutchinson.

dom, and adored it with the same reverence, and moistened it with those same tears, which would otherwise have sanctified his sepulchre." Waddington's *Hist. of the Church*, vol. iii., p. 192. See also Neander's *Church Hist.*, vol. ix., pp. 319–506; Gieseler's *Church Hist.*, vol. v., pp. 103–122; Bonnechose *Reformateurs avant la Reforme*, &c., 2 vols. (W. L. A.)

HUSSARS, a name given to the national cavalry of Hungary and Croatia. They were first raised in 1458, and received their name either from the method in which they were called out, or from the Tartar *uswar*, which signifies cavalry. In the armies of modern Europe hussars are light horse, and differ from light dragoons only in some peculiarities of dress and equipment.

HUSTINGS (from the Saxon word *hustinge*, house of trial), a court annually held in Guildhall before the lord mayor and aldermen of London. Its antiquity appears from the laws of Edward the Confessor. Some other cities have likewise had a court bearing the same name, as Winchester and York. This term is now applied to those temporary structures where elections are conducted.

HUTCHESON, Francis, the father, or at least the reviver, of speculative philosophy in Scotland, was born, August 8, 1694, in Ireland, but in what part of that country is unknown. His father was a minister of the Presbyterian Church, and Hutcheson himself studied theology in Glasgow with the view of following out his father's career. On taking licence he became pastor of a Presbyterian congregation in the synod of Ulster, and while there published his *Inquiry into the Original of our Ideas on Beauty and Virtue*, a work which made his name widely known, and introduced him to the notice of King, the archbishop of Dublin, himself well known in his day as a writer on ethical subjects. In 1728 Hutcheson published his essay on the *Nature and Conduct of the Passions and Affections*, in virtue of which he was in the following year promoted to the chair of moral philosophy in Glasgow. His next works were mere text-books for the use of his classes, and were respectively entitled *Synopsis Metaphysicæ Ontologiam et Pneumatologiam Complectens;* and *Philosophiæ Moralis institutio Compendiaria, Ethices et Jurisprudentiæ Naturalis principia Complectens.* The work on which his chief fame as an ethical writer depends, however, did not appear till after his death, which took place at Glasgow in 1747. It was published in 2 vols. 4to, under the title of *System of Moral Philosophy*, by his son Dr F. Hutcheson, and was prefaced with an excellent biographical sketch of the author by Dr Leechman. For analyses of Hutcheson's system, and the place it holds in the history of speculative philosophy, see *Preliminary Dissertations* I. and II. prefixed to this work, by Dugald Stewart and Sir James Mackintosh respectively.

HUTCHINSON, John, a philosophical and theological writer of the last century, was born in 1674 at Spennithorne, in Yorkshire. He received an excellent education from a gentleman who lodged with his father, and after leaving the paternal roof served as steward in several families of rank and wealth. His best friend, however, was the Duke of Somerset, who, when he was himself made Master of the Horse, appointed Hutchinson his riding purveyor. This office afforded him great facilities for his favourite study of natural history, and enabled him to make a large and valuable collection of fossils. These, along with his M.S. notes on them, he made over to Dr Woodward, the duke's physician, to arrange and publish. Woodward, however, bequeathed both the fossils and their collector's injunctions to the university of Cambridge. Hutchinson construed this act into an attempt to deprive him of his fame as a geologist, and did his best to expose Woodward's conduct in his *Moses' Principia*, of which the first part saw the light in 1724. In this strange work the author, after giving his version of the Woodward affair, gravely set about disproving the Newtonian doctrine of gravitation. Three years later he published the second part, in which he followed up his attack on Newton, and quoted Scripture in proof of the existence of a *plenum* in opposition to the doctrine of a *vacuum*, on which the Newtonian philosophy is based. From this time till his death he continued to publish at intervals volume after volume in defence of his views. He died August 28, 1737. Eleven years after his death his collective works were published in 12 vols. 8vo, under the title of *The Philosophical and Theological Works of the late truly learned John Hutchinson, Esq.* In the preface to this edition there is an elaborate defence of Hutchinson, and an exposition of his views by Spearman and Bate, the literary executors of the author. A good summary of these views will also be found in a little book called *Thoughts Concerning Religion*, published at Edinburgh in 1743. The gist of these is that in the Bible is contained a complete and infallible system of natural history and philosophy as well as of religion and theology. This, however, is to be gathered not from the ordinary translations of the Bible, but from the Hebrew original. That language, according to Hutchinson, is the only complete and perfect form of human speech, and was on that account chosen by the Almighty as his instrument of communication with man. But it is not to be interpreted according to the literal meaning of the words. The true is the typical sense, which can only be reached by a deep acquaintance with the etymology of Hebrew. Every root of that tongue, on the Hutchinsonian theory, contains hidden meanings, and symbolizes some intellectual object. This elastic machinery put into his hands the means of wringing from the Hebrew text interpretations that harmonized perfectly with his system. An illustration will show more clearly what is meant. "The *hawk*," says Hutchinson, "is eminent for *seeing;* so *hawk* and *seeing* are the same word; and the same *idea* may be in two things in other respects quite different—*e.g.*, the atoms of light move in a line, like marbles in a groove; so do the storkened masses of air which are darkness, they are continuous in a line; the first impels the second, and so on that the motion of the first mass or grain puts the whole line into motion; and this motion gives the same idea when you consider the coagulated grains of air thus following each other, as when the atoms of light follow and drive forward each other; and so a word may be translated, as is often the case, to signify direct contraries, as *irradiate* is made to do in Hebrew." On this principle Hutchinson evolves his system, in which, rejecting the received doctrines of gravitation, attraction, magnetism, and electricity, and denying the existence of a *vacuum*, he maintains that the operations of nature are carried on by the three agents of fire, light, and spirit. Now these three agents, which are in themselves only a modification of one and the same substance—the air—Hutchinson holds to typify the three persons of one and the same essence—to wit, the Trinity. Carrying out this principle of symbolism, he maintained that all the ceremonies enjoined on the Old Testament Jews were adumbrations of the life and sufferings of the Saviour, and that the Jews, in knowledge of this, observed these rites in the same manner and spirit as the followers of Christ afterwards obeyed the commands and precepts that fell from the lips of their Lord.

Hutchinson || Hutchinson.

Though Hutchinson can scarcely be regarded as having founded a distinct sect, yet many able men since his days have been found to accept and maintain these doctrines. Even now, though their numbers are small, they are not extinct. In the list of those who openly defended them are found the names of Robert Spearman and Julius Bate, who superintended the third edition of Hutchinson's works; Dr Horne, bishop of Norwich, who afterwards, however, became a convert to the received views; William Jones, the

Hutton, Charles.

biographer of the bishop; Lee, the author of *Nature's Characteristics of Truth;* Hodges, at one time provost of Oriel College, Oxford; Parkhurst, the lexicographer; and several distinguished divines of the Episcopal and Presbyterian churches of England and Scotland.

HUTTON, CHARLES, a celebrated English mathematician, was born at Newcastle-upon-Tyne, Aug. 14, 1737. His father, who to other duties added that of an inspector of mines, gave him such an education as his means allowed; but the school to which he sent his son was a bad one, and the young Hutton soon distanced his teacher. His knowledge of the higher mathematics he acquired without help from any one. At the age of eighteen he obtained an ushership in a school at Jesmond, and when his principal was promoted to a living in the church, Hutton was appointed to succeed him. Among his pupils at this place was John Scott, afterwards Lord Eldon, chancellor of England. In 1760 he married, and began the work of tuition on a larger scale in Newcastle, eking out his income by contributions to the *Ladies' Diary*, the *Gentleman's Magazine*, and other works of that class. His first acknowledged work, however, is his *Practical Treatise on Arithmetic and Book-Keeping*—the work of a master-hand, which threw into the shade all previous treatises on these subjects. Next appeared, in 1771, his *Theoretical and Practical Treatise on Mensuration*. In this year the bridge at Newcastle happened to be destroyed by an unusually heavy flood. Hutton drew up a plan, providing against the recurrence of such a calamity, which in the ensuing year he enlarged and published under the title of *Principles of Bridges, and the Mathematical Demonstration of the Laws of Arches*. In 1773, after a severe competitive trial, he was chosen professor of mathematics in the Royal Military Academy of Woolwich. Made a fellow of the Royal Society in 1774, he fulfilled the duties of foreign secretary to that learned body from 1779 to 1783. During this period the Royal Society had nearly been dissolved from the discontent called forth by the conduct of Sir Joseph Banks, the president. He was accused of introducing into the body ignorant men of rank and wealth, and overlooking those whose claims to the honour were founded only on real scientific, especially mathematical, genius. Hutton found himself accused of neglecting his duties of foreign secretary, and indignantly resigned. He drew up a defence of his conduct, however, which was fully sustained by the vote of the society. (A detailed account of this unhappy affair is given in Kippis' *Observations on the late Contests in the Royal Society*, Lond. 1784.) The treatment of Hutton was peculiarly ungracious, especially if account be taken of the solid services which he rendered to the society. Besides contributing a large number of papers to its *Transactions*, he had gone through the enormous labour of making all the mathematical calculations for Maskelyne's experiments at Schehallion, in Perthshire, for determining the mean density of the earth. These labours were fully appreciated by the *savans* of Edinburgh, who in 1779 procured for Hutton the degree of LL.D. from the university of that city. For the next six or seven years, Hutton's works were almost entirely mathematical in their character, comprising his *Mathematical Tables; Tables of the Product and Power of Numbers*, &c., which he followed up in 1795 with his *Mathematical and Philosophical Dictionary*, the most valuable contribution to scientific biography that has yet appeared in England. Perhaps the most laborious of all Hutton's works was that which he next undertook, viz., his abridgement of the *Philosophical Transactions*. In this he was assisted by Drs Shaw and Pearson, who relieved him of the historic and literary parts of the task, while he reserved to himself the mathematical and scientific portions. This undertaking was completed in 1809, and filled 18 volumes in 4to. Hutton received L.6000 for the share he had taken in it. Soon after this he found himself obliged by bad health to resign the appointment he had so long and ably held at Woolwich. A retiring pension of L.500 a-year assured him that his services had been duly appreciated by the Board of Ordnance. In 1819–20 he began a correspondence with Laplace to vindicate his claim to notice in that philosopher's account of the experiments on the density of the earth; and in the *Connaissance des Temps* for 1823 he had the pleasure of seeing that his labours on that difficult problem were amply acknowledged by the great French philosopher. Hutton had reached his eighty-sixth year, when he died Jan. 27, 1823.

Hutton, James || Huysum.

All the biographical notices of Hutton are unanimous in describing him as one of the most skilful of teachers, and the most amiable of men. His modesty and simplicity were as remarkable as his intellectual gifts. To his friends and pupils he exhibited a warmth of personal affection that attached both to him in a very rare degree. It was also with him a sacred duty to seek out the poor and unbefriended student of science, and promote and otherwise assist him to the best of his power.

Hutton wrote many other works besides these mentioned above; but we need only add to the list his *Conic Sections*, and his English version of Montucla's *Recreations in Mathematics and Natural Philosophy*. A catalogue *raisonné* of his works will be found in the *Biog. Univers.*, and in his *Life* by Olinthus Gregory, his successor at Woolwich.

HUTTON, *James*, M.D., the author of the Huttonian theory of the earth, was born at Edinburgh, June 3, 1726, and died in 1797. After passing through the ordinary courses at the High School and University of his native city, he began the study of the law, but soon exchanged it for the more congenial pursuits of natural science. He studied medicine for three years at Edinburgh, then for two in Paris, and finally graduated at Leyden. Returning to London in 1749, he began to practise as a physician, but with such small success that in the following year he removed to Scotland, where, inheriting his father's estate, he devoted himself to agriculture. A residence in England, and afterwards in the Low Countries, perfected him in that art as then understood, and enabled him to introduce those improvements into the husbandry of Scotland that have made the agricultural system of that country the most perfect now in use. The last thirty years of his life were devoted chiefly to those geological and meteorological studies of which he embodied the results in his *Theory of the Earth*, and his *Theory of Rain*. The illustrations of these works by Playfair are justly regarded as among the finest specimens of philosophical writing that the English tongue has to show. The value of Hutton's contributions to natural science, and his place in the history of that branch of philosophy, are discussed in the sixth *Preliminary Dissertation* to this work by Professor Forbes, par. 591. Hutton's *Life* has been written by his friend Playfair, in *Edin. Transactions*, vol. v.

HUY, a strongly fortified town of Belgium, capital of a cognominal arrondissement in the province of Liège, 17 miles S.W. of the town of that name. It stands on both sides of the Meuse, its two parts being connected by an ancient stone bridge. It has a strong citadel, cathedral, collegiate church, and town-hall. The chief manufactures are linen, paper, leather, and cast iron. It has also a considerable trade in corn, coal, iron, wine, &c. Pop. 9000.

HUYGENS, CHRISTIAN. See historical part of art. ASTRONOMY; and the fourth and fifth *Preliminary Dissertations* to this work.

HUYSUM, JAN VAN, one of the greatest fruit and flower painters, was born at Amsterdam in 1682. He learned his art from his father Justus van Huysum, a painter of very considerable merit, but whose fame has been completely lost in that of his son. After thoroughly mastering

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the technicalities of his art, and the styles of the greatest masters of that branch of it in which he himself became unrivalled, Van Huysum betook himself to the study of nature. He sounded her most secret depths, and reproduced the brightest tints of her brightest ornaments with a skill and truthfulness that sometimes deceived the keenest eyes. He always chose the most gorgeous flowers to paint from, and was careful to watch the hour of the day at which their lustre was most brilliant. He heightened the effect of his flower-groups by placing them in vases of the most graceful shape, and working out the ornaments traced on them with the same exquisite finish as he put upon the flowers themselves. When his fame was fairly established he received almost fabulous prices for his works; and was thus enabled to bestow upon them the highest amount of care and finish. He was very jealous of his fame, and would allow no one to enter his studio while he was at work. It was believed that he had some secret in the mixing of his colours, which enabled him to preserve the brilliancy of his tints; but this, if it ever existed, perished with him. There are some very good specimens of Van Huysum in English galleries, and his pieces always fetch very high prices in the market. Van Huysum died in England in 1749.

HYBERNATION, the term employed by naturalists to denote that state in which certain animals pass a portion of each year in a more or less complete suspension of their active functions; and as this state has most frequently been observed during the rigour of winter, it has been designated *Hybernation*, from the Latin word *hyberna*.

The continued application of cold to such animals will induce a suspension of their active faculties, and artificial heat will dissolve their hybernation: yet this state cannot be altogether the consequence of a low temperature; for hybernation is observed, in tropical climates, in some insectivorous mammals and reptiles, when the dry heats of those regions abridge the supply of suitable food. These facts would show that hybernation is also caused, and perhaps chiefly so, by the want of due aliment to keep up or renovate the irritability of the vital organs. Without some such law, the existence of insectivorous animals, both in high latitudes and in tropical climates, would have been impossible; and we must regard hybernation as one of those admirable adaptations of special means to an important end, which the history of animated nature so frequently presents.

In the most complete hybernation the animals, on the approach of that season, retreat to their places of temporary concealment, their vital functions begin to be more slowly performed, they cease to eat, breathe more slowly, and finally their respiration would appear to be totally suspended, while the movements of the heart become more languid, and are performed at much longer intervals of time; the animal heat is much diminished, and finally, insensibility is profound. In such cases the small degree of oxygenation necessary to maintain sufficient irritability in the muscles of the heart to prevent their absolute rest is probably supplied by the dermoid surface of the animal.

In our climates the bat and the hedgehog present the best known instances of hybernation among mammals. In them all the vital functions, except a very languid circulation of the blood, appears to be totally suspended at that season, when a want of insect food would condemn them to starvation. In some other European mammals the hybernation, though somewhat analogous, is less complete. This is the case with certain frugivorous species that lay up stores of vegetable food in their winter domiciles; as the dormouse, the squirrel, and the marmot. In them the insensibility would appear to be less profound, and the respiration never wholly suspended, though much diminished in frequency. A good observer of the habits of the Alpine marmot, Professor Mangili, calculates that during its six months of torpidity, this animal only makes 71,000 inspirations; while, in its active state, it makes no less than 72,000 in 48 hours. The large collection of dried grass which the marmot lays up in its hybernaculum is probably intended for consumption in its occasional revivals during its long hybernation; although Schinz supposes that this ample store of food is untouched until its full restoration to activity on the return of warm weather in April, which he supposes to take place before the new grass is sufficient for its wants. It is certain, however, that tame marmots, when awakened by artificial heat, eat whenever they are roused up. Mammals of other countries, that lay up similar stores of food, have similar habits and hybernations; as various genera of the family *Mus*,—*Merion canadensis*, and *M. labradorius*; *Aricola œconomica*, or economic mouse; *Cricetus vulgaris*, or hamster, &c. These animals probably have the same kind of hybernation as the marmot. The common bear, the teeth of which prove it to be chiefly a vegetable feeder, passes a considerable portion of the winter without food, and in profound sleep. All these animals become fat in autumn, which seems to be intended to supply the waste of the system during their hybernation.

Hybla.

In hot climates certain mammals also undergo hybernation. Thus the three species of *Centenes* or tenrec of Madagascar, which have much analogy with our hedgehog, being like it furnished with a spiny covering, and living on insects, sustain a torpidity of three months, according to Brugière, at the season when the dry heats of that climate cut off their supply of insect food.

Insectivorous birds are less subject to hybernation than mammals in cold climates, because they possess the power of an easy migration to regions where insect food is easily procured. Such birds are migratory; as are many of our land birds. Yet the writer of this article has known instances in these islands of the hybernation of *Rallus crex*, or land rail, and the swallow. Cuvier not only mentions the hybernation of *Hirundo riparia* or sand martin, but expresses his belief of that bird being found hybernating below the surface of water in marshes.

The hybernation of many cold-blooded animals is with us very complete. Snakes, lizards, toads, and frogs lie in a state of complete torpor during the winter months, while the lips of the latter are glued together, and they are buried in mud at the bottom of stagnant water at that season. They cannot breathe during that process; but probably the small quantity of oxygenation required by their system is sufficiently obtained through their skin.

In North America, as with us, snakes are hybernating animals, though in warmer regions they are active throughout the year. The same takes place with lizards. In these cases, hybernation seems rather, however, the consequence of the want of due nutriment than of mere cold. A fact mentioned by Von Humboldt confirms this. The largest species of serpent, the *Boa murina*, during the long rains that inundate the immense deserts of Central South America, remains buried in the soil until the mud, dried by the heats which invariably succeed the rainy season, cracks, and emancipates the imprisoned monster from his earthy tomb. Yet in Surinam and Brazil, this boa, like other serpents there, passed the whole year in uninterrupted activity. (T. S. T.)

HYBLA, in *Ancient Geography*, the name of several cities of Sicily. Two of these places were of considerable note. The most important of them was distinguished by the epithet Magna or Major. It stood on the southern side of Mount Ætna, in a district of great fertility. The only event of interest in its history was its revolt from the Romans in the second Punic War, and its speedy recapture by that people. Its site has not yet been fixed with positive certainty. Cluverius places it at Paterno, about 12 miles from Catania, and his conjecture has been followed by the best modern geographers. Hybla the Little was

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identical with the Greek colony of Megara, which was thence called Megara Hyblæa. It stood on the sea-coast in the territory of the Greater Hybla. In its neighbourhood were the Hyblæi Colles, which produced great quantities of honey of proverbial excellence. The town itself was destroyed by Gelon of Syracuse, after an existence of about two centuries and a half, and its inhabitants were dispersed. In the second Punic War it again appears in history as making common cause with the Syracusans against Marcellus, by whom it was taken and destroyed. The ruins of this Hybla were visible till within a comparatively recent period at the mouth of a small stream called the Alabus, now the Cantaro. Near the site of the old town is the modern village of Melilli, which is said to take its name from the honey for which the surrounding hills were once so famous.

HYBRID, a term derived from the Greek ὕβρις, *a mule*, is used by naturalists to denote the offspring of two animals or plants of different species. Of these the best known and most useful is the progeny of the horse and the ass, which has from remote antiquity been largely employed in the East as a beast of burden, and is well known in Europe as the most sure-footed of domestic quadrupeds. The male parent may belong to either species; but the offspring of the mare and the he-ass is superior in size and strength to that of the stallion and the she-ass. To the former Buffon restricts the name of *mulet* or *mule*, and names the latter *bardeau*. Hybrids have also been produced between the dog, the wolf, the jackal, and the fox; between the lion and the tiger; between the sheep and the goat. These may be considered as hybrids between allied species, or may be termed *specific hybrids*. But hybrids are known also between the stallion and the cow, the cow and the stag, the antelope and the goat; and even between the bull and the sheep, animals belonging to different genera, which may be termed *generic hybrids*.

Other classes of animals afford instances of hybrid progeny. Specific hybrids occur among birds; as between the hooded and carrion crows, the goldfinch and the canary, the latter and the linnet, the wood-grouse and the black-cock, the goose and the swan; and it is said that generic hybrids have occurred between the pheasant and the *Tringa pugnax* or reeve. Among fishes, hybrids might have been supposed to be more common than among the classes already noticed; because their spawn must be frequently mixed; yet such are not very common, though they are found among *Salmonidæ*, *Cyprini*, and a few other genera. Among reptiles, hybrids have occurred between the toad and the frog; but Spallanzani was unable to obtain them between the frog and the newt, or between the latter and the toad. In the division of insects, hybrids, both specific and generic, are not unknown; as among different species of *Papilionidæ* and *Chrysomelidæ;* and they are said to have arisen from the congress of *Melalontha agricola* with *Cetonia hista*, of *Cantharis melanura* with *Elater niger*.

In the vegetable kingdom, although the well-known experiment of grafting different plants on the same stock, when each produces its own fruit, would show that the food of plants is nearly similar; and although the pollen of one flower is apt to be carried to the pistil of a different flower by the winds, or by insects, yet hybrid plants are rarer in a state of nature than we might have expected. But in our conservatories, where many different plants are in juxtaposition, and more especially if artificial impregnation be adopted, hybrid plants are produced. This is well known to florists, who have thus obtained varieties of the rose, calceolaria, &c. But the comparative rarity of hybrids among native plants shows that there is some natural impediment to the production of hybrids in the vegetable kingdom.

With regard to animals, nothing is better established than that individuals of different species, when left to themselves, do not voluntarily copulate. Thus, the stallion will not cover the ass if a mare be present; and to effect copulation of the mare with the he-ass, she must be blindfolded. Yet we have seen the stallion without repugnance cover the female mule when in heat, and the she-mule readily receive the ass. The hybrids between the zebra and the ass are readily produced also, if the natural mates of either be not present. The curious experiments of Buffon prove, that individuals of different species are not naturally inclined to copulate. He reared in the same kennel the young of both sexes of the dog, the fox, and the wolf; and when young they played familiarly together; but the females of each species, when in heat, exhibited insurmountable repugnance to receive the males of the other species; and mortal combats, instead of copulation, took place between different sexes of the different species. John Hunter also found that when he had a she-wolf lined by a greyhound, it was necessary to hold her fast; and, although during copulation she remained pretty quiet, immediately after she attempted to attack the greyhound.

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It is well known, that hybrid animals are generally barren; and this seems a provision of nature to prevent the confusion of species. There are a few instances on record of common mules producing young. Both the male and female mule have perfect generative organs, and are uncommonly salacious; yet their congress with each other is almost always sterile. It has, however, been long known, that the mule can engender with the mare, as is mentioned by Aristotle, who states also, that the she-mule conceives, but very seldom brings her fœtus to perfection. We have once seen a foal that was dropt by a female mule; but the circumstance is very rare. The fertility of certain other hybrids with males of the pure species is noticed by Buffon, in his Dissertation on Mules, and in the celebrated experiments of John Hunter. Hunter submitted the female hybrid between a jackal and a dog to a male terrier, and the hybrid between a dog and a wolf to a male greyhound; and puppies in both instances were produced. Hence he inferred, that the dog, the jackal, and the wolf, belong to the same species. This conclusion is perhaps not so decisive as that great anatomist supposed: for may it not be merely the effort of nature to return to the pure breed? Yet this argument, with the total want of any wild prototype of the domestic dog, unless we derive it from the wolf, the jackal, or the fox, would favour the idea of their original identity. The difference in form and size is not a strong objection to this view; for it is certainly not greater than between the mastiff and the greyhound, the water-spaniel and the lap-dog; of the specific identity of which we entertain no doubts. In a state of nature, however, hybrids are seldom if ever produced in the animal kingdom, even among nearly allied species, and nature seems to abhor such intermixtures. (T. S. T.)

HYDASPES, now the JELUM, one of the five rivers of the Punjab. See PUNJAB.

HYDE, EDWARD (afterwards *Earl of Clarendon*), was born at Dinton, in the county of Wilts, on the 18th of February 1609. He was the third son of Henry Hyde, the descendant of a family of that name, which had resided from a remote period at Norbury, in Cheshire. Edward, after receiving his first education under his father's roof, was sent, at the age of thirteen, to Magdalen Hall, at Oxford. He was originally intended for the church; but, in consequence of the death of his last surviving elder brother, his destination was changed, whilst he was at the university, from the profession of the church to that of law, and in 1625 he was entered at the Middle Temple. A severe ague with which he was attacked that year caused a suspension of his studies, and temporary removal from the Middle Temple, to which he returned in 1626. In 1628, when riding the Norfolk summer circuit with his uncle,

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Sir Nicholas Hyde, chief-justice of the King's-Bench, who died in 1631, he caught the small-pox; and his legal studies were again for a long time interrupted. He married, in 1629, a daughter of Sir George Ayliffe, but she died of the small-pox six months afterwards. He married a second time in 1632, in which year he lost his father. His second wife was a daughter of Sir Thomas Aylesbury, Bart., master of requests; and by her he had several children. Hyde now applied himself to the study of the law with a diligence which he had not shown before, and his success soon surpassed the expectations of his contemporaries. Meanwhile he lived little with lawyers; but he had many associates of political and literary celebrity—Lord Falkland, Selden, Chillingworth, Waller the poet, Ben Jonson, May the historian, Hales, Sheldon, Earles, and Morley. To these may be added a few men of high rank, as the Marquis of Hamilton, the Earls of Pembroke, Holland, and Manchester, and Lord Coventry. In 1635, through an accidental circumstance, he also obtained the notice of Archbishop Laud. In the course of an inquiry into the state of the customs instituted by the primate in his capacity of commissioner of the treasury, Hyde was mentioned to him as one who had been much consulted by some aggrieved merchants, and could afford the information desired. From this time Laud saw him frequently, employed him upon many occasions, and caused him to be noticed and employed by others. From 1635 till 1640 may be regarded as the most fortunate period of Hyde's life. He was successful in his profession, possessed a competent private fortune, and was happily married. In 1640 he was elected member of parliament for Wootton-Basset and for Shaftesbury, and took his seat for the former. The parliament met on the 13th of April, and was dissolved on the 5th of May. Hyde's first brief parliamentary career was characterized by activity and an honest zeal in the correction of abuses, from which not all the friendship of Laud and the favour of the court was able to divert him. In his first speech he denounced the earl-marshal's court, which, in its protection of the privileges of the titled classes, had been intolerably vexatious and oppressive; and he showed himself a true and practical friend of rational freedom. During this very short session, he served in seven committees. He foresaw the evil consequences of the hasty dissolution, and endeavoured in vain to prevail on Laud to employ his influence with the king to prevent it. In the next parliament, which met in November 1640, Hyde sat for Saltash. He recommenced his proceedings against the earl-marshal's court, of which he procured the suppression. He was also chairman of a committee of inquiry into the abuses of the Council of York, and the court of the Council of the Marches; and he conducted the impeachment of three of the barons of the exchequer for illegal exactions at the bidding of the crown. But Hyde, though zealous for the redress of grievances, was opposed to the encroachments of parliamentary authority, which began to assume a formidable aspect. Strongly attached to Episcopacy, he also disliked the attempts of the parliament to remodel the government of the church; and boasts that, as chairman of the committee on that question, he interposed so many delays that the project was suspended. He vehemently protested against the Commons' remonstrance, his opposition to which was the occasion of his first introduction to Charles I. He had written an answer to it, which he showed in confidence to Lord Digby. Digby made it known to the king, who sent for Hyde, requested the paper, approved and published it as the reply of the king with the advice of his council. Soon afterwards the king offered to Hyde the office of solicitor-general, which the latter declined, alleging that he could better serve his sovereign in an unofficial capacity. To this the king assented; and meanwhile committed to him, to Lord Falkland, and to Sir John Colepepper, the entire management of his affairs in the House of Commons, assuring them that he would take no step therein without their concurrence. Notwithstanding this assurance, Charles, without apprizing these chosen councillors, not long afterwards had recourse to the ill-timed measure of attempting to seize the five members in the House of Commons. Though the consequences of this rash act were irretrievable, and the royal cause was almost hopeless, Hyde continued courageously to support it. During many months he was secretly employed in writing answers for the king to the declarations of the parliament, and had frequent interviews with him by stealth; but he was at length suspected, and narrowly escaped committal to the Tower by flying to the king at York. Though Hyde had thus become openly an adherent of the king, he long refused office. He declined the proffered post of secretary of state; and it was not till March 1643 that, on the promotion of Sir John Colepepper to the mastership of the rolls, he accepted the chancellorship of the exchequer. He was one of the commissioners at the negotiations at Uxbridge, where, as on other occasions, he fruitlessly laboured to effect peace between king and parliament, as far as was compatible with a preservation of the royal prerogative and the rights of the established church.

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In 1644, after the battle of Naseby, Hyde was appointed, together with Sir John Colepepper and Lords Capel and Hopton, to form a council to attend, watch over, and direct the Prince of Wales. After hopelessly witnessing for many months a course of disastrous and ill-conducted warfare in the west, they fled with him, first to Scilly, and thence to Jersey; from which, at the entreaty of the queen, but against the opinion of Hyde and others of the council, the prince, in 1646, repaired to his mother at Paris, attended only by Sir John Colepepper, and leaving Hyde at Jersey. In this retreat Hyde remained till the spring of 1648, engaged in the composition of his *History of the Rebellion*. He also wrote, during this period, an answer to a declaration of the parliament, in which they charged the king with all the evils which had happened, and justified the discontinuance of all further addresses to him. In May 1648, he was summoned to attend the prince, who, at the head of a fleet which had espoused the royal cause, was blockading the Thames. Hyde, after encountering sundry difficulties, and amongst others seizure by privateers off Ostend, did not meet the prince till his return to the Hague, about the end of August, from his fruitless expedition. Hyde found dissensions in the prince's little court at the Hague, especially between Prince Rupert and Lord Colepepper. The news of the death of Charles I. for a while afflicted and appalled them; but their animosities soon broke out afresh, and disturbed the councils of the new sovereign. In 1649, at the suggestion of Lord Cottington, Hyde and that nobleman were sent as ambassadors to the court of Spain for the purpose of soliciting its assistance. They were coolly received, and had the mortification of perceiving that the Spanish court was more inclined to cultivate the friendship of the commonwealth of England; and to the memorial which they presented to the king of Spain in a private audience, they obtained only a cold and ambiguous reply. The treatment they experienced from the Spanish government was meanly time-serving, and varied with the fortune of Charles's affairs. On his determining to proceed to Scotland, upon the invitation of the Scotch council and parliament, the ambassadors were treated with more regard. Upon the news of Cromwell's victory over Argyll's army, they were desired to depart. Accordingly, Hyde quitted Spain, unaccompanied by his colleague Lord Cottington, who chose to remain as a private person, though not permitted to reside at Madrid. On Hyde's return from Spain in 1651, he met at Paris the king, returned from the ill-fated expedition

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which terminated in his defeat at Worcester; which rash interference, and the king's negotiation with the Scotch, and acceptance of the covenant, Hyde severely censured. He found himself exposed to the enmity of many, especially of the queen. Sundry calumnies were circulated against him, and two petitions were prepared—one from Presbyterians, the other from Papists—praying his removal from Charles's councils. But Charles's confidence in Hyde was not shaken by these intrigues; and he appears to have seen their groundlessness, and properly appreciated the valuable services of so honest, able, and zealous a minister. Extreme poverty was amongst the evils which, in a greater or less degree, since Hyde's departure from Jersey, he and his family had been compelled to bear. His family resided principally at Antwerp, and he and they were almost reduced to want the most common necessaries of life; yet his courage and integrity never faltered, and he would not even (as many had done) compound for his estates in England, lest thereby he should seem to acknowledge the existing government. Year after year, too, the hope of relief to the royalist party from foreign aid was waning away; and neither foreign war nor domestic conspiracy seemed to avail against the power of Cromwell. In 1658 Cromwell died, but the protectorate passed, like an inheritance, into the hands of his son; and though the hopes of the royalists were naturally excited, the prospects of restoration were still found to be dark, vague, and distant. Hyde, who was now lord chancellor, corresponded much with those whom the weakness of Richard Cromwell and the distracted state of England had rendered favourable to the royal cause, and proved instrumental in forwarding that Restoration which was at length more ostensibly effected by the powerful agency of Monk.

The period immediately following the Restoration was that of Hyde's greatest power. He was the first minister, presiding over a cabinet in which the principal offices were filled by his friends (for such were Sir Edward Nicholas, the Earl of Southampton, and the Marquis of Ormonde), and the principal measures of the government were peculiarly his. The first great measure of his administration was the act of indemnity. This was in accordance with the king's declaration from Breda, in which he promised pardon to all his subjects, save such as should be excepted by parliament, by which was intended the exclusion of those who had been instrumental in his father's death. The lord chancellor was on the side of mercy, and urged the speedy adoption of this healing measure on a reluctant and vindictive parliament. In the settlement of property under the act of indemnity some apparent injustice was unavoidably committed, by the necessity of dealing differently, not according to the merits of persons, but the nature of the property to be dealt with, and the title by which it was held. Transactions between individuals could not be reached; but grants to or purchases by individuals from the usurping state became subject to revision from defect of title; and crown and church lands were recovered from their holders, whilst the impoverished royalist who had sold his property to support the cause of the king was doomed to see the sale confirmed, and himself debarred from compensation. The royalists consequently murmured loudly. They called the statute an act of "indemnity for the king's enemies, and of oblivion for his friends;" and they hated the chancellor for the part he took in framing this act, and his steady adherence to the principles of it. The next important measure was the settlement of the revenue. It is asserted by several authorities, that the chancellor might have obtained for the king from the parliament, in the first fervour of their revived loyalty, an annual revenue of L.2,000,000. But it was not his wish to render the sovereign independent of the aid of his parliament, and he therefore sought for him only L.1,200,000, a sum scarcely sufficient for the exigencies of the state, unless administered with due economy. This sum the parliament readily granted. Military tenures, and the oppressive privileges of wardship, purveyance, and pre-emption, were abolished, and the excise on liquors was granted in their stead. The restoration of the bishops to the House of Lords, the statute against tumultuous petitioning, the vesting of the supreme command of the militia solely in the crown, and the repeal of the triennial acts, were measures promoted by the chancellor for the purpose of strengthening the prerogative of the crown. In the regulation of the judicature he deserved high praise. He showed a rare impartiality and discernment in his appointments, and eminent integrity and diligence in the administration of his own office. His conduct in ecclesiastical matters was less liberal and judicious. He believed Episcopacy to be the only form of church government suitable to monarchy, and was too little tolerant towards other sects. Under his administration several oppressive acts were passed; the act of uniformity, compelling clergymen, on pain of abandoning their livings, to subscribe to the forms of the Church of England, and to the doctrine of passive obedience, by which two thousand were ejected; the act against conventicles, imposing fines on all present at any meeting for religious worship at which five assisted besides the family; and the five-mile act, by which dissenting teachers who had not taken the oath of passive obedience were forbidden to approach within five miles of a place where they had preached since the act of indemnity. But the sin of such oppressions lay chiefly with the parliament. In that which succeeded the convention-parliament there were a great majority of high-churchmen. Venners' insurrection had strengthened the prejudices against sectarians; and it is by no means certain that Clarendon could have stemmed the torrent of intolerance, even if he had wished or attempted to do so.

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In 1660, on the 3d of September, his daughter Anne was secretly married to the Duke of York; an union which, after much opposition from the mother and sister of the duke, and the calumnies of profligate courtiers, was acknowledged about the end of the year. The discovery was received by the chancellor with violent demonstrations of indignation and grief. He seems to have been solicitous to repel the imputation of having secretly promoted an alliance so flattering to his ambition, and to have dreaded the effects of the jealousy it might excite. He had in the following year a share in negotiating a marriage for the king with Catherine of Portugal; a marriage which, when it proved unfruitful, was groundlessly supposed to have been promoted by Clarendon under that expectation, and with a view that his son-in-law or his descendants might inherit the throne. Such suppositions would have been far fetched, even if an incapacity in the princess to bear children had really existed; and it must fall to the ground when the contrary is known. Difference of religion was the only obvious objection to this alliance; but there was no Protestant princess to whom Charles would ally himself; and amongst Catholics the princess of Portugal was perhaps least objectionable, and conferred the advantages of a dowry of L.500,000, Tangiers, Bombay, and free trade with Portugal and its colonies. The profligacy of Charles, and the malign influence of Lady Castlemaine, afterwards Duchess of Cleveland, which Clarendon vainly endeavoured to resist, were the main causes of the unhappiness of this marriage.

Hyde showed no avidity for emoluments or distinctions. After the Restoration, when Monk was created a duke, and Montague an earl, Hyde declined a proffered peerage, resting his refusal on unwillingness to excite disaffection amongst the new supporters of monarchy by an apparent eagerness on the part of the king to load with honours his old adherents. When the marriage of his daughter with the Duke of York became known, this objection ceased; a public mark of the king's unaltered regard became desirable, and

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Hyde accepted the barony of Hindon. A further elevation took place in 1661, at the coronation, on the request of the Duke of York; and the chancellor was created Earl of Clarendon, and took his seat as such on the 11th of May. At the time when he was made a baron he accepted a present of L.20,000 from the king; but he had declined at an earlier period the more valuable grant of ten thousand acres of crown land, which Charles was willing to bestow.

One of the measures of his administration which has exposed him to most reproach, was the sale of Dunkirk in 1662. Yet it cannot be shown that the motive was corrupt, or the measure indefensible. Money was wanted; large arrears had been due to the army; and large sums had been necessarily expended in military and naval stores. The revenue settled by the parliament was insufficient in amount, and with difficulty collected; and subsidies were granted by the parliament in 1661 as an additional aid. The wants of the state were still urgent. Dunkirk was a source of expense to the yearly amount of L.120,000. France was willing to purchase; and after much negotiation between Clarendon and D'Estrades, Dunkirk was sold to France for 5,000,000 livres. A more truly censurable act of Clarendon's administration was sanctioning the acceptance of money for Charles from Louis XIV., though he had the honesty to refuse it for himself, and laying the foundation of that secret correspondence which at length rendered the king of England almost the pensioned servant of France. The sale of Dunkirk tended to weaken the popularity of Clarendon with the nation. He soon began to lose the favour of the king, by his opposition, in July 1663, to a measure Charles had much at heart, namely, a bill to invest the king with a discretionary power of dispensing, for a fine, penal laws against all sects, by which Charles hoped to favour the Catholics, though this purpose was necessarily cloaked under a promise of toleration, including all Protestant dissenters. Clarendon, who knew and disapproved of the motive, vehemently opposed this bill, and caused it to be laid aside; and Charles from that time began to entertain a dislike of his minister, which the enemies of Clarendon sedulously fostered. The Duke of Buckingham and other chosen associates of the king tried to undermine the influence of Clarendon by mimicry and taunts, representing him as a churlish pedagogue, and inciting the king to emancipate himself from restraint. His influence as a minister was also lessened by the substitution of Bennet for his firm friend Sir Edward Nicholas, and by the reviving power of Coventry and Ashley. He also paid the penalty of power, in bearing the load of whatever calamities befel the nation. Even the plague, and the fire of London, and the disastrous issue of the Dutch war (a war to which the public was favourable, and he was adverse), concurred to weaken his popularity. The defenceless state of the Thames, which enabled the Dutch to invade it successfully, and the conclusion of a peace which the people disliked, were imputed to the chancellor. Anxious to pursue a middle course, and careless of the public favour, he had gained the friendship of no party alike able and willing to support him. The Protestant dissenters disliked him as the promoter of the measures against Nonconformists; the Catholics as having frustrated the king's endeavour to grant them indulgence; the Royalists as the supporter of the act of indemnity and oblivion; the populace because he had built a large house, which, it was already rumoured, was the ostentatious result of secret bribes from France or Holland. The profligate and ambitious court disliked him as a reprover of their license, and an obstacle to their advancement; and Charles, who, aided by the high-church party, might have supported him against these assailants, had recently entertained a fresh ground of dislike. He knew that Clarendon opposed his infamous plan of obtaining a divorce; and he believed him to have promoted the marriage of Miss Stewart, whom, after obtaining such divorce, Charles had intended to espouse. The discontented nation clamoured for a victim; and the ungrateful king was glad to sacrifice to popular vengeance the minister whose stubborn honesty was opposed to the gratification of his will. He sent a message to Clarendon, then in affliction from the recent death of his wife, advising him to resign, with a view of saving himself from impeachment. Clarendon refused to take so humiliating a step; and Charles deprived him of the Great Seal on the 13th of August 1667. Clarendon, whom the impeachment preferred by Lord Bristol four years before had left unshaken, was now again exposed to this attack under circumstances which rendered it more powerful against him. Urged by the dukes of Buckingham and Albemarle, the Commons drew up, on the 6th of November, an impeachment, consisting of seventeen articles, which, after several days' debate, was on the 12th carried up to the Lords. He was accused of designing to govern by a standing army, and advising the king to discontinue parliaments; of saying that the king was in his heart a Papist; of receiving money for illegal patents; of imprisoning in remote garrisons; of unjust sale of offices; of corruptly procuring the customs to be farmed at low rates; of pretended debts to be paid by the king; of receiving sums from the vintners to afford them undue advantages; of procuring grants to be made to himself and his relations; of introducing arbitrary government in the colonies; of frustrating a proposal for the preservation of Nevis and St Christopher's; of advising and effecting the sale of Dunkirk; of unduly causing the king's letters-patent to Dr Croucher to be altered; of arbitrary conduct in the council; of having caused *quo warrantos* to be issued against corporations, with the intent of extorting money; of having corruptly procured the bill of settlement for Ireland; of having deceived the king in his administration of foreign affairs, and betrayed his councils to the enemy; and of having counselled the division of the fleet in June 1666. To these flimsy charges Lord Clarendon replied by the mouth of his son, that if any one was proved, he would submit to the rest. His accusers were ashamed to make any one of them the specific ground of an impeachment; and accordingly he was impeached of high treason in general terms, and his imprisonment demanded, until the Commons, "in convenient time," shall exhibit "articles against him." The Lords refused to imprison him on this general accusation. Much controversy ensued between the two Houses, during which, in compliance with the entreaties of his friends, and the intimated wishes of the king, Clarendon closed the dispute by withdrawing himself from the kingdom on the 29th of November 1667, and retiring to France. He left on his departure a vindication of his conduct, addressed to the House of Lords, which address was communicated to the Commons, by whom it was voted that it was scandalous and seditious, and should be burned by the hangman. The Commons then attemped to obtain his attainder, but were opposed by the Lords; and the two Houses finally concurred in an act of banishment and incapacity, unless he appeared and took his trial before the 1st of February, which act was passed on the 18th of December 1667. Fresh persecutions awaited Clarendon. The court of France, in order to gain the favour of England, wished to expel him from their dominions; and it was not till their hopes of alliance were dispelled by the triple league, that they showed kindness to the distinguished exile, and Clarendon received a special permission to reside in any part of France. He abode principally at Montpellier, where, resuming his literary labours, he completed his celebrated *History*, and the *Memoir of his own Life*. From thence he repaired to Rouen, where, in the year 1674, he addressed to Charles II. a fruitless prayer for permission to spend the short remainder of his life in England. A few months afterwards

Hyde, Edward.

Hyde, Thomas.

he died at Rouen, on the 9th of December 1674, in the sixty-fifth year of his age.

The character of Lord Clarendon has been much exposed to undeserved extremes of praise and of censure. He has been made the idol of the high-church party, and bitterly assailed by their opponents. As a minister he appears to have been incorrupt, indefatigable, zealous for the public service, and anxious to hold an even balance between the liberties of the subject and the privileges of the crown, and to secure to the restored king only the constitutional powers of limited monarchy. His chief faults were harshness towards the Nonconformists, and acquiescence in the king's clandestine acceptance of pecuniary aid from France. His merits cannot be fairly estimated, without considering the difficulties of his position, the profligacy and corruption of the times in which he lived, to which he boldly and honourably opposed himself, and comparing his administration with the disgraceful epoch by which it was succeeded. He was upright and uncompromising, and neglectful of the arts of popularity, both towards men of high and of humble station. His abilities were very great, but consisted perhaps rather in quickness than in depth and comprehensiveness of mind. He was ready and powerful as an orator, and prompt and able in the despatch of business, of which, in spite of frequent illness, he bore by far the greatest share during the period of his administration. In private life he was unimpeachable. As a writer he will ever occupy a high place. His history, as characterized by a distinguished modern historian, is "a monument of powerful ability and impressive eloquence." Its remarkable beauties are its masterly delineation of celebrated characters, the occasional eloquence of its descriptive passages, and the frequent interspersion of luminous reflections. Its chief faults are diffuseness of style, and the want of accuracy and arrangement. Its fidelity as a history cannot be upheld; a defect attributable partly to the circumstance of his having trusted much to recollection in the absence of requisite materials, partly to that desire to render it serviceable to the cause of the royalists, with which he professed to have commenced it.

His principal works are, his *History of the Rebellion; A short View of the State of Ireland;* and *The Life of Edward Earl of Clarendon,* in which is included a Continuation of his History of the Grand Rebellion. Of these three works, a complete edition, containing the passages suppressed by former editors, was published for the first time at Oxford in 1826. *Brief View and Survey of the Dangerous and Pernicious Errors to Church and State in Mr Hobbes' Book entitled the Leviathan,* Oxford, 1676; *A Collection of Tracts,* fol. London, 1727, containing—A Vindication of Himself; Reflections on several Christian Duties, Divine and Moral, by way of Essays; Contemplations and Reflections upon the Psalms of David; A Dialogue of the Want of Respect due to Age; and a Dialogue concerning Education.

(See *Life of Clarendon,* by himself, and his *History of the Rebellion;* Clarendon's *State Papers;* Wood's *Athenæ Oxonienses;* Whitelocke's *Memorials;* Burnet's *History of his Own Times; Memoirs of James II.;* Pepys's *Diary;* Evelyn's *Diary; Parliamentary History; State Trials; Life of Clarendon,* by Thomas Henry Lister; and Macaulay's *History of England,* &c. (T. H. L.)

HYDE, *Thomas,* one of the most learned of English orientalists, was born in 1636, at Billingsley, near Bridgenorth in Yorkshire. He inherited his taste for linguistic studies from his father, who was rector of that parish. At the age of sixteen he entered King's College, Cambridge, and under Wheeloch, the famous professor of Arabic, made great and rapid progress in the Eastern tongues. After spending a year at that university, Hyde removed to London, where he was engaged to aid Walton in his edition of the *Polyglot Bible.* Besides correcting the Arabic, Syriac, and Persian texts, he transcribed in Persian characters the Persian translation of the Pentateuch that had been printed in Hebrew shortly before at Constantinople, and appended a Latin version of his own. The success with which he accomplished these difficult tasks met the acknowledgments of the most learned men of the age. In 1658 Hyde entered Queen's College, Oxford, to which he was shortly after made Hebrew reader. In the following year, after graduating as M.A., he was chosen under-keeper, and finally librarian-in-chief of the Bodleian library. In 1660 he was made a canon of Salisbury; in 1678 archdeacon of Gloucester; and four years later took his degree of D.D. The death of Pococke in 1691 opened up to him the Laudian professorship of Arabic; and soon after, on the deprivation of Altham, he became regius professor of Hebrew, and canon of Christ Church. Worn out by his unremitting labours, he resigned his librarianship in 1701, and died two years later, February 18, 1703.

Hyde ‖ Hydera-bad.

The range of Hyde's erudition in Oriental matters was vast. There was hardly an Eastern tongue to be learned with which he was not familiar. He even knew Chinese—a language which very few Europeans of that day could boast of knowing. He learned it from Chin-fo-coung, a learned young Chinese brought to this country by the Jesuits. His mastery of the more accessible languages of the East—such as Turkish, Arabic, Persian, Hebrew, Armenian, &c.—is proved by his numerous and still valuable works. The best of these is his *Veterum Persarum et Magorum religionis Historia,* in which, for the first time, an attempt is made to correct from Oriental authorities the errors of the Greek and Latin historians who have described the religion of the ancient Persians. Of his other works may be mentioned his *Tabulæ Long. ac Latit. Stellarum Fixarum ex observatione Ulugh Beighi,* &c., to which Hyde has appended a learned commentary exhibiting the different names of the stars among the Orientals and the Greeks, and endeavouring to trace them to a common origin; *Quatuor Evangelia et Acta Apostolorum Linguâ Malaïcâ caracteribus Europæis,* Oxford, 1677; *Epistola de Mensuris et Ponderibus Serum sive Sinensium,* appended to Bernard's treatise *De Mensuris et Ponderibus; De Ludis Orientalibus,* libri ii., Oxford, 1694. The whole of Hyde's works, except that on the Religion of the Ancient Persians, were reprinted by Granville Sharp, under the title of *Syntagma Dissertationum quas olim D. Thomas Hyde, separatim edidit,* Oxford, 1767. In this edition, Sharp incorporated a number of other works of Hyde's which had been left in MS. The *Hist. Relig. Vet. Pers.* was not included in Sharp's edition, as it had been republished shortly before by Hunt and Costard.

HYDE, a manufacturing town of England, county of Chester, 7½ miles E.S.E. of Manchester. The town owes its importance to the cotton manufacture, which affords employment to nearly the whole population. There are extensive coal mines in the vicinity. Pop. (1851) 10,051.

HYDER ALI. See HINDUSTAN.

HYDERABAD, an extensive province of Hindustan, in the Deccan, which is situated principally between the 16th and 22d degrees of N. Lat. The name is now applied generally to all the territories of the Nizam. This territory composed a considerable portion of the ancient Telingana. The country is hilly, but not mountainous, being for the most part an elevated table-land, in consequence of which the climate is colder than might be expected from the latitude. In the vicinity of the city of Hyderabad, the mean temperature in the house, according to observations made at sunrise, at 2 o'clock in the afternoon, and at sunset, for one year, was—in January 74°, February 76°, March 84°, April 91°, May 93°, June 88°, July 81°, August 80°, September 79°, October 80°, November 76°, December 74°; giving as an annual mean, 81⅓°. The S.W. monsoon commences about the beginning of June, and terminates about the beginning of October. After it has ceased, variable weather continues for a few weeks, and this is followed by the N.E. monsoon. At midwinter the variation of temperature in the northern part of the territory is very great and sudden. The mornings are very cold, and ice is formed,

Hydera-bad.

but the days are hot. Numerous rivers intersect the territory, the principal of which are the Godavery, the Wurda, and the Kistna, with their numerous tributaries. The country is consequently fertile, and, under proper management, would yield abundantly. But the whole territory is principally rented to powerful zemindars, or is granted in jaghires to the officers of government. This distribution of the landed property, which, with the exception of some portions set aside for charitable purposes, and the estates of the Nizam and the different branches of his family, is in the hands of a few individuals, is supposed to be injurious to agriculture, and of course to the interests of the revenue. The cultivators are wretchedly poor, and are much oppressed by their superiors the holders, who are subject to little or no restraint from their nominal sovereign. Where they are properly cultivated, the fields yield excellent crops of wheat, which is transported by the inland carriers to the sea-coast, whence salt is brought in return. At present, the principal trade carried on between the Nizam's dominions and those under the British government, consists in the exportation of cotton to Berar and to the Northern Circars, and also to the markets at Vellore, Arnee, and the vicinity. They bring back salt and salted fish, cloths manufactured in the Northern Circars, Arnee muslins, and European manufactures; the latter principally for the supply of the British forces subsidized by the Nizam, and for clothing his army. The chief towns of this kingdom are Hyderabad, Golcondah, Warangole, Secunderabad, Beder, and Ellichpore. The majority of the people are Hindus: but having been long the seat of a Mohammedan government, a considerable portion of the inhabitants are of that religion. The revenue of the Nizam is returned at L.1,150,000. In addition to the subsidiary force maintained by the British government in Hyderabad, in accordance with the treaty of 1800, the Nizam has a large military force, consisting of cavalry, infantry, and artillery, besides a body of irregular troops, composed of Arabs, Scindees, Moguls, and Seiks.

This country was formerly subject to the rajahs of Telingana and Bijanagur; but being afterwards conquered by the Mohammedans, was formed into a separate kingdom in the year 1512, under the name of Golcondah, by Mohammed Kooly, originally a Turkish adventurer. In 1687, it was brought under the dominion of Aurungzebe, and was converted into one of the provinces of the Mogul empire, and, with the other five southern provinces, was formed into a viceroyalty, under an officer appointed by the court of Delhi, called the soobahdar of the Deccan. In 1719, a Mogul officer, Cheen Khilij Khan, being appointed to this government, with the title of Nizam al Moolk, or superintendent of the kingdom, collected a large army, and got possession of all the strongholds of the Deccan; and setting up for independence, he overawed the emperor Mohammed Shah and his ministers. After the invasion of Nadir Shah in 1739, he left to the Mogul nothing but the name of sovereign; and he, having made Aurungabad his capital, died at Boorhanpore in the year 1748, aged 104 years. He was succeeded by his second son, who was assassinated in 1750, and succeeded by his nephew Muzuffer Jung, who was assassinated the following year, and succeeded by his cousin Salabut Jung. This weak prince was dethroned by his youngest brother Nizam Ali, who for nearly twenty years was engaged in wars with Hyder Ali, the British, and the Mahrattas, during which his territories were greatly contracted. In 1766, Nizam Ali concluded a treaty with the East India Company, under which they engaged to have a body of troops ready to settle the affairs of his highness's government in everything that was right and proper. Subsequently Nizam Ali united his forces with those of Hyder Ali, but the alliance proving unprosperous, he concluded a new treaty with the East India Company in 1768. In the following year, on the breaking out of the war with Tippoo, a treaty was concluded between the Nizam, the Peishwa, and the British government. Tippoo purchased peace at the sacrifice of half his dominions, and the Nizam had no reason to be dissatisfied with his share of the spoil. At a later period the Nizam claimed the assistance of the British government against the Mahrattas, which being refused, he sought safety in the entertainment of a body of French troops, who, however, were dismissed in accordance with the provisions of a treaty concluded in 1798. On the fall of Tippoo, and the annihilation of the state of Seringapatam, the Nizam participated largely in the division of the territory; and in 1800 he concluded a treaty offensive and defensive, by which he became a dependant and ally of the British. He agreed to receive into his territories a British force of 8000 infantry and 1000 cavalry; to relinquish to the British the management of all his foreign relations; and, for the regular payment of the troops stationed in his country, to cede certain portions of territory to the British. By a commercial treaty concluded in 1802 with the British, it was agreed, in lieu of all local duties, that a duty of five per cent. should be levied on all articles respectively imported into the territories of each. In 1804, after the conclusion of the war with Scindia and the rajah of Nagpoor, the Nizam acquired a large accession of territory. Nizam Ali died in 1803. He was succeeded by Secander Jah, who died in 1829. Under the successor of this prince the misgovernment of the country greatly increased, and the debt of the state was allowed to accumulate to an enormous extent, the British government being creditors for arrears amounting to half a million sterling. The claim was pressed on the notice of the Nizam's government, and its settlement was at length effected by a territorial cession, the revenues of which were made applicable to the reduction of the debt and the maintenance of the Nizam's military contingent. The territory of the Nizam may be estimated at 420 miles in length by 220 miles in breadth, and contains 10,000,000 of inhabitants.

Hydera-bad.

HYDERABAD, the capital of the above-mentioned province of Hyderabad, and of the Nizam's dominions, is situated on the south side of the Musa River, which runs rapidly during the rains, but in the dry season has scarcely two feet of water. It is said to have been founded about the year 1586 by Sultan Mohammed Kootub Shah, who, thinking the air of Golcondah did not agree with his constitution, gave orders for building a new city, which continued to be the residence of the Kootub Shah dynasty till the year 1687, when it was taken by Aurungzebe. The late Nizam Ali was the first of the Nizams who made it his residence, and he spent considerable sums in improving it. It is now a large and populous place, about 7 miles in circumference, and is surrounded by a stone wall, with towers at the angles and gates, which, though incapable of defence against artillery, is a good protection against the incursions of cavalry. It contains two palaces and some elegant mosques, this having long been the seat of Mohammedanism in the Deccan; and between it and Golcondah there are some handsome tombs. There is a considerable suburb on the opposite side of the river, and in this quarter is situate the British residency, the communication between it and the city and palace being maintained by a handsome stone bridge. The elevation of the town above the sea is 1800 feet. At present it is estimated to contain 200,000 inhabitants, including the suburbs. The travelling distance from Calcutta by the Northern Circars is 902 miles, by Nagpoor 1043 miles, from Madras 352, from Bombay 480, from Delhi 923, from Poonah 387, from Seringapatam 406. E. Long. 78° 32′, N. Lat. 17° 22′.

Hyderabad, a city of Hindustan, in the province of Scinde, of which it is the capital. The fortress of Hyderabad, which, previously to the annexation of the country to the British empire, was appropriated solely to the residence of the princes and their families, is situated on a rock the foot of which is washed by a branch of the River Indus, here

Hyderabad.

named the Fulalee. It is of an irregular pentagonal figure, suited to the natural form of the rock, and is defended by round towers, and a high brick wall perforated with loopholes. The situation is remarkably strong; the sides of the hill being in many places so steep as to render the ascent to the fortress difficult, even though a breach were made in the walls. The weakest point is towards the south-east, opposite a break in the rock from the Fulalee. A dry ditch twelve feet broad protects the northern side. The position is good, and the fortifications adequate to resist any attack of native troops. Hyderabad is situated 130 miles from the sea, on the eastern side of the main stream of the Indus, with which it is connected by the Fulalee at the distance of 3 miles. Sir Charles Napier entered the place on the 20th February 1843, having previously received the submission of six of the ameers of Scinde. On the 24th he marched out to give battle to Sheer Mohammed, of Meerpore, who yet remained in arms, and was posted in great force behind a neighbouring watercourse, which had been partially fortified. The ameer was, however, attacked and defeated, the British force being thus enabled to march upon Meerpore. The country around Hyderabad rises into hills, although it is level till within a few miles of that city. The Indus is a perpetual source of fertility, affording an inexhaustible supply of water for the irrigation of the fields. The flat country of Scinde is intersected by branches from the main stream, and by canals; and the transition from the parched deserts of Cutch to such a scene of fertility is described by Dr Burnes as affording a very striking contrast. The Fulalee in the month of August is from two and a half to three fathoms deep at Hyderabad, and is covered with boats laden with heavy goods. The population is 24,000. E. Long. 68. 28., N. Lat. 25. 22.

Hydra || Hydraulics.

HYDRA, a rocky island in the Grecian Archipelago, 6 miles off the coast of Argolis. It is 12 miles in length, from N.N.E. to S.S.W., by 3 in breadth. The surface presents scarcely a speck of vegetation, and the inhabitants are entirely dependent on trade and commerce. Its insular position and facilities for trade pointed it out as a suitable place of refuge from the oppression of the Turks. At the commencement of the war of independence it had no fewer than 150 vessels, while the bravery of the people, and their efficiency as seamen, contributed in no small degree to the successful issue of that contest. The town of Hydra, which, with the exception of two adjacent villages, is the only inhabited part of the island, is situated on the N.W. side, and rises abruptly from the harbour in successive tiers in the form of an amphitheatre. The harbour is a deep bay, neither spacious nor secure. In 1825 the population of the island was estimated at 40,000; but at present it does not amount to more than half that number.

HYDRAOTES, in Sanscrit, IRAVATI, modified into the present appellation the RAVEE, one of the five rivers of the Punjab. See PUNJAB.

HYDRODYNAMICS.

Definition.

1. HYDRODYNAMICS, from ὑδωρ, "water," and δυναμις, "power," is properly that science which treats of the power of water, whether it acts by pressure or by impulse. In its more enlarged acceptation, however, it treats of the pressure, equilibrium, cohesion, and motion of fluids, and of the machines by which water is raised, or in which that fluid is employed as the first mover. Hydrodynamics is divided into two branches, *Hydrostatics* and *Hydraulics*. Hydrostatics comprehends the pressure, equilibrium, and cohesion of fluids, and Hydraulics their motion, together with the machines in which they are chiefly concerned.

HISTORY.

Hydrodynamics in some respects a modern science.

2. The science of hydrodynamics was cultivated with less success among the ancients than any other branch of mechanical philosophy. When the human mind had made considerable progress in the other departments of physical science, the doctrine of fluids had not begun to occupy the attention of philosophers; and, if we except a few propositions on the pressure and equilibrium of water, hydrodynamics must be regarded as a modern science, which owes its existence and improvement to those great men who adorned the seventeenth and eighteenth centuries.

Discoveries of Archimedes. A. C. 250.

3. Those general principles of hydrostatics which are to this day employed as the foundation of that part of the science, were first given by Archimedes in his work Περὶ ὀχουμένων, or *De Insidentibus Humido*, about 250 years before the birth of Christ, and were afterwards applied to experiments by Marinus Ghetaldus in his *Archimedes Promotus*. Archimedes maintained that each particle of a fluid mass, when in equilibrio, is equally pressed in every direction; and he inquired into the conditions, according to which a solid body floating in a fluid should assume and preserve a position of equilibrium. We are also indebted to the philosopher of Syracuse for that ingenious hydrostatic process by which the purity of the precious metals can be ascertained, and for the screw engine which goes by his name, the theory of which has lately exercised the ingenuity of some of our greatest mathematicians.

4. In the Greek school at Alexandria which flourished under the auspices of the Ptolemies, the first attempts were made at the construction of hydraulic machinery. About 120 years after the birth of Christ, the fountain of compression, the syphon, and the forcing pump, were invented by Ctesibius and Hero; and though these machines operated by the elasticity and weight of the air, yet their inventors had no distinct notions of these preliminary branches of pneumatical science. The syphon is a simple instrument which is employed to empty vessels full of water or spirituous liquors, and is of great utility in the arts. The forcing pump, on the contrary, is a complicated and abstruse invention, which could scarcely have been expected in the infancy of hydraulics. It was probably suggested to Ctesibius by the *Egyptian wheel* or *Noria*, which was common at that time, and which was a kind of chain pump, consisting of a number of earthern pots carried round by a wheel. In some of these machines the pots have a valve in their bottom which enables them to descend without much resistance, and diminishes greatly the load upon the wheel; and if we suppose that this valve was introduced so early as the time of Ctesibius, it is not difficult to perceive how such a machine might have led this philosopher to the invention of the forcing pump.

Inventions of Ctesibius and Hero. A. D. 120.

Forcing Pump.

Egyptian wheel.

5. Notwithstanding these inventions of the Alexandrian school, its attention does not seem to have been directed to the motion of fluids. The first attempt to investigate this subject was made by Sextus Julius Frontinus, inspector of the public fountains at Rome in the reigns of Nerva and Trajan; and we may justly suppose that his work entitled *De Aquæductibus urbis Romæ Commentarius* contains all the hydraulic knowledge of the ancients. After

Labours of Sextus Julius Frontinus in hydraulics. A. D. 110.

History. describing the *nine*[1] great Roman aqueducts, to which he himself added *five* more, and mentioning the dates of their erection, he considers the methods which were at that time employed for ascertaining the quantity of water discharged from adjutages, and the mode of distributing the waters of an aqueduct or a fountain. He justly remarks that the expense of water from an orifice, depended not only on the magnitude of the orifice itself, but also on the height of the water in the reservoir; and that a pipe employed to carry off a portion of water from an aqueduct, should, as circumstances required, have a position more or less inclined to the original direction of the current. But as he was unacquainted with the true law of the velocities of running water as depending upon the depth of the orifice, we can scarcely be surprised at the want of precision which appears in his results.

The Romans acquainted with the art of conducting water in pipes.

It has generally been supposed that the Romans were ignorant of the art of conducting and raising water by means of pipes; but it can scarcely be doubted, from the statement of Pliny and other authors, that they not only were acquainted with the hydrostatical principle, but that they actually used leaden pipes for the purpose. Pliny asserts that water will always rise to the height of its source, and he also adds that, in order to raise water up to an eminence, leaden pipes must be employed.[2]

6. The labours of the ancients in the science of hydrodynamics terminated with the life of Frontinus. The sciences had already begun to decline, and that night of ignorance and barbarism was advancing apace, which for more than a thousand years brooded over the nations of Europe. During this lengthened period of mental degeneracy, when less abstruse studies ceased to attract the notice, and rouse the energies of men, the human mind could not be supposed capable of that vigorous exertion, and patient industry, which are so indispensable in physical researches. Poetry and the fine arts, accordingly, had made considerable progress under the patronage of the family of Medici, before Galileo began to extend the boundaries of science. This great man, who deserves to be called the father and restorer of physics, does not appear to have directed his attention to the doctrine of fluids: but his discovery of the uniform acceleration of gravity, laid the foundation of its future progress, and contributed in no small degree to aid the exertions of genius in several branches of science.

Labours of Galileo. Born 1564, died 1641.

Of Castelli. Born 1577, died 1644.

7. Castelli and Torricelli, two of the disciples of Galileo, applied the discoveries of their master to the science of hydrodynamics. In 1628 Castelli published a small work, *Della Misura dell 'acque correnti*, in which he gave a very satisfactory explanation of several phenomena in the motion of fluids, in rivers and canals. But he committed a great paralogism in supposing the velocity of the water proportional to the depth of the orifice below the surface of the vessel. Torricelli observing that in a *jet d'eau* where the water rushed through a small adjutage, it rose to nearly the same height with the reservoir from which it was supplied, imagined that it ought to move with the same velocity as if it had fallen through that height by the force of gravity. And hence he deduced this beautiful and important proposition, that the velocities of fluids are as the square roots of the pressures, abstracting from the resistance of the air and the friction of the orifice. This theorem was published in 1643, at the end of his treatise *De Motu Gravium naturaliter accelerato*. It was afterwards confirmed by the experiments of Raphael Magiotti, on the quantities of water discharged from different adjutages under different pressures; and though it is true only in small orifices, it gave a new turn to the science of hydraulics.

Of Torricelli. Born 1608, died 1647.

History.

8. After the death of the celebrated Pascal, who discovered the pressure of the atmosphere, a treatise on the equilibrium of fluids (*Sur l'Equilibre des Liqueurs*), was found among his manuscripts, and was given to the public in 1663. In the hands of Pascal, hydrostatics assumed the dignity of a science. The laws of the equilibrium of fluids were demonstrated in the most perspicuous and simple manner, and amply confirmed by experiments. The discovery of Torricelli, it may be supposed, would have incited Pascal to the study of hydraulics. But as he has not treated this subject in the work which has been mentioned, it was probably composed before that discovery had been made public.

Of Pascal. Born 1623, died 1662.

9. The theorem of Torricelli was employed by many succeeding writers, but particularly by the celebrated Mariotte, whose labours in this department of physics deserve to be recorded. His *Traité du Mouvement des Eaux*, which was published after his death in the year 1686, is founded on a great variety of well-conducted experiments on the motion of fluids, performed at Versailles and Chantilly. In the discussion of some points he has committed considerable mistakes. Others he has treated very superficially, and in none of his experiments does he seem to have attended to the diminution of efflux arising from the contraction of the fluid vein, when the orifice is merely a perforation in a thin plate; but he appears to have been the first who attempted to ascribe the discrepancy between theory and experiment to the retardation of the water's velocity arising from friction. His cotemporary Guglielmini, who was inspector of the rivers and canals in the Milanese, had ascribed this diminution of velocity in rivers, to transverse motions arising from inequalities in their bottom. But as Mariotte observed similar obstructions even in glass pipes, where no transverse currents could exist, the cause assigned by Guglielmini seemed destitute of foundation. The French philosopher, therefore, regarded these obstructions as the effects of friction. He supposes that the filaments of water which graze along the sides of the pipe lose a portion of their velocity; that the contiguous filaments having on this account a greater velocity, rub upon the former, and suffer a diminution of their celerity; and that the other filaments are affected with similar retardations proportional to their distance from the axis of the pipe. In this way the medium velocity of the current may be diminished, and consequently the quantity of water discharged in a given time, must, from the effects of friction, be considerably less than that which is computed from theory.

Of Mariotte. Died 1684.

10. That part of the science of hydrodynamics which relates to the motion of rivers seems to have originated in Italy. This fertile country receives from the Apennines a great number of torrents, which traverse several principalities before they mingle their waters with those of the Po, into which the greater part of them fall. To defend themselves from the inundations with which they were threatened, it became necessary for the inhabitants to change the course of their rivers; and while they thus drove them from their own territories, they let them loose on those of their neighbours. Hence arose the continual quarrels which once raged between the Bolognese and the inhabitants of Modena and Ferrara. The attention of the Italian engineers was necessarily directed to this branch of science; and from this cause a greater number of works

The motion of rivers first attended to in Italy.

[1] These nine aqueducts delivered every day 14,000 quinaria, or about 50,000,000 cubic feet of water, or about 50 cubic feet for the daily consumption of each inhabitant, supposing the population of Rome to have been a million. According to Professor Leslie, the supply in modern Rome is forty cubic feet per person, in London three cubic feet, and in Paris one-half a cubic foot.—See *Elements of Nat. Phil.* p. 419.

[2] Plin. xxxvi. 7. See also Palladius *De Re Rustica* ix. 11, &c., and Horace Epist. I. x. 20, Ovid Met. iv. 120.

History. were written on the subject in Italy than in all the rest of Europe.

Theory of Guglielmini.

11. Guglielmini was the first who attended to the motion of water in rivers and open canals.[1] Embracing the theorem of Torricelli, which had been confirmed by repeated experiments, Guglielmini concluded that each particle in the perpendicular section of a current has a tendency to move with the same velocity as if it issued from an orifice at the same depth from the surface. The consequences deducible from this theory of running waters are in every respect repugnant to experience, and it is really surprising that it should have been so hastily adopted by succeeding writers. Guglielmini himself was sufficiently sensible that his parabolic theory was contrary to fact, and endeavoured to reconcile them by supposing the motion of rivers to be obstructed by transverse currents arising from irregularities in their bed. The solution of this difficulty, as given by Mariotte, was more satisfactory, and was afterwards adopted by Guglielmini, who maintained also that the viscidity of water had a considerable share in retarding its motion.

Discoveries of Sir Isaac Newton. Born 1652, died 1727.

12. The effects of friction and viscidity in diminishing the velocity of running water were noticed in the *Principia* of Sir Isaac Newton, who has thrown much light upon several branches of hydrodynamics. At a time when the Cartesian system of vortices universally prevailed, this great man found it necessary to investigate that absurd hypothesis, and in the course of his investigations he has shewn that the velocity of any stratum of the vortex is an arithmetical mean between the velocities of the strata which enclosed it; and from this it evidently follows, that the velocity of a filament of water moving in a pipe is an arithmetical mean between the velocities of the filaments which surround it. Taking advantage of these results, it was afterwards shewn by M. Pitot, that the retardations arising from friction are inversely as the diameters of the pipes in which the fluid moves. The attention of Newton was also directed to the discharge of water from orifices in the bottom of vessels. He supposed a cylindrical vessel full of water to be perforated in its bottom with a small hole by which the water escaped, and the vessel to be supplied with water in such a manner that it always remained full at the same height. He then supposed this cylindrical column of water to be divided into two parts; the first, which he calls the *cataract*, being a hyperboloid generated by the revolution of a hyperbola of the fifth degree around the axis of the cylinder which should pass through the orifice; and the second the remainder of the water in the cylindrical vessel. He considered the horizontal strata of this hyperboloid as always in motion, while the remainder of the water was in a state of rest; and imagined that there was a kind of cataract in the middle of the fluid. When the results of this theory were compared with the quantity of water actually discharged, Newton concluded that the velocity with which the water issued from the orifice was equal to that which a falling body would receive by descending through half the height of water in the reservoir. This conclusion, however, is absolutely irreconcilable with the known fact, that jets of water rise nearly to the same height as their reservoirs, and Newton seems to have been aware of this objection. In the second edition of his *Principia*, accordingly, which appeared in 1714, Sir Isaac has reconsidered his theory. He had discovered a contraction in the vein of fluid (*vena contracta*), which issued from the orifice, and found that, at the distance of about a diameter of the aperture, the section of the vein was contracted in the subduplicate ratio of two to one. He regarded, therefore, the section of the contracted vein as the true orifice from which the discharge of water ought to be deduced, and the velocity of the effluent water as due to the whole height of water in the reservoir; and by this means his theory became more conformable to the results of experience. This theory, however, is still liable to serious objections. The formation of a *cataract* is by no means agreeable to the laws of hydrostatics; for when a vessel is emptied by the efflux of water through an orifice in its bottom, all the particles of the fluid direct themselves toward this orifice, and therefore no part of it can be considered as in a state of repose. History.

The oscillation of waves first considered by Newton.

13. The subject of the oscillation of waves, one of the most difficult in the science of hydrodynamics, was first investigated by Sir Isaac Newton. In the forty-fourth proposition of the second book of his *Principia*, he has furnished us with a method of ascertaining the velocity of the waves of the sea, by observing the time in which they rise and fall. If the two vertical branches of a syphon, which communicate by means of a horizontal branch, be filled with a fluid of known density, the two fluid columns, when in a state of rest, will be in equilibrio and their surfaces horizontal. But if the one column is raised above the level of the other, and left to itself, it will descend below that level, and raise the other column above it, and, after a few oscillations, they will return to a state of repose. Newton occupied himself in determining the duration of these oscillations, or the length of a pendulum isochronous to their duration; and he found, by a simple process of reasoning, that, abstracting from the effects of friction, the length of a synchronous pendulum is equal to one-half of the length of the syphon, that is, of the two vertical branches and the horizontal one, and hence he deduced the isochronism of these oscillations. From this Newton concluded, that the velocity of waves formed on the surface of water, either by the wind or by means of a stone, was in the subduplicate ratio of their size. When their velocity, therefore, is measured, which can be easily done, the size of the waves will be determined by taking a pendulum which oscillates in the time that a wave takes to rise and fall.

Labours of the Marquis Poleni. Born 1683, died 1761.

14. In the year 1718, the Marquis Poleni published, at Padua, his work *De Castellis per quæ derivantur Fluviorum aquæ*, &c. He found, from a great number of experiments, that if A be the aperture of the orifice, and D its depth below the surface of the reservoir, the quantity of water discharged in a given time will be as $2\,AD \times \frac{0.571}{1.000}$, while it ought to be as 2AD, if the velocity of the issuing fluid was equal to that acquired by falling through D. By adapting to a circular orifice through which the water escaped, a cylindrical tube of the same diameter, the Marquis found that the quantity discharged in a determinate time was considerably greater than when it issued from the circular orifice itself; and this happened whether the water descended perpendicularly or issued in a horizontal direction.

Daniel Bernouilli's theory of the motion of fluids. Born 1700. Died 1782.

15. Such was the state of hydrodynamics in 1738, when Daniel Bernouilli published his *Hydrodynamica, seu de viribus et motibus Fluidorum Commentarii.* His theory of the motion of fluids was founded on two suppositions, which appeared to him conformable to experience. He supposed that the surface of a fluid, contained in a vessel which was emptying itself by an orifice, remains always horizontal; and if the fluid mass is conceived to be divided into an infinite number of horizontal strata of the same bulk, that these strata remain contiguous to each other, and that all their points descend vertically, with velocities inversely proportional to their breadth, or to the horizontal sections of the reservoir. In order to determine the motion of each stratum, he employed the principle of the *conservatio viri-*

[1] See his principal work, entitled *La Misura dell' acque correnti.*

History. *um vivarum*, and obtained very elegant solutions. In the opinion of the Abbé Bossut, his work was one of the finest productions of mathematical genius.[1]

Objected to by Maclaurin, Born 1698, died 1746; and John Bernouilli, Born 1667, died 1748.

16. The uncertainty of the principle employed by Daniel Bernouilli, which has never been demonstrated in a general manner, deprived his results of that confidence which they would otherwise have deserved; and rendered it desirable to have a theory more certain, and depending solely on the fundamental laws of mechanics. Maclaurin and John Bernouilli, who were of this opinion, resolved the problem by more direct methods, the one in his Fluxions, published in 1742; and the other in his *Hydraulica nunc primum detecta, et directe demonstrata ex principiis purè mechanicis*, which forms the fourth volume of his works. The method employed by Maclaurin has been thought not sufficiently rigorous; and that of John Bernouilli is, in the opinion of La Grange, defective in perspicuity and precision.

D'Alembert applies his principle of dynamics to the motion of fluids, Born 1717.

17. The theory of Daniel Bernouilli was opposed also by the celebrated D'Alembert. When generalising James Bernouilli's Theory of Pendulums, he discovered a principle of dynamics so simple and general, that it reduced the laws of the motions of bodies to that of their equilibrium. He applied this principle to the motion of fluids, and gave a specimen of its application at the end of his Dynamics in 1743. It was more fully developed in his *Traité des Fluides*, which was published in 1744, where he has resolved, in the most simple and elegant manner, all the problems which relate to the equilibrium and motion of fluids. He makes use of the very same suppositions as Daniel Bernouilli, though his calculus is established in a very different manner. He considers, at every instant, the actual motion of a stratum, as composed of a motion which it had in the preceding instant, and of a motion which it has lost. The laws of equilibrium between the motions lost, furnish him with equations which represent the motion of the fluid. Although the science of hydrodynamics had then made considerable progress, yet it was chiefly founded on hypothesis. It remained a desideratum to express by equations the motion of a particle of the fluid in any assigned direction. These equations were found by D'Alembert, from two principles, that a rectangular canal, taken in a mass of fluid in equilibrio, is itself in equilibrio; and that a portion of the fluid, in passing from one place to another, preserves the same volume when the fluid is incompressible, or dilates itself according to a given law when the fluid is elastic. His very ingenious method was published in 1752, in his *Essai sur la resistance des fluides*. It was brought to perfection in his *Opuscules Mathématiques*, and has been adopted by the celebrated Euler.

Before the time of D'Alembert, it was the great object of philosophers to submit the motion of fluids to general formulæ, independent of all hypothesis. Their attempts, however, were altogether fruitless; for the method of fluxions, which produced such important changes in the physical sciences, was but a feeble auxiliary in the science of hydraulics. For the resolution of the questions concerning the motion of fluids, we are indebted to the method of partial differences, a new calculus, with which Euler enriched the sciences. This great discovery was first applied to the motion of water by the celebrated D'Alembert, and enabled both him and Euler to represent the theory of fluids in formulæ restricted by no particular hypothesis.

Experiments of Michelotti, A. D. 1764.

18. An immense number of experiments on the motion of water in pipes and canals was made by Professor Michelotti of Turin, at the expense of the sovereign. In these experiments the water issued from holes of different sizes, under pressures of from 5 to 22 feet, from a tower constructed of the finest masonry. Basins (one of which was 289 feet square) built of masonry, and lined with stucco, received the effluent water, which was conveyed in canals of brickwork, lined with stucco, of various forms and declivities. The whole of Michelotti's experiments were conducted with the utmost accuracy; and his results, which are in every respect entitled to our confidence, were published in 1774 in his *Sperienze Idrauliche*. History.

Of the Abbe Bossut.

19. The experiments of the Abbé Bossut, whose labours in this department of science have been very assiduous and successful, have, in as far as they coincide, afforded the same results as those of Michelotti. Though performed on a smaller scale, they are equally entitled to our confidence, and have the merit of being made in cases which are most likely to occur in practice. In order to determine what were the motions of the fluid particles in the interior of a vessel emptying itself by an orifice, M. Bossut employed a glass cylinder, to the bottom of which different adjutages were fitted; and he found that all the particles descend at first vertically, but that at a certain distance from the orifice they turn from their first direction towards the aperture. In consequence of these oblique motions, the fluid vein forms a kind of truncated conoid, whose greatest base is the orifice itself, having its altitude equal to the radius of the orifice, and its bases in the ratio of 3 to 2.—It appears also, from the experiments of Bossut, that when water issues through an orifice made in a thin plate, the expense of water, as deduced from theory, is to the real expense as 16 to 10, or as 8 to 5; and, when the fluid issues through an additional tube, two or three inches long, and follows the sides of the tube, as 16 to 13.—In analyzing the effects of friction, he found, 1. That small orifices gave less water in proportion than great ones, on account of friction; and, 2. That when the height of the reservoir was augmented, the contraction of the fluid vein was also increased, and the expense of water diminished; and by means of these two laws he was enabled to determine the quantity of water discharged, with all the precision he could wish. In his experiments on the motion of water in canals and tubes, he found that there was a sensible difference between the motion of water in the former and in the latter. Under the same height of reservoir, the same quantity of water always flows in a canal, whatever be its length and declivity; whereas, in a tube, a difference in length and declivity has a very considerable influence on the quantity of water discharged. According to the theory of the resistance of fluids, the impulse upon a plane surface is as the product of its area multiplied by the square of the fluid's velocity, and the square of the sine of the angle of incidence. The experiments of Bossut, made in conjunction with D'Alembert and Condorcet, prove, that this is sensibly true when the impulse is perpendicular; but that the aberrations from theory increase with the angle of impulsion. They found, that when the angle of impulsion was between 50° and 90°, the ordinary theory may be employed, that the resistances thus found will be a little less than they ought to be, and the more so as the angles recede from 90°. The attention of Bossut was directed to a variety of other interesting points, which we cannot stop to notice, but for which we must refer the reader to the works of that ingenious author.

Inquiries of Flaugergues concerning the oscillation of waves.

20. The oscillation of waves, which was first discussed by Sir Isaac Newton, and afterwards by D'Alembert, in the article *Ondes* in the French Encyclopædia, was now revived by M. Flaugergues, who attempted to overthrow the opinions of these philosophers. He maintained, that a wave is not the effect of a motion in the particles of water,

[1] The germ of Daniel Bernouilli's theory was first published in his memoir entitled *Theoria Nova de Motu Aquarum per Canales quocunque Fluentes*, which he had communicated to the Academy of St Petersburg as early as 1726.

History. by which they rise and fall alternately, in a serpentine line, when moving from the centre where they commenced; but that it is a kind of intumescence, formed by a depression at the place where the impulse is first made, which propagates itself in a circular manner when removing from the point of impulse. A portion of the water, thus elevated, he imagines, flows from all sides into the hollow formed at the centre of impulse, so that the water being, as it were, heaped up, produces another intumescence, which propagates itself as formerly. From this theory M. Flaugergues concludes, and he has confirmed the conclusion by experiment, that all waves, whether great or small, have the same velocity.

And of M. Lagrange. Born 1730, died 1813.

21. This difficult subject has also been discussed by M. Lagrange, in his *Mécanique Analytique*. He found that the velocity of waves in a canal, is equal to that which a heavy body would acquire by falling through a height equal to half the depth of the water in the canal. If this depth, therefore, be one foot, the velocity of the waves will be 5·945 feet in a second; and if the depth is greater or less than this, their velocity will vary in the subduplicate ratio of the depth, provided it is not very considerable. If we suppose that, in the formation of waves, the water is agitated but to a very small depth, the theory of Lagrange may be employed, whatever be the depth of the water and the figure of its bottom. This supposition, which is very plausible, when we consider the tenacity and adhesion of the particles of water, has also been confirmed by experience.

Experiments and theory of the Chevalier Dubuat, 1779.

22. The most successful labourer in the science of hydrodynamics was the Chevalier Dubuat, engineer in ordinary to the King of France. Following in the steps of the Abbé Bossut, he prosecuted the inquiries of that philosopher with uncommon ingenuity; and in the year 1786 he published, in two volumes, his *Principes d'Hydralique*,[1] which contains a satisfactory theory of the motion of fluids, founded solely upon experiments. The Chevalier Dubuat considered that if water were a perfect fluid, and the channels in which it flowed infinitely smooth, its motion would be continually accelerated, like that of bodies descending in an inclined plane. But as the motion of rivers is not continually accelerated, and soon arrives at a state of uniformity, it is evident that the viscidity of the water, and the friction of the channel in which it descends, must equal the accelerating force. M. Dubuat, therefore, assumes it as a proposition of fundamental importance, that when water flows in any channel or bed, the accelerating force, which obliges it to move, is equal to the sum of all the resistances which it meets with, whether they arise from its own viscidity or from the friction of its bed. This principle was employed by M. Dubuat, in the first edition of his work, which appeared in 1779; but the theory contained in that edition was founded on the experiments of others. He soon saw, however, that a theory so new, and leading to results so different from the ordinary theory, should be founded on new experiments more direct than the former, and he was employed in the performance of these from 1780 to 1783. The experiments of Bossut having been made only on pipes of a moderate declivity, M. Dubuat found it necessary to supply this defect. He used declivities of every kind, from the smallest to the greatest; and made his experiments upon channels, from a line and a half in diameter, to seven or eight square toises.

Researches of M. Venturi, 1798.

23. M. Venturi, Professor of Natural Philosophy in the University of Modena, succeeded in bringing to light some curious facts respecting the motion of water, in his work on the *Lateral Communication of Motion in Fluids*. He observed, that if a current of water is introduced with a certain velocity into a vessel filled with the same fluid at rest, and if this current, passing through a portion of the fluid, is received in a curvilineal channel, the bottom of which gradually rises till it passes over the rim of the vessel itself, it will carry along with it the fluid contained in the vessel; so that after a short time has elapsed, there remains only the portion of the fluid which was originally below the aperture at which the current entered. This phenomenon has been called by Venturi, the lateral communication of motion in fluids; and, by its assistance, he has endeavoured to explain many important facts in hydraulics. He has not attempted to explain this principle; but has shown that the mutual action of the fluid particles does not afford a satisfactory explanation of it. The work of Venturi contains many other interesting discussions, which are worthy of the attention of every reader.

History.

Discoveries of Coulomb, 1800

24. Although the Chevalier Dubuat had shown much sagacity in classifying the different kinds of resistances which are exhibited in the motion of fluids, yet it was reserved for Coulomb to express the sum of them by a rational function of the velocity. By a series of interesting experiments on the successive diminution of the oscillation of disks, arising from the resistance of the water in which they oscillated, he was led to the conclusion, that the pressure sustained by the moving disk is represented by two terms, one of which varies with the simple velocity, and the other with its square. When the motions are very slow, the part of the resistance proportional to the square of the velocity is insensible, and hence the resistance is proportional to the simple velocity. M. Coulomb found also, that the resistance is not perceptibly increased by increasing the depth of the oscillating disk in the fluid; and by coating the disk successively with fine and coarse sand, he found that the resistance arises solely from the mutual cohesion of the fluid particles, and from their adhering to the surface of the moving body.

Experiments of M. Girard.

25. The law of resistance discovered by Coulomb, was first applied to the determination of the velocity of running water by M. Girard, who considers the resistance as represented by a constant quantity, multiplied by the sum of the first and second powers of the velocity. He regards the water which moves over the wetted sides of the channel as at first retarded by its viscidity, and he concludes that the water will, from this cause, suffer a retardation proportional to the simple velocity. A second retardation, analogous to that of friction in solids, he ascribes to the roughness of the channel, and he represents it by the second power of the velocity, as it must be in the compound ratio of the force and the number of impulsions which the asperities receive in a given time. He then expresses the resistance due to cohesion by a constant quantity, to be determined experimentally, multiplied into the product of the velocity of the perimeter of the section of the fluid.

1814.

26. The influence of heat in promoting fluidity was known to the ancients;[2] but M. Dubuat was the first person who investigated the subject experimentally. His results, however, were far from being satisfactory; and it was left to M. Girard to ascertain the exact effect of temperature on the motion of water in capillary tubes. When the length of the capillary tube is great, the velocity is quadrupled by an increase of heat from 0° to 85° centig.; but when its length is small, a change of temperature exercises little or no influence on the velocity. He found also, that, in ordinary conduit pipes, a variation of temperature exercises scarcely any influence over the velocity.

Investigations of M. Prony, 1804.

27. The theory of running water was greatly advanced by the researches of M. Prony. From a collection of the best experiments by Couplet, Bossut, and Dubuat, he selected 82, of which 51 were made on the velocity of water

[1] A third volume of this work was published in 1816, entitled *Principes d'Hydraulique et Pyrodynamique*, relating chiefly to the subject of heat and elastic fluids.

[2] Pliny, *Quæst. Nat.*

History. in conduit pipes, and 31 on its velocity in open canals; and by discussing these on physical and mechanical principles, he succeeded in drawing up general formulæ, which afford a simple expression of the velocity of running water.

Researches of M. Eytelwein of Berlin, 1801. 28. M. Eytelwein of Berlin published, in 1801, a valuable compendium of Hydraulics, entitled *Handbuch der Mechanik und der Hydraulik*, which contains an account of many new and valuable experiments made by himself. His work is divided into 24 chapters, the most important of which are the 7th, which treats of the motion of water in rivers, and the 9th, which treats of the motion of water in pipes. He has shown that the *mean velocity* of water in a second in a river or canal flowing in an equable channel, is $\frac{11}{11}$ths of a mean proportional between the fall in two English miles, and the hydraulic mean depth; and that the *superficial velocity* of a river is nearly a mean proportional between the hydraulic mean depth and the fall in two English miles.

The following are some of the other important results which are given in his work:—The contraction of the fluid area is 0·64, the coefficient for additional pipes 0·65, the coefficient for a conical tube similar to the curve of contraction 0·98. For the whole velocity due to the height, the coefficient by its square must be multiplied by 8·0458. For an orifice, the coefficient must be multiplied by 7·8; for wide openings in bridges, sluices, &c., by 6·9; for short pipes, 6·6; and for openings in sluices without side walls, 5·1. Our author investigates the subject of the discharge of water by compound pipes, the motions of jets, and their impulses against plane and oblique surfaces, and he shows theoretically, that a water wheel will have its effect a maximum when its circumference moves with half the velocity of the stream.

Mallet and Vici, 1809. 29. A series of interesting hydraulic experiments was made at Rome in 1809, by MM. Mallet and Vici.[1] They found that a pipe, whose gauge was *five ounces* French measure (or 0·03059 French kilolitres), furnished *one-seventh* more water than *five* pipes of *one* ounce, an effect arising from the velocity being diminished by friction in the ratio of the perimeters of the orifices as compared with their areas.

Researches of M. Poisson, 1816. Notwithstanding the investigations of Newton, D'Alembert, and Lagrange, the problem of waves was still unsolved; and the Institute of France was induced to propose, as the subject of its annual prize for 1816, "The Theory of Waves on the Surface of a heavy Fluid of indefinite Depth." M. Poisson had previously studied this difficult subject, and he lodged his first memoir in the bureau of the Institute on the 2d October 1815, at the expiration of the period allowed for competition. M. Poisson supposes the waves to be produced in the following manner:—A body of the form of an elliptic paraboloid is immersed a little in the fluid, with its axis vertical and its vertex downwards. After being left in this position till the equilibrium of the fluid is restored, the body is suddenly withdrawn, and waves are formed round the place which it occupied. This first memoir contains the general formula for waves propagated with a uniformly accelerated motion; but in a second memoir, read in December, he gives the theory of waves propagated with a constant velocity. This last class of waves are much more sensible than the first, and are those which are seen to spread in circles round any disturbance made at the surface of water. In determining the superficial as well as the internal propagation of these waves, he considers only the case when the disturbance of the water is so small, that the second and the higher powers of the velocity of the oscillating particles may be neglected; and he assumes, that a fluid particle which is at any instant at the surface, continues there during the whole of the motion, a supposition which the condition of the continuity of the fluid renders necessary. He supposes the depth of the water constant throughout its whole extent, the bottom being considered as a fixed horizontal plane at a given distance beneath its natural surface. He then treats, *first*, the case in which the motion takes place in a canal of uniform width, over which obstruction is made of the horizontal dimension of the fluid; and, *secondly*, the case in which the fluid is considered in its true dimensions.

History.

Researches of M. Cauchy, 1816. 30. The prize offered by the Institute was gained by M. Augustin Louis Cauchy, then a young mathematician of the highest promise. In his memoir, which was published in the third volume of the *Mémoires des Sçavans*, he treats only of the first kind of waves above mentioned; and his investigation claims to be more complete than that in the first memoir of Poisson, in so far as it leaves entirely arbitrary the form of the function relative to the initial form of the fluid surface, and, therefore, allows the analysis to be applied when bodies of different forms are used to produce the initial disturbance. From his analysis, M. Cauchy concludes, "that the heights and velocities of the different waves produced by the immersion of a cylindrical or prismatic body, depend not only on the width and height of the part immersed, but also on the form of the surface which bounds this part." He is also of opinion, that the number of the waves produced may depend on the form of the immersed body, and the depth of immersion.

Results of theory respecting waves. 31. The following abstract of the principal results obtained by theory, respecting the nature of waves, has been given by Mr Challis:—

"With respect first to the canal of uniform width, the law of the velocity of propagation found by Lagrange, is confirmed by Poisson's theory when the depth is small, but not otherwise.

"When the canal is of unlimited depth, the following are the chief results:—

"1. An impulse given to any point of the surface, affects instantaneously the whole extent of the fluid mass.

"The theory determines the magnitude and direction of the initial velocity of each particle resulting from a given impulse.

"2. The summit of each wave moves with a uniformly accelerated motion.

"This must be understood to refer to a series of very small waves, called by M. Poisson *dents*, which perform their movements, as it were, on the surface of the larger waves, which he calls '*les ondes dentelées*.' Each wave of the series is found to have its proper velocity, independent of the primitive impulse.

"3. At considerable distances from the place of disturbance, there are waves of much more sensible magnitude than the preceding.

"Their summits are propagated with a uniform velocity, which varies as the square root of the breadth, *à fleur d'eau* of the fluid originally disturbed. Yet the different waves which are formed in succession, are propagated with different velocities; the foremost travels swiftest. The amplitudes of oscillations of equal duration, are reciprocally proportional to the square root of the distances from the point of disturbance.

"4. The vertical excursions of the particles situated directly below the primitive impulse, vary according to the inverse ratio of the depth below the surface. This law of decrease is not so rapid but that the motion will be very sensible at very considerable depths; it will not be the true law, as the theory proves, when the original disturbance extends over the whole surface of the water, for the decrease of motion in this case will be much more rapid.

"The results of the theory, when the three dimensions of the fluid are considered, are analogous to the preceding,

[1] See Mallet, *Notices Historiques*, Paris, 1830.

History. 1, 2, 3, 4, and may be stated in the same terms, excepting that the amplitudes of the oscillations are inversely *as the distances* from the origin of disturbance, and the vertical excursions of the particles situated directly below the disturbance vary inversely as the *square* of the depth."

32. M. Hachette, in the year 1816, presented to the National Institute a memoir containing the results of experiments which he had made on the spouting of fluids, and the discharge of vessels. The objects he had in view were to measure the contracted part of a fluid vein; to examine the phenomena attendant on additional tubes; and to investigate and describe the figure of the fluid vein, and the results which take place when different forms of orifices are employed. M. Hachette showed in the second part of his memoir, that greater or lesser volumes of water will be discharged in the same time through tubes of different figures, the apertures in all having the same dimensions. He also gave several curious results respecting other fluids issuing out of orifices into air or a *vacuum*.

Experiments of Weber and Bidone, 1825.

33. Several very interesting experiments on the propagation of waves, have been made by M. Weber and by M. Bidone. Although Weber's[1] experiments were not made in exact conformity with the condition which the theory required, yet they, generally speaking, harmonize with it; and they particularly establish the existence of the small accelerated waves near the place of disturbance, and of a perceptible motion of the particles of the fluid at considerable depths below the surface. When an elliptic paraboloid is used to produce the waves, with its axis vertical, and its vertex downwards, and when, of course, the section of the solid in the plane of the surface of the water is an ellipse, the velocity of propagation is, according to the theory, greater in the direction of the major axis than in that of the minor, in the ratio of the square root of the one to the square root of the other; but this result is not confirmed by Weber's experiments.

Investigations of M. Bidone, 1826-7.

In 1826 M. Bidone,[2] besides his experiments on waves, made a series on the velocity of running water at the hydraulic establishment of the University of Turin, and he published an account of them in 1829.[3] After giving a description of his apparatus and method of experimenting, he gives the figures obtained from fluid veins, sections of which were taken at different distances from the orifice, and the results, which are extremely curious, are illustrated by diagrams.

34. Towards the end of last, and the beginning of the present century, several hydraulic engines were invented, which have proved of great service to the arts. The *Bramah press* was patented by its inventor in 1796. Like all inventions of the first class, it has received little if any improvement since it left Bramah's hand. It derives its great power from the principle of fluids transmitting pressure in every direction. In the year 1775 Mr Whitehurst devised a machine for elevating water, the principle of its action being the momentum of the water itself. This machine was in 1798 much improved by Mr Boulton; it is now, however, replaced by the more scientific invention known as *Montgolfier's hydraulic ram*, which is recognised by some as an independent invention, but by others as an improvement on Whitehurst's. About the year 1817, *Hœll's machines* began to be revived and greatly improved by M. Reichenbach; in his hands they were transformed into the elegant yet powerful *water-column machines*, so extensively employed in the German and French mines.

35. M. Poisson's first memoir on the Theory of Capillary Attraction, was read before the National Institute, November 1828, in which his object was to form the equations of equilibrium of fluids on physical principles, that is, by supposing that a fluid mass is made up of distinct molecules, separated from each other by spaces excessively small, and void of ponderable matter. His second memoir, entitled *Nouvelle Theorie de l'Action Capillaire*, was published in May 1834. The principal object which Poisson had in view in this treatise was to bring the theory of capillary attraction to the greatest degree of perfection that the power of analysis and the knowledge of facts would admit. Laplace's theory of capillarity, however, is still used to explain the phenomena of the subject.

History.

Experiments of Poncelet and Lesbros, 1827–28.

36. A series of useful experiments was made in 1827 and 1828, under the sanction of the French government, by MM. Poncelet and Lesbros,[4] at the Military School of Metz. The apparatus which they used consisted of *four* basins. The *first* had an area of 25,000 sq. met.; the *second* one of 1500 sq. met., and a depth of 3·70 met., and was so contrived, by means of sluices, as to have a complete command of the level of the water during the experiment; the *third* basin, which communicated directly with the second basin, was 3·68 met. long and 3 wide, to receive the water discharged by the orifices; and the *fourth* basin was a gauge capable of containing 24,000 litres. In carrying on the experiments, the opening of the orifices, the height or charge of the fluid in the reservoir, as well as the level of the water in the gauge basin relative to each discharge of fluid, were measured to the tenth of a millimetre, so that the approximation was at least $\frac{1}{200}$th of the whole result.

These experiments were made on rectangular vertical orifices 20 centimetres wide, pierced in a thin plane wall, and completely isolated both from the sides and bottom of the vessel. The special object which Poncelet and Lesbros had in view was to determine the laws of escape of water from such orifices, limited towards the upper edge by a moveable flood-gate:—1. In the hypothesis of thin plates, where, on the water escaping freely into the air, the orifice is completely isolated from the side walls and bottom of the reservoir; 2. In the hypothesis where the orifice is more or less near the bottom and sides, and disposed perpendicularly or obliquely with respect to the plate containing it; 3. In the hypothesis of thick walls, where the water would be immediately received into a course or canal of short length, open at the upper edge; and, 4. To study the physical or mathematical laws of each phenomenon, and to inquire into the causes why the results of experiment differ from those of theory. The experimenters never lost sight of the application of these laws to practice.

In the year 1827 M. Poncelet published a *Mémoire sur les Roues Hydrauliques à Aubes Courbes*, containing his experiments on the undershot wheel with curved palettes, which he had invented in the year 1824. The best undershot previous to the introduction of the *Poncelet wheel*, never developed more than 0·25 of the work of the water, whereas this utilized 0·60 of that work, which is nearly equivalent to the maximum effect of the breast wheel. The principle on which the Poncelet wheel acts, and that which makes it utilize so much of the work of the water, is that the water on entering any curved palette, enters it without any shock, and continues in this state, till at last, when about to quit the palette, it does so without any sensible velocity. This under-shot wheel is much used in France.

Previous to the year 1827, the wheels required in the mills and manufactories of Germany and France were generally those which worked with the axis horizontal, or the tub and spoon wheels with the axis vertical; but in that year a young mechanician named Fourneyron introduced a wheel working with the axis vertical, yet wholly different from the

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[1] *Wellenlehre auf Experimente gegrundet*, Leipzig, 1825.

[2] *Turin Memoirs*, vol. xxv.

[3] *Expériences sur la forme et sur la direction des Veines et des Courans d'Eau, lancés par diverses ouvertures*, 1832.

[4] *Expériences Hydrauliques sur les Lois de l'Ecoulement de l'Eau*, etc., 1832.

History. latter kind. Instead of introducing this horizontal wheel within, as was at that time done, he placed it without the cylinder, opposite its lower part, and separated from it by a small space. In order to put the wheel in motion, water was introduced into the cylinder from above, and escaped by a circular opening at its lower part opposite the wheel. As the cylinder is always kept full of water, the palettes are conveniently struck, and all at once. From this simple arrangement, it results that this hydraulic engine, or *turbine*, as it has been called, is the best in use. Shortly after the invention was made public, M. Fourneyron was awarded the prize of 6000 francs, which was offered by the Society for the Encouragement of National Industry. These turbine wheels are mostly used on the Continent; they utilize between 75 and 85 per cent. of the work expended by the water.

Mr George Rennie, 1830. 37. In the year 1830, Mr George Rennie undertook a series of experiments on the friction of water against revolving cylinders and disks, on the direct resistances to globes and disks revolving in air and water alternately, on the coefficients of contraction, and on the expenditure of water through orifices, additional tubes, and pipes of different lengths.

Mr J. Scott Russel's experiments on the motion of vessels and on waves, and the consequences he deduces therefrom, are to be seen in his *Researches in Hydrodynamics*, 1837.

Mr Jardine. The late Mr Jardine made several experiments on the discharge of water from long pipes. The waste actually given by the supply pipe from Comiston to the reservoir on the Castle Hill, Edinburgh, was compared with the volume as given by the formulæ of Eytelwein, Gerard, Dubuat, and Prony, and he found that the two were nearly coincident.

Improvement in theory of fluids, by Prof. Airy, 1830. 38. An improvement on the common theory of fluids was lately suggested by Professor Airy, in his lectures at Cambridge. It had been usual to assume the law of equal pressure as a datum of observation. Professor Airy, however, has shown that this property may be deduced from another more simple, and equally given by observation; namely, that the division of a perfect fluid may be effected without the application of sensible force; and hence, it immediately follows, that the state of equilibrium or motion of a mass of fluid, is not altered by a mere separation of its parts by an indefinitely thin partition. Professor Miller has given a definition of fluids founded on this principle, and a proof of the law of equal pressure, at the beginning of his *Elements of Hydrostatics*, &c., published at Cambridge in 1831. Dr Thomas Young had employed an equivalent principle to that of Mr Airy in determining the manner of the reflection of waves of water;[1] and Mr Challis considers it as necessary in the solution of some hydrostatical and hydrodynamical problems.

Researches of Prof. Mosely, 1830. There are certain cases in the analytical theory of Hydrodynamics which require a more simple analysis than others; such, for example, as those of *steady* motion, or of motion which has arrived at a permanent state, so that the velocity is constant in quantity and direction at the same point. Equations applicable to this kind of motion seem to have been first given by Professor Mosely, in his *Elementary Treatise on Hydrostatics and Hydrodynamics*. The following is the principle from which he has derived them. *When the motion is steady, each particle, in passing from one point to another, passes successively through the states of motion of all the particles which at any instant lie in its path.* This general principle is applicable to all kinds of fluids, and is true, whether or not the effect of heat is taken into account, provided the condition of steadiness remains. As it enables us to consider the motion of a single particle in place of that of a number, it readily affords the equations of motion.

Researches of Mr Challis. 39. As it was desirable to know how the same equation might be obtained from the general equations of fluid motion, Mr Challis undertook this inquiry, and published the results of it in the *Transactions of the Cambridge Philosophical Society*.[2] In this paper, he has given a method of doing this both for incompressible and elastic fluids, and he has shown that a term in the general formulæ which occasions the complexity in most hydrodynamical questions, disappears in cases of steady motion. Mr Challis is of opinion that these equations may be employed in very interesting researches, and he mentions, as instances, the motion of the atmosphere as affected by the rotation of the earth, and a given distribution of temperature due to solar heat. History.

Experiments of M. Eytelwein and others. 40. The science of Hydrodynamics has of late years been cultivated by M. Eytelwein of Berlin, by Dr Matthew Young, who has explained the cause of the increased velocity of efflux through additional tubes, by Mr Vince, Dr T. Young, Coulomb, and Don George Juan.

The subject of *waves* has occupied the attention of Mr Green, Professor Kelland, Mr Earnshaw, and more especially Mr Airy, the astronomer-royal, who has given much valuable and original matter in his excellent treatise on *Tides and Waves*. Our knowledge of the flow of water through orifices and over weirs has been much extended by the experiments of MM. Daubisson and Castel, undertaken between the years 1830 and 1838. Mr Provis, in 1838, experimented on the *flow of water through small pipes*. About the year 1840, M. V. Regnault instituted a series of interesting experiments, by order of the minister of public works, and at the request of the central commission of steam engines, for the purpose of determining *the principal laws and numerical data which enter into the calculation of steam engines*. The nature of his investigations necessarily led him to determine the compressibility of water and mercury, and his results may be considered as very accurate. The experiments are detailed at great length in the *Mémoires de l'Institut* for 1847.

Professor Magnus of Berlin, in 1848, made several experiments *on the motion of fluids*; they were intended to refute the notion of Venturi, who, in his *Lateral Communication of Motion in Fluids*, asserts that if any very mobile body be caused to approach a jet of water, the body will be carried forward by the air, to which a motion has been imparted by the jet. He next shows that the action of a jet on a plane, the jet and plane being under the surface of water, increases with the distance from the orifice; and, lastly, he attempted to ascertain the manner in which the water of the jet mixes with that into which it is projected. Professor Challis has considered the *Principles of Hydrodynamics*, in the new series of the *Philosophical Magazine*, 1851. Mr T. E. Blackwell made in 1851 a very extensive and practically useful series of experiments on weirs. The last matter that we shall mention in this history of the subject, is the *centrifugal pump*, improved by Mr Appold. Bramah and Dietz long ago attempted to produce machines working by a continuous movement of rotation. Dietz' centrifugal pump has been a considerable time in use; it is far surpassed by *Appold's Centrifugal Pump*. Mr Appold received for his invention the council medal at the Great Exhibition of 1851. Mr Appold was the first who successfully applied curved vanes to the centrifugal pump. It appears, however, that so far back as 1839, curved vanes were adopted in pumps erected in the United States, but for some reason or other, they were replaced by plain straight fins, and therefore of less efficiency. Gwinne, Bessemer, and several others, have made improvements on the centrifugal pump.

We refer the reader to M. Ch. Combe's *Sur les Roues à Réaction ou à Tuyaux*, 1843; and to a historical review of the Centrifugal Pump in the *Practical Mechanic's Magazine* for 1851.

[1] *Nat. Phil.*, vol. ii., p. 64.

[2] Vol. iii., part iv.

PART I.—HYDROSTATICS.

Hydrostatics.

41. HYDROSTATICS is that branch of the science of hydrodynamics which comprehends the pressure and equilibrium of non-elastic fluids, as water, oil, mercury, &c.; the method of determining the specific gravities of substances, the equilibrium of floating bodies, and the phenomena of capillary attraction.

DEFINITIONS AND PRELIMINARY OBSERVATIONS.

42. A fluid is a collection of very minute particles, cohering so little among themselves, that they yield to the smallest force, and are easily moved among one another.

43. Fluids have been divided into *perfect* and *imperfect*. In perfect fluids the constituent particles are supposed to be endowed with no cohesive force, and to be moved among one another by a pressure infinitely small. But, in imperfect or viscous fluids, the mutual cohesion of their particles is very sensible, as in oil, varnish, melted glass, &c.; and this tenacity prevents them from yielding to the smallest pressure. Although water, mercury, alcohol, &c. have been classed among perfect fluids, yet it is evident that neither these nor any other liquid is possessed of perfect fluidity. When a glass vessel is filled with water above the brim, it assumes a convex surface; and when a quantity of it is thrown on the floor, it is dispersed into a variety of little globules, which can scarcely be separated from one another. Even mercury, the most perfect of all the fluids, is endowed with such a cohesive force among its particles, that if a glass tube, with a small bore, is immersed in a vessel full of this fluid, the mercury will be lower in the tube than the surface of the surrounding fluid;—if a small quantity of it be put in a glass vessel, with a gentle rising in the middle of its bottom, the mercury will desert the middle, and form itself into a ring, considerably rounded at the edges; or if several drops of mercury be placed upon a piece of flat glass, they will assume a spherical form; and if brought within certain limits, they will conglobulate and form a single drop. Now, all these phenomena concur to prove, that the particles of water have a mutual attraction for each other; that the particles of mercury have a greater attraction for one another, than for the particles of glass; and, consequently, that these substances are not entitled to the appellation of perfect fluids.

44. It was universally believed, till within the last seventy years, that water, mercury, and other fluids of a similar kind, could not be made to occupy a smaller space, by the application of any external force. This opinion was founded on an experiment made by Lord Bacon, who inclosed a quantity of water in a leaden globe, and by applying a great force attempted to compress the water into a less space than it occupied at first: The water, however, made its way through the pores of the metal, and stood on its surface like dew. The same experiment was afterwards repeated at Florence by the Academy del Cimento, who filled a silver globe with water, and hammered it with such force as to alter its form, and drive the water through the pores of the metal. Though these experiments were generally reckoned decisive proofs of incompressibility, yet Bacon himself seems to have drawn from his experiment a very different conclusion; for after giving an account of it, he immediately adds, that *he computed into how much less space the water was driven by this violent pressure.*[1] This passage from Lord Bacon does not seem to have been noticed by any writer on hydrostatics, and appears a complete proof that the compressibility of water was fairly deducible from the issue of his experiment. In consequence of the reliance which was universally placed on the result of the Florentine experiment, fluids have generally been divided into *compressible* and *incompressible*, or *elastic* and *non-elastic fluids*: water, oil, alcohol, and mercury, being regarded as incompressible and non-elastic; and air, steam, and other aëriform fluids, as compressible or elastic. Hydrostatics.

45. About the year 1761, the ingenious Mr Canton began to consider this subject with attention, and distrusting the result obtained by the Academy del Cimento, resolved to bring the question to a decisive issue.[2] Having procured a small glass tube, about two feet long, with a ball at one end, an inch and a quarter in diameter, he filled the ball and part of the tube with mercury, and brought it to the temperature of 50° of Fahrenheit. The mercury then stood six inches and a half above the ball; but after it had been raised to the top of the tube by heat, and the tube sealed hermetically, then, upon bringing the mercury to its former temperature of 50°, it stood $\frac{3}{100}$th of an inch higher in the tube than it did before. By repeating the same experiment with water exhausted of air, instead of mercury, the water stood $\frac{43}{100}$th of an inch higher in the tube than it did at first. Hence, it is evident, that when the weight of the atmosphere was removed, the water and mercury expanded, and that the water expanded $\frac{11}{100}$th of an inch more than the mercury. By placing the apparatus in the receiver of a condensing engine, and condensing the air in the receiver, he increased the pressure upon the water, and found that it descended in the tube. Having thus ascertained the fact, that water and mercury are compressible, he subjected other fluids to similar experiments, and obtained the results in the following table:

	Millionth Parts.	Specific Gravity.
Compression of Mercury,	3	13.595
Sea-Water,	40	1.028
Rain-Water,	46	1.000
Oil of Olives,	48	0.918
Spirit of Wine,	66	0.846

Lest it should be imagined that this small degree of compressibility arose from air imprisoned in the water, Mr Canton made the experiment on some water which had imbibed a considerable quantity of air, and found that its compressibility was not in the least augmented. By inspecting the preceding table, it will be seen that the compressibility of the different fluids is nearly in the inverse ratio of their specific gravities.

46. The experiments of Mr Canton have been since confirmed by Professor Zimmerman. He found that sea-water was compressed $\frac{1}{340}$th part of its bulk, when inclosed in the cavity of a strong iron cylinder, and under the influence of a force equal to a column of sea-water 1000 feet in height. From these facts, it is obvious that fluids are susceptible of contraction and dilatation, and that there is no foundation in nature for their being divided into compressible and incompressible. If fluids are compressible, they will also be elastic; for when the compressing force is removed, they will recover their former magnitude; and

[1] *Bacon's Works*, by Shaw, vol. ii. p. 521; *Novum Organum*, part. ii. sect. 2. alph. 45. § 222.

[2] See the *Philosophical Transactions* for 1762 and 1764, vols. lii. and liv.

Pressure, &c., of Fluids.

hence their division into elastic and non-elastic is equally improper.

A series of very valuable experiments on the compressibility of water has since that time been made by Professor Oersted of Copenhagen. At the temperature at which water has a maximum density, which, according to Professor Stampfer of Vienna, is at 38° 75′ Fahrenheit, Professor Oersted found the *true* compressibility of water by one atmosphere (or 336 French lines of mercury) to be 46·1 millionths of the volume; the difference between the true and the apparent compressibility arising from the effect of the heat developed by the compression, by which the liquid and the bottle are dilated. He found also that the differences of volume in the compressed water are proportional to the compressing power; and that this law holds as far as the pressure of 65 atmospheres, and probably much farther; but how far he was not able to determine, as his apparatus could not resist a greater pressure. He repeated Canton's experiments with great care, and verified his results. Oersted confirms Canton's result that water is less compressible during summer than during winter. (See *Report* of Third Meeting of British Association.)

Mr Perkins proved the compressibility of water by subjecting that fluid to mechanical pressure: for a description of his apparatus, see *Philosophical Transactions* for 1820.

Colladon and Sturm have made experiments on the compressibility of different liquids, and under a pressure of one atmosphere they assign the following:—Water, 0·0000496; alcohol, 0·0000916; mercury, 0·00000338, each of its own volume.

These results are somewhat different from those of Oersted, but this may be owing to the compression of the tubes or vessels.

Pressure, &c., of Fluids.

M. Regnault[1] made (in 1847) very accurate experiments on the compressibility of fluids with an apparatus a little different from that which Oersted used; he found the following results:—The volume of a mass of water subjected to pressure diminishes by 0·000048 of its volume for every atmosphere; *i.e.*, if a mass of water having a volume of a million *litres*, when its surface is subjected to no compressing force, comes to be subjected to a pressure of 1, 2, 3, 4, &c., atmospheres, its volume will diminish by 48 litres, twice 48 litres, thrice 48 litres, four times 48 litres, &c., respectively. When mercury is the fluid pressed, then it diminishes by 0·0000035 of its volume for every atmosphere incumbent on its surface.

47. The doctrines of hydrostatics have been deduced by different philosophers from different properties of fluids. Euler has founded his analysis on the following property, "that when fluids are subjected to any pressure, that pressure is so diffused throughout the mass, that when it remains in equilibrio all its parts are equally pressed in every direction."[2] D'Alembert at first[3] deduced the principles of hydrostatics from the property which fluids have of rising to the same altitude in any number of communicating vessels; but he afterwards[4] adopted the same property as Euler, from the foundation which it furnishes for an algebraical calculus. The same property has been employed by Bossuet, Prony, and other writers, and will form the first proposition of the following chapter.

CHAPTER I.—ON THE PRESSURE AND EQUILIBRIUM OF FLUIDS.

48. Prop. I.—When a pressure acts on the surface of a perfect fluid which is without weight, and at rest, it is equally pressed in every direction.

As it is the distinguishing property of fluids that their particles yield to the smallest pressure, and are easily moved among themselves (26), it necessarily follows, that if any particle is more pressed towards one side than towards another, it will move to that side where the pressure is least; and the equilibrium of the fluid mass will be instantly destroyed. But by the hypothesis the fluid is in equilibrio, consequently the particle cannot move towards one side, and must therefore be equally pressed in every direction.

In order to illustrate this general law, let EF (fig. 1) be a vessel full of any liquid, and let *mn*, *op* be two orifices at equal depths below its surface; then, in order to prevent the water from escaping, it will be necessary to apply two pistons, A and B, to the orifices *mn*, *op* with the same force, whether the orifice be horizontal or vertical, or in any degree inclined to the horizon; so that the pressure to which the fluid mass is subject, which in this case is its own gravity, must be distributed in every direction. But if the fluid has no weight, then the pressure exerted against the fluid at the orifice *op*, by means of the piston B, will propagate itself through every part of the circular vessel EF, so that if the orifices *mn*, *tu* are shut, and *rs* open, the fluid would rush through this aperture, in the same manner as it would rush through *mn* or *tu*, were all the other orifices shut. This proposition, however, is true only in the case of perfect fluids; for when there is a sensible cohesion between the particles, as in water, an equilibrium may exist even when a particle is less pressed in one direction than in another; but this inequality of pressure is so exceedingly trifling, that the proposition may be considered as true, even in cases of imperfect fluidity.

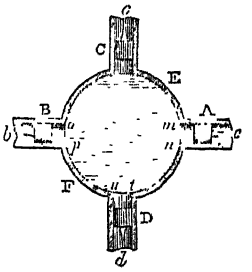


Fig. 1.

49. Prop. II.—If to the equal orifices *mn*, *tu*, *op*, *rs*, of a vessel, containing a fluid destitute of weight, be applied equal powers A, B, C, D, in a perpendicular direction, or if the orifices *mn*, &c., be unequal, and the powers A, B, &c., which are respectively applied to them be proportional to the orifices, these powers will be in equilibrio. Fig. 1.

It is evident from the last proposition, that the pressure exerted by the power B is transmitted equally to the orifices *mn*, *rs*, *tu*, that the pressure of the power C is transmitted equally to the orifices *mn*, *op*, *tu*, and so on with all other powers. Every orifice, then, is influenced with the same pressure, and, consequently, none of the powers A, B, C, D can yield to the action of the rest. The fluid mass, therefore, will neither change its form nor its situation, and the powers A, B, C, D will be in equilibrio. If the powers A, B, C, D are not equal to one another, nor the orifices *mn*, *op*, *rs*, *tu*; but if A : B = *mn* : *op*, and so on with the rest, the fluid will still be in equilibrio. Let A be greater than B, then *mn* will be greater than *op*; and whatever number of times B is contained in A, so many times will *op* be contained in *mn*. If A = 2 B, then *mn* = 2 *op*, and since the orifice *mn* is double of *op*, the pressure upon it must also be double; and, in order to resist that pressure, the power A must also be double of B; but, by hypothesis, A = 2 B, consequently the pressures upon the orifices, or the powers A, B, will be in equilibrio. If the power A is any other multiple of B, it may be shown in the same way that the fluid will be in equilibrio.

The application of the principle contained in this propo-

[1] *Mem. de l'Inst.* 1854. [2] *Nov. Comment. Petropol.*, tom. xiii., p. 305. [3] *Mélanges de Littérature, d'Histoire, et Philosophie.* [4] *Traité des Fluides*, § 20.

sition in the case of the Bramah press, constitutes that machine one of the most perfect instruments with which we are acquainted; for the power exerted by one man may be employed to balance several thousand tons.

50. PROP. III.—The surface of a fluid of small extent at rest, and subject to gravity, is horizontal.

The truth of the proposition is a necessary consequence of gravity acting on the fluid particles. For the attraction of gravity being supposed to be lodged in the centre of the earth, and a surface of small extent being incomparable with respect to the distance of the attracting centre, we may suppose, without sensible error, that the particles on this surface of small extent are all pulled with the same intensity, and, therefore, they must all be in the same plane, which will be horizontal. For if the plane be not horizontal, let fig. 2 be a section of the mass, with its surface BSA; take A and B, particles of its surface, and BC, AD, vertical columns of liquid molecules, C and D being in the same horizontal line. Now, neglecting the atmospheric column, the pressures at A and B are nothing, but at D and C they are equivalent to the weight of two liquid cylinders AD and BC, having equal bases. Hence, since there is a difference of weights in the columns, A and B cannot be on the same level, and, therefore, the surface BSA of the fluid cannot be in equilibrium. Again, a particle as S would seek its lowest level, and so all others similarly situated, until the whole surface particles over a small extent would be in the same plane; and the pressure at all points of the surface of a fluid being the same, the fluid is in equilibrium, and therefore a fluid surface of small extent will be horizontal. The principle of the proposition is applied in the art of levelling.

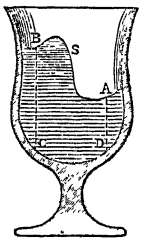


Fig. 2.

51. As the direction of gravity is in lines which meet near the centre of the earth; and as it appears from this proposition, that the surface of fluids is perpendicular to that direction, their surface will be a portion of a spheroid similar to the earth. When the surface has no great extent, it may be safely considered as a plane; but when it is pretty large, the curvature of the earth must be taken into account.

52. PROP. IV.—Fluids rise to the same level throughout a system of communicating vessels.

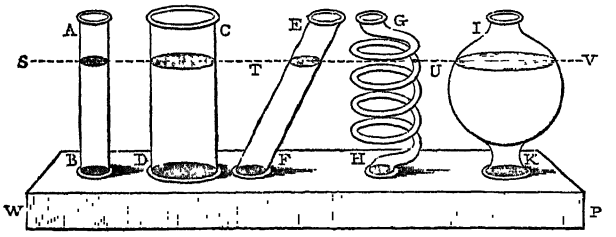


Fig. 3.

Suppose that there were alongside of each other several vessels, A, C, E, G, I (fig. 3), of different forms and capacities, cylindrical, spiral, conical, or spherical, containing fluid, and communicating with one another by means of a common vessel P. Now, if water be poured into this vessel, it follows from Prop. III. (50), that the fluid will stand at a common level in each of the vessels A, C, E, G, I; and if a line be drawn parallel to one surface, it will be parallel to all the surfaces, and it will also be parallel to the horizontal plane. Therefore, also, if we remove the different shaped vessels from the common reservoir, and introduce into the vessel ABEF solid bodies, T, GFH, UK, &c., then, after each immersion, the surface will still be horizontal; and when all the solids have been immersed, we shall have, as it were, a system of communicating vessels in which the surface of the fluid will necessarily be horizontal.

53. When the communicating vessels are so small, that they may be regarded as capillary tubes, the surface of the fluid will not be horizontal, as will afterwards be shown. (See *Capillary Attraction*, art. 114.)

54. This proposition explains the reason why the surface of small pools in the vicinity of rivers is always on a level with the surface of the rivers themselves, when there is any subterraneous communication between the river and the pool. The river and the pool may be considered as communicating vessels.

55. The practical application of the preceding proposition is finely shown in the methods employed for supplying towns with water. The ancients built aqueducts for this purpose, perhaps not so much from ignorance of the principle that water always seeks its own level, as from the difficulty of making their pipes water-tight at the joints. In modern times, pipes carefully jointed and secured are almost invariably used. The New River Water-works, however, which supply part of London with water, embrace both aqueducts and pipes.

56. PROP. V.—The pressure at any point below the surface of a fluid subject to gravity and at rest, varies as its depth.

Let point B (fig. 4) be immediately under the surface at a depth AB. The series of particles in the column AB is at rest, and may be supposed separated from the rest of the fluid mass, and lodged in a tube, not capillary, or the whole may be supposed rigid or solid like ice. Now, every particle of the column has weight, and so the upper will press upon those lower, and these again on the lowest particles; hence, the pressure on the point B will be equal to the aggregate weight of all the liquid particles; and hence, also, the pressure will vary as the depth of the point below the surface.



Fig. 4.

Similarly, also, let the point subject to pressure be C (fig. 5), not directly under the surface. Take ED a vertical from the surface, and draw DC horizontal; then we may consider the series of particles DC as a solid mass. Now, as the pressure is the same at all points along the line DC, and as the pressure at D is equivalent to a weight of fluid particles DE, so also is the pressure at C of the same value. Therefore, DE being equal to FC, the pressure at C varies as its depth below the surface of the fluid.

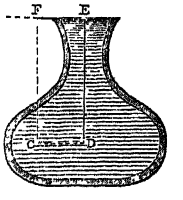


Fig. 5.

57. PROP. V.—To find the pressure on a line sunk in a fluid subject to gravity.

Let the line be parallel to the surface of the fluid, and the portion of it the pressure on which is required be the unit of length. Let MN (fig. 4) be this portion of the given line at the depth AM. There may be now supposed to be a solidified mass of particles, with base MN and height AM, resting on MN, each particle of which has weight, and wholly separate from the rest of the mass. If, then, a unit of bulk weigh $g\rho$, where g expresses the action of gravity on one particle, and ρ the density of the fluid; and

Pressure, &c., of Fluids.

if z be the depth of the line, or the number of units in the depth over the unit of length, the weight of the whole column will be expressed by $g\rho z$. But this weight is the same as the pressure to which the unit of length is exposed; let this be p, therefore $p = g \cdot \rho \cdot z$.

The same will be the result, if the portion MN were lying oblique to the horizontal surface, the mean depth being z.

58. Cor.—Hence, if we have A units of length, or a portion of a line of which the length is A, then if its depth be z, the pressure will be $p \cdot A = g\rho z \cdot A = P$.

The quantity ρ is the same for the same fluid, but different for different fluids. Further, in problems of a practical nature, the pressure of the atmosphere on any line or area, equal to that sunk in the fluid, must be added on to the weight of the fluid, so as to obtain the true pressure.

59. Prop. VI.—If a surface be sunk in a fluid subject to gravity, find the pressure upon it, or on the surface of the vessel containing fluid.

Let the given area be A, and suppose it broken up into an infinity of small areas, a, a_1, a_2, a_3, &c.... a_n, the mean depths of which under the surface let be, z, z_1, z_2, z_3, &c.... z_n, then the different pressures on these partial areas will be (Prop. V.) respectively, $g\rho za$, $g\rho z_1 a_1$, $g\rho z_2 a_2$, $g\rho z_3 a_3$, &c. .... $g\rho z_n a_n$; therefore, the total pressure on the surface = $g\rho za + g\rho z_1 a_1 + g\rho z_2 a_2 + g\rho z_3 a_3 + \ldots + g\rho z_n a_n$. But if Z be the depth of the centre of gravity below the surface, and S the area of the plane, then, by a property of the centre of gravity (see Mechanics), we have $g\rho SZ = g\rho za + g\rho z_1 a_1 + g\rho z_2 a_2 + g\rho z_3 a_3 + \ldots + g\rho z_n a_n$. But $g\rho SZ$ is evidently the weight of a column of fluid, of which the height is Z and base is S.

Wherefore, the pressure of a fluid on any surface is the weight of a column of the fluid, the base of which is the area of the surface pressed, and the height, the depth of the centre of gravity of the area below the surface of the fluid.

60. Cor. 1.—From this proposition it follows, that the whole pressure on the sides of a vessel which are perpendicular to its base, is equal to the weight of a rectangular prism of the fluid, whose altitude is that of the fluid, and whose base is a parallelogram, one side of which is equal to the altitude of the fluid, and the other to half the perimeter of the vessel.

Cor. 2.—The pressure on the surface of a hemispherical vessel full of fluid, is equal to the product of its surface multiplied by its radius.

Cor. 3.—In a cubical vessel the pressure against one side is equal to half the pressure against the bottom; and the pressure against the sides and bottom together, is to that against the bottom alone, as three to one. Hence, as the pressure against the bottom is equal to the weight of the fluid in the vessel, the pressure against both the sides and bottom will be equal to three times that weight.

Cor. 4.—The pressure sustained by different parts of the side of a vessel are as the squares of their depths below the surface; and if these depths are made the abscissæ of a parabola, its ordinates will indicate the corresponding pressures.

61. Prop. VII.—To find the pressure on the bottom of a vessel of any form containing fluid.

If the walls of the vessel be vertical as α (fig. 6), and its base parallel to the surface, it is clear that the pressure on the bottom will be equal to the whole weight of fluid contained in α. But if the containing vessels be as β and γ of fig. 6, then the pressure on the base AB in the former case is greater than the weight of the fluid, while the latter is less than that weight. For the pressure on AB of β, is the weight of a column ABDC, which is heavier than the contained fluid, and the pressure on AB of γ is a column ABDC, which is lighter than the contained fluid.

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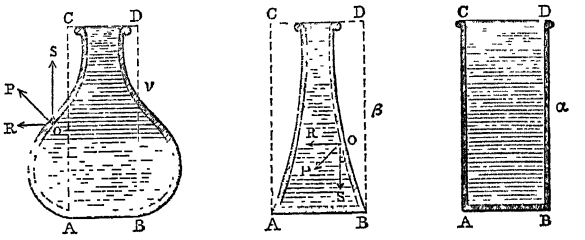


Fig. 6.

If the vessel be as β, then a pressure, P, arising from the resistance of the side at a point o, will act perpendicularly inward, with a force proportioned to the depth of o; and the same will be the case for the several pressures at the different points of the inclining sides; but these pressures, as P, may each be resolved into vertical, as S, and horizontal, as R, components, of which all the horizontal ones for every section balance, whereas the vertical components acting downwards and parallel will have a single resultant, which will be an amount of additional fluid, as it were, pressing on the base. On the other hand, in γ, of fig. 6, the pressures, as P in points, as o, of the sides acting perpendicularly outwards, may be resolved into vertical and horizontal components: the latter destroy each other at every section; the former, acting upwards or downwards, according to the position of o, have a single resultant, acting in opposition to the general weight of the fluid, which is the same as if a quantity of fluid were removed from the vessel. Hence, if the bases be all equal, and the fluid at the same height in each vessel, whatever be their forms, the pressure on base will be equal to the weight of a column of fluid, having for its base that of the vessel, and for its height the depth of the base below the surface of the fluid.

62. In order to illustrate the preceding propositions, let there be four vessels, A, B, C, D (fig. 7), having bottoms all

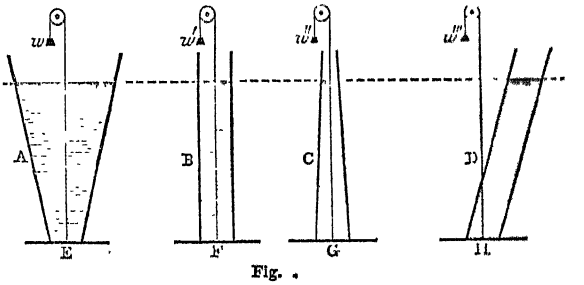


Fig. 7.

of the same area, and closed by plates E, F, G, H, of the same weight. Let the plates also be kept in their places by means of strings passing over pullies, and acted on by the equal weights W, W', W'', W'''. These weights will measure the pressure of water on the plates, *i.e.*, on the bases of the vessels. For if water be poured into each vessel till there be just enough to balance the weight, or when the plates are about to descend, it will be found that the water will be at the same height in each vessel. The same will be the case, whatever be the shape of the vessels, even although one may be a thousand times more capacious than another.

63. *Definition.*—The *centre of pressure* is that point of a surface exposed to the pressure of a fluid, to which, if the total pressure were applied, the effect upon the plane would be the same as when the pressure was distributed over the whole surface: Or, it is that point to which, if a force equal to the total pressure were applied in a contrary direction, the one would exactly balance the other or, in other words,

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the force applied and the total pressure would be in equilibrio.

To find the centre of pressure.

64. PROP. VIII.—To find the centre of pressure of any plane surface immersed in a fluid to any depth.

Let ABC (fig. 8) be a plane surface sunk in a fluid, and inclined at an angle, θ, to the surface of the fluid which it meets, when produced, in HI. Let l = AG be the distance of point A from the water-line, or HI, measured along GAx drawn at right angles to HI in the plane of ABC; let A be the origin of rectangular co-ordinates to which ABC is referred, GAx the axis of x, and Ay, parallel to HI, that of y. EF is an elemental area of the surface ABC. Take Y and X as the rectangular co-ordinates of the centre of pressure.

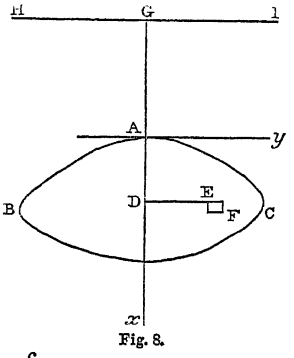


Fig. 8.

Now the pressure at every point equals the height of a column of particles, and this being so, we may take all the pressures on ABC as parallel forces. Hence, from STATICS, we have,

X. pressure on ABC = moment of pressure on ABC (1), and,
Y. pressure on ABC = moment of pressure on ABC (2).

If we suppose area ABC to be broken up into a series of very small surfaces as EF, of which dx and dy are the dimensions, it is evident that the pressure on the whole surface ABC will be the sum of the pressures on these small elements. But the pressure on the area EF $= p \,.\, dx \,.\, dy =$ $g\rho \times$ the perpendicular from EF to HI $. dx \,.\, dy = g\rho\,(x+l)$ $. \sin\theta \, dx \,.\, dy$; where x is the abscis of the infinitely small area EF:

$$\therefore \text{The whole pressure on ABC} = \iint p \,.\, dx \,.\, dy$$
$$= g\rho \,.\, \sin\theta \iint (x+l)\, dx \,.\, dy.$$

If we multiply this last by x, it will give us the moment about Ay, and if by y, it will give us the moment about Ax. Wherefore, moment of pressure on ABC about Ay

$$= g\rho \sin\theta \iint (x+l)\, x \,.\, dx \,.\, dy\,;$$

and, moment of pressure on ABC about Ax

$$= g\rho \sin\theta \iint (x+l)\, y, \, dx \,.\, dy.$$

Substitute now in (1) and (2) the values thus found,

$$\therefore X \,.\, g\rho \sin\theta \iint (x+l)\, dx\, dy = g\rho \sin\theta \iint (x+l)\, x\, dx\, dy;$$

$$Y.\ g\rho \sin\theta \iint (x+l)\, dx\, dy = g\rho \sin\theta \iint (x+l)\, y\, dx\, dy;$$

$$\text{or, } X \iint (x+l)\, dx\, dy = \iint (x+l)\, x\, dx\, dy \ (3);$$

$$Y \iint (x+l)\, dx\, dy = \iint (x+l)\, y\, dx\, dy \ (4).$$

Since equations (3) and (4) will give a value for X and Y respectively, the centre of pressure is known. If the surface be curved, and its curvature known, then, on integrating, we have,

$$X \int (x+l)\, y\, dx = \int (x+l)\, x\, y\, dx$$

$$Y \int (x+l)\, y\, dx = \int \frac{(x+l)\, y^2\, dx}{2}, \text{ which are}$$

very important formulæ.

If any point of the surface ABC coincide with the surface, then $l = 0$, Pressure, &c., of Fluids.

$$\therefore X \int x\, y\, dx = \int x^2 y\, dx, \text{ and } Y \int x\, y\, dx = \int \frac{x\, y^2\, dx}{2}.$$

If the surface be sunk to a great depth, or l = infinity = ∞, then will the centre of gravity coincide with the centre of pressure; for, from (3) and (4), since the infinite parts must be equal,

$$Xl \iint dx\, dy = l \iint x\, dx\, dy; \text{ or, } X \int y\, dx = \int x\, y\, dx;$$

$$Yl \iint dx\, dy = l \iint y\, dx\, dy; \text{ or, } Y \int y\, dx = \int \frac{y^2\, dx}{2}.$$

But the values of X and Y, determined from these last equations, are the co-ordinates of the centre of gravity of a plane area bounded by a plane curve. Hence, under such a condition, the centre of pressure is the same as the centre of gravity.

65. COR. 1.—A physical plane, one side of which is exposed to the pressure of a fluid, may be kept at rest by a single force, equal and opposite to the pressure of the fluid applied at its centre of pressure. Corollaries.

COR. 2.—Where a plane lamina of a very small uniform thickness is moveable round its Y axis, the values of X and Y will be those of the co-ordinates of its centre of percussion.

COR. 3.—The centre of pressure of a triangle, the base of which coincides with the level of the water, is at a distance of one-third the height of the triangle from its base. If the summit coincide with the surface, then the centre of pressure will be at two-thirds the height, measuring from the summit.

66. The application of the preceding proposition is of the utmost consequence in the case of flood-gates, sea-walls, dykes, brewers' vats, and the like.

SECTION II.—INSTRUMENTS FOR ILLUSTRATING THE PRESSURE OF FLUIDS.

Machine for illustrating the hydrostatic paradox.

67. We have already seen from arts. 59, 61, 62, that the pressure on the bottom of a vessel of any form, does not depend on the quantity of fluid contained therein, but on the area of the base and the depth of the fluid. The *hydrostatic bellows* is an excellent instrument for showing this principle. A and B (fig. 9) are two strong boards, united together by means of leather, so as to form a sort of bellows, but perfectly water-tight, C is a vertical tube communicating with the interior of the bellows. If water, or any other fluid, be poured down the tube C by the funnel F, it will enter the bellows AB, and raise the upper board A, even though loaded with a heavy weight W. The upper board A will continue to be forced up till either the bellows be full or the tube be filled throughout its whole length. Suppose that an equilibrium subsists between the water in the tube and bellows, and let DE be the height of the column of water in the tube above the surface of water in the bellows. Then the weight of this column DE will be that which supports the whole weight raised; for the fluid DC in the tube is in equilibrium with that in the bellows, and hence the pressure at the surface of the fluid in the bellows is in equilibrium with the column DE

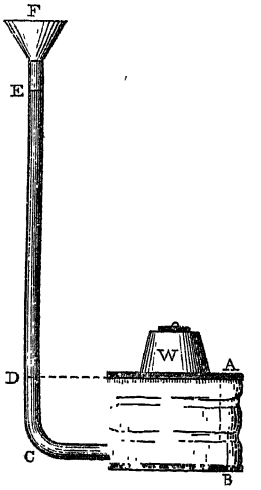


Fig. 9.

Pressure, &c., of Fluids.

68. Suppose that the whole weight raised is W, which includes the load, the weight of the upper board and of the leather, let S be the area of the upper board A, s the sectional area of the tube; let also p be the unit of pressure on a unit of surface transmitted from the surface at D by the column DE; then, since fluids press equally in every direction, the upward pressure on the board A will $= p.S$, which balances the downward pressure of the weight W. Hence $p.S = W$. Now, the whole pressure at $D = p.s$; wherefore we have $W = p.S$, and pressure at $D = p.s$.

$\therefore$ W : pressure at $D = p.S : p.s = S : s$.

$\therefore$ W = weight raised $= \frac{S}{s}$. pressure at D,

$= \frac{S}{s}$. weight of a column DE.

Hence the weight which can be raised will be increased if we increase the area of the upper board, or if we diminish the sectional area of the tube, or if we increase the pressure of the column, *i.e.*, if we lengthen the tube.

69. In a theoretical point of view the ratio $\frac{S}{s}$ may become infinitely large; hence any quantity of fluid, however small, may be so employed as to sustain any weight however large.

The same instrument may be employed for the same purpose when air or any gas is blown or forced in at the funnel F, and condensed in the bellows. In which case a very heavy weight may be raised by means of a small vertical tube. Hence, a person standing on the hydrostatic bellows might raise himself by blowing into the tube.

Hence, also, a small vertical pipe like that in fig. 9, fitted into a barrel full of water or other fluid, may, when filled with water or other fluid, be a means of bursting the barrel.

Similarly, also, it is highly probable, that the sudden formation of inland lakes is due to this pressure of water. For, suppose that a considerable extent of water-tight stratum forms the roof of a subterranean lake, and that this water, and therefore the roof, is subject to the pressure of a column several hundred feet high; it is clear that, as soon as the upward pressure of the column exceeds the strength of the material forming the roof, the latter will break up and a lake will be formed.

The siphon.

70. The siphon is a bent tube, ABCDE (fig. 10), having two legs, one shorter than the other, wherewith when the shorter end is plunged into a vessel containing fluid, it may be emptied into another without there being any communication between the vessels. Before a transference of the liquid takes place the tube is previously filled with fluid, and its ends stopped by the fingers, then inverted, and the shorter end placed into the vessel which is to be emptied; the other end being left free, the water escapes by it, and will continue to escape until the level of the water in the vessel be in the same plane as the mouth of the short leg.

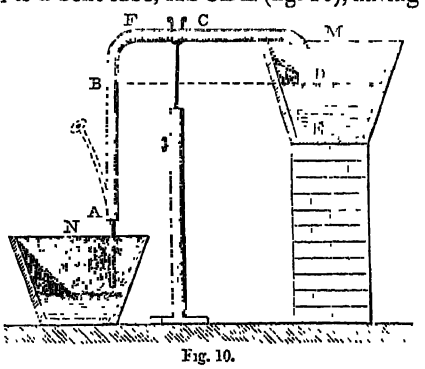


Fig. 10.

71. In order to explain the flow of water through the tube, let us suppose that the end A, after the siphon has been filled, is made water-tight by means of a moveable piston, and that the surface of M is open to the atmosphere. The inner and outer surfaces of the piston will be exposed to pressure, so also will the surface of fluid in M; the latter, as also the fluid in the short leg, will be subject to the atmospheric pressure, but the former will have the pressure on the outer face constant, while that on the inner face will depend on its position in the long leg. As the piston rises from A in the siphon leg, the pressure on the inner face of the piston gradually diminishes. If the piston be at F, or in the horizontal part C, its outer face will be subject to the atmospheric pressure, but its inner face to that pressure exercised on the fluid surface of M, less the weight of a column of fluid, the height of which is the vertical distance of the inner face of the piston above the surface of the fluid in M. Let the piston be gradually drawn downwards, and the pressure on the inner face increases, since, on arriving at B, which is on the same level as the fluid surface in M, it equals that of the atmosphere. Hence, if the siphon were of the form BFCD, and B and D in the same horizontal line, no water would flow out at B, simply because the pressure at B is the same as that at D. Let, now, the piston be lower than B, then is its inner face pressed not only by the atmosphere on the fluid surface of M, but also by the weight of a fluid column of a height equal to the distance between it and B. The water will then flow out by this leg. The lower, therefore, the piston is, the greater will be the excess of the pressure on the inner over that on the outer face; and when it comes to the mouth of the tube at A this excess will be a maximum; hence, as soon as the piston has been withdrawn, a flow of water will take place by the mouth A, with a velocity equal to that with which a body, falling freely from B, would have on reaching A. The velocity of escape, however, will not be accurately the above, owing to the bending of the tube, and also to the friction of the water in passing along the siphon.

Pressure, &c., of Fluids.

72. The pressure of the atmosphere is then a very important matter in the action of the siphon, since without this element the fluid would not rise in the shorter leg. If a *prepared* siphon, *i.e.*, filled with fluid, and its ends temporarily stopped, were set to act under the exhausted receiver, the fluid would divide itself into two portions; that in the long leg would fall out on one side, while that in the short leg would fall back into the fluid in the vessel. Again, if the siphon should have, between the surface of the fluid to be emptied and its bend, a distance of more than 32 feet, then it will not work; if nearly 32 feet, its action will be very sluggish.

73. The filling of the siphon with fluid so as to prepare it for working, is not the best method; generally a small tube rises vertically from near A, as shown by the dotted lines (fig. 10). The air is drawn out of the siphon by means of this small tube, and as the air is more and more rarified, the water rises to the top of the short leg, then, flowing along the horizontal portion, if any, enters the long leg and passes out. It is in this way that tuns of wine and other spirits are emptied, without requiring to pierce a hole in the lower end, the bung hole being open; it will suffice if a white-iron siphon be introduced into the bung hole, and the space around the plunged leg be free that the pressure of the atmosphere may be allowed to act.

74. The application of the principle of the siphon in nature is finely shown in the action of *reciprocating*, or *intermitting* springs, that is, of those which flow and cease at regular or irregular periods. A large subterraneous cavern, or porous bed, may be regarded as a reservoir collecting water by narrow pipes or channels; and the only outlet to this collected water will be by natural or artificial pipes rising to the surface, forming, in every respect, a natural siphon. The reservoir will evidently be drained by the latter pipes, whenever a sufficient *head* or pressure is upon the collected water. Hence, also, ARTESIAN WELLS are but natural siphons.

Flotation.

CHAPTER II.—ON FLOTATION AND SPECIFIC GRAVITIES.

SECTION I.—FLOTATION.

75. The consideration of floating bodies enables us to determine the conditions of rest or motion when placed in a fluid; if at rest, whether their position will be stable or unstable, and if in motion, the circumstances under which they rise or sink in the fluid.

76. PROP. I.—A body at rest and immersed in a fluid, is forced upwards by a pressure equal to the weight of the fluid displaced.

Proposition of Archimedes.

Let us suppose first of all, that we have in the vessel of fluid (fig. 11) a cubical mass M. When the surface *ef* is horizontal, the fluid is at rest, and so also is M. The vertical faces of M are pressed equally, and the forces are balanced among themselves; but the lower and upper face sustain different pressures; the excess lies on the former, and is equal to the weight of a cubical mass, M, of fluid. Now, since M, which we may suppose to be a mass of the fluid solidified, is at rest, its weight will act downwards, and the supporting fluid will exert, as it were, a pressure forcing it upwards; and as M is in equilibrium, the downward and upward pressures will be equal to each other. Suppose now that we remove the fluid mass M, and introduce a body of a different material, such that the equilibrium shall still be unchanged, it is evident that we shall have the same upward force of the supporting fluid, and downward force of the body, balancing each other. If the weight of the body immersed be equal to that of the fluid displaced, as will then be the case, the body will be at rest; if the former weight should exceed the latter the body will sink, if the latter the former, the body will float on the surface.

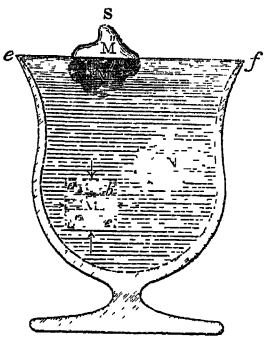


Fig. 11.

77. Again, the body immersed and at rest in the fluid may be supposed to be of any form as N (fig. 11); then it will be supported in the same way as a similarly conditioned mass of the fluid would be, that is, the upward and downward pressure of the supporting fluid and body respectively will be the same. Hence the truth of the proposition.

This proposition is known as the principle of Archimedes, having been first discovered by him.

78. *Definition.*—When a body floats in a fluid, the plane passing through the body, and coinciding with the surface plane of the fluid, is called the *plane of flotation.*

79. PROP. II.—When a body floats in a fluid, the weight of the volume which it displaces is equal to the weight of the body, and the downward force of the body, as also the upward force of the fluid, is equal to the weight of fluid displaced.

Let S be a body floating in the vessel (fig. 11), a mass M″ being above, and M′ being below the plane of flotation, so that the whole mass, say $M = M' + M''$. Now, evidently, when S floats, it is buoyed up by some under pressure, and before immersion took place, a volume of fluid was sustained in the same manner; as we have then an upward pressure supporting at one time a volume M′ of fluid, and again a body, a mass of which M′ is immersed, it follows that the weight of the floating body and that of the volume of fluid displaced are equal to each other.

Again, if we take any point of the surface of the mass below the plane of flotation, then the pressure at this point of the body will be the weight of a fluid column of a height equal to the depth of that point below the surface; and the same holds true for all the other pressures on the other points of the mass immersed, *i.e.*, the weights of the several fluid columns. But the weight of all the fluid columns equals that of the fluid displaced, hence the downward pressure of the body and the upward pressure of the sustaining fluid each equals the weight of the fluid displaced.

Call V the volume of the floating body, ρ its density, then its weight is $(M' + M'')\, g = V\rho g$. Call V′ the volume of M′, and ρ' the density of the fluid, then weight of displaced fluid $= V'\rho' g$; $\therefore V\rho g = V'\rho' g$, or $V\rho = V'\rho'$. If $\rho = \rho'$ then $V = V'$, and the body will be wholly under the fluid.

80. COR.—From this proposition, we learn that a floating body is buoyed up by a force equal to the weight of the fluid displaced. This follows from the principle of Archimedes, and means that a body either floating or wholly immersed, loses as much of its weight as equals that of the fluid displaced. Hence a bucket full of water placed in its own medium is lighter than when surrounded by air. Corollary.

The application of the preceding proposition is finely shown in Green's *Canal Lifts*, whereby laden barges may be transferred vertically from one level to another of a canal; for an account of which we refer to the *Trans. Inst. Civ. Engin.* 4to, vol. ii., p. 185.

81. When a body is not at rest in a fluid, it will ascend or descend with a moving force equal to the difference between the weight of the solid, or part of the solid immersed, and the weight of an equal volume of the fluid. It is on this principle that the *Camel* is explained. Two large boxes or chests, with a number of separate compartments in each, are filled with water, and sunk one on each side of a sunken vessel which is to be raised, the chests being made fast to the keel by straps passing underneath it. The water is now pumped out, and the buoyant power of the chests raises the vessel. This is also the principle on which *life-preservers* act. Fish also owe their equilibrium to the same principle, since on rising or sinking the weight of the column of water diminishes or increases and so expands or contracts their body.

82. *Definition.—Metacentre.*—Let the body be slightly disturbed through a small angle, then by the *metacentre* is meant, the point of intersection of the vertical line through the centre of gravity of the fluid displaced, and the vertical line through the centre of gravity of the body when at rest. Metacentre.

83. PROP. III.—If a body float in a fluid, the line joining the centres of gravity of the body, and the fluid displaced is in the same vertical.

The floating body, we have seen, presses downwards, and the fluid presses upwards with an equal force; we may therefore reckon these pressures as forces acting respectively at the centre of gravity of the body, downwards, and at the centre of gravity of the fluid displaced, upwards. Hence, the body cannot be at rest, unless these forces be equal and opposite, *i.e.*, unless the line joining the centres of gravity of the body and of the fluid displaced be in the same vertical.

84. COR.—In all other positions the forces will constitute what is called a *statical couple*, which admits of no single resultant of the two components. Corollary.

Flotation.

85. We can now determine the conditions under which a floating body will remain at rest: these are—

1*st*, That the weight of the body be equal to that of the fluid displaced; and

2*d*, That the centre of gravity of the body, and the centre of gravity of the fluid displaced, be in the same vertical.

86. In all cases of the equilibrium of floating bodies these conditions must obtain. They are insufficient, however, to determine the nature of the equilibrium, but refer to a motion of translation upwards, downwards, or forwards, not to a motion of rotation. Thus, suppose a body floating in a fluid to be at rest, and let it be struck obliquely, then the body will move under the influence of two motions—one of translation, the other of rotation. By the first, the body will oscillate backwards and forwards, till, after a time, it will resume its original position. By the second, the motion will differ with the nature of the floating body; but these motions may be referred to three classes:—1*st*, When the body oscillates about its original position, and at last returns to it. 2*d*, When, after passing through a certain angle, the body remains at rest, without recovering its first position. 3*d*, When it has no tendency whatever to come back to its first position, but continues to recede the farther from it.

87. In these three cases we have the nature of the equilibrium of floating bodies. Hence the first gives us an equilibrium of stability, the second one of neutrality or indifference, and the third, one of instability.

A floating body, therefore, is said to be in *stable equilibrium*, when, on suffering a slight displacement, or being made to revolve through a certain angle, it returns to its first position.

A floating body is said to be in *neutral* or *indifferent equilibrium*, when, on being slightly disturbed, it will rest in any position.

A floating body is said to be in *unstable equilibrium*, when, on receiving a slight disturbance, it continually departs from its first position.

88. The nature of the equilibrium of a floating body is a very important matter, more especially in ship-building, and in the distribution of the cargo, as also of the ballast of a vessel.

89. Prop. IV.—To determine when the equilibrium is stable, unstable, or neutral.

Let AB (fig. 12) be a body floating in a fluid, g the centre of gravity of the body, mg the direction of gravity when the body was at rest, as in the dotted figure, but which, when the body has been displaced, lies in gw; g' the centre of gravity of the fluid displaced. Pass a vertical through g', meeting gm in m; m is called the metacentre of the body. Now, the weight of the body at g acting down, and the pressure of the fluid at g' acting up, tend to bring the body back to its position of rest. Hence, when m is above g, the equilibrium is stable. This is the case when the body is loaded at the lowest parts, and it is clear that the action of each will be to bring g to the lowest position it can take.

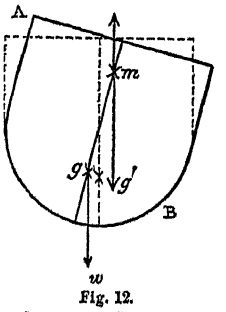


Fig. 12.

When m is below g, then, the fluid pressing upwards, and the weight acting downwards, will each tend to move the body farther and farther from its first position, so that the equilibrium is unstable.

When m coincides with g, then the forces being equal and opposite, and acting at the same point, the body will rest in that position, and the equilibrium will be neutral or indifferent. Flotation.

90. Cor.—Hence the necessity of having the heavier goods of a ship's cargo stowed away at the bottom of the vessel, and of having the ship properly ballasted, or the keel well laden. For the masts and rigging may tend to raise the centre of gravity of the ship above the metacentre, in which case the vessel would be thrown on her beam ends. Similarly, also, it is much more safe to sit in a small boat than to stand upright, for the centre of gravity of the craft is low in the former, but high in the latter case. Corollary.

SECTION II.—SPECIFIC GRAVITIES.

91. *Definition.*—By the specific gravity of a substance is meant the ratio subsisting between the weights of equal volumes of that substance and some other known substance taken as a standard. Specific gravities.

92. It has been agreed among philosophers to take as the standard of comparison the purest distilled water, at a temperature of 60° Fahr., and when the *barometer* is at 30 inches; the values or quotients of the ratios expressing the specific gravities of different substances, being all set down in a *table of specific gravities*. Thus the weight of a cubic foot of pure platina is 19,500 ounces, but the weight of a cubic foot of standard water is 1000 ounces; therefore the ratio between the former and latter numbers, or $\frac{19500}{1000} = 19{\cdot}5 =$ the specific gravity of pure platina—that is to say, since all matter is equally heavy, that there are $19\frac{1}{2}$ times more matter in a cubic foot of platina than there is in a cubic foot of pure distilled water. If, then, unity or 1 be taken as the specific gravity of water, 19·5 will be that of pure platina, or we have only in the *table* to count off from right to left three places, so as to obtain the specific gravity of the several substances there set down.

93. With respect to the specific gravities of the gases, on the other hand, they may be reckoned in terms of water or atmospheric air; in either case we shall have the same results. Biot and Arago have deduced from very accurate experiments, that when the temperature was at 59° Fahr., air was 800 times lighter than water, and when at the freezing point, it was 770 times lighter. The weight of a cubic foot of air, then, being taken as 1 ounce, 1000 such volumes will weigh 1000 ounces. But it is found that 1000 cubic feet of hydriodic acid weighs 4300 ounces. Hence the specific gravity of hydriodic acid is the ratio between the latter and the former numbers, or $\frac{4300}{1000} = 4{\cdot}3$.

94. Prop. V.—The densities of different substances are as their specific gravities.

Let A and B be the bodies, having volumes V and V', and densities ρ and ρ', respectively; then, A weighs $V\rho g$, while B weighs $V'\rho' g$. If the substances be compared with the standard fluid, the density of which, like the specific gravity, is unity, the weights of volumes V and V' of it will be Vg and $V'g$; therefore,

$$\text{Sp. gr. of A} = \frac{V\rho g}{Vg}, \text{ and sp. gr. of B} = \frac{V'\rho' g}{V'g};$$

$$\text{or, Sp. gr. of A : sp. gr. of B} = \frac{V\rho g}{Vg} : : \frac{V'\rho' g}{V'g} = \rho : \rho'.$$

95. Cor.—The specific gravity of different substances will be as the weights of equal bulks of the substances. Corollary

96. Prop. VI.—If a body be immersed in a fluid, the weight lost is to the weight of the body, as the specific gravity of the fluid is to the specific gravity of the body.

Specific Gravities.

Suppose that W is the weight of the body, and W′ that lost by immersion; then W − W′ is the weight by which it sinks, since W′ is the weight of the fluid displaced. Let V be the volume of the body, ρ and ρ' the density of the body and fluid respectively; then

$$W = V\rho g, \text{ and } W' = V\rho' g.$$
$$\therefore W' : W = V\rho' g : V\rho g = \rho' : \rho. \text{ But (by Prop. V.)}$$
$$= \text{Specific gr. of fluid : specific gr. of body.}$$

97. Prop. VII.—To find the specific gravity of a substance.

Let W be the weight of the body in air, W′ its weight in water; then weight lost = W − W′ = weight of fluid displaced, and the volume displaced = that of the body. Hence W − W′ is the weight of a volume of fluid equal to the volume of the body. Therefore, by def. 92,

$$\text{Specific gravity of substance} = \frac{W}{W - W'}.$$

Let the body be lighter than water; then, in order to make it sink, let a different body be attached to it, the weight of which is W_1 in air, and W_2 in water. Let also W′ be the weight of both bodies in the water. Then, W being weight of body,

Weight of water equal in volume to both bodies $= W + W_1 - W'$
Weight of water equal in volume to attached body $= W_1 - W_2$
∴ Weight of water equal in volume to the body the specific gravity of which is required $= W_1 + W_2 - W'$ by subtraction;

$$\therefore \text{Specific gravity of body} = \frac{W}{W_1 + W_2 - W'}.$$

If the body be soluble, as sugar, &c., in water, it must be inclosed in wax or some other envelope, and a process similar to the last case will determine its specific gravity.

98. Prop. VIII.—To find the specific gravity of a compound body. All bodies of the same material have always the same specific gravity; but a compound body has a specific gravity different from that of either of its components.

Let V and V′ be the volumes of the components, ρ and ρ' their densities, ρ'' that of the compound; then

$$(V + V')\rho'' = V\rho + V'\rho'; \text{ or, } (V + V')\frac{\rho''}{\rho_2} = V\frac{\rho}{\rho_2} + V'\frac{\rho'}{\rho_2}$$

where ρ_2 = unity or 1; or, $(V + V')S'' = VS + V'S'$, since specific gravities are as their densities (94);

$$\therefore \text{Specific gravity of compound} = S'' = \frac{VS + V'S'}{V + V'}.$$

99. It is said that Hiero, king of Syracuse, gave a goldsmith a quantity of pure gold to be made into a crown. On the crown being brought to him and examined, Hiero suspected that the goldsmith had adulterated the pure metal; he therefore inquired at Archimedes if his suspicions could be verified or disproved without injuring the crown. Archimedes, shortly after, showed Hiero that the crown was alloyed with a base metal. The adulteration must have been detected by the principles already explained.

100. Prop. IX.—To find the specific gravity of a fluid.

Let a vessel be filled with the fluid, and, being weighed in air, let its weight be W, and let W′ be the weight of the vessel when empty; let also the same vessel when filled with pure distilled water, and weighed in air, be W″; if care be taken, the volumes of the fluid and of the water will be the same. Now the volume of the fluid weighs W − W′, while an equal volume of water weighs W″ − W′;

$$\therefore \text{Specific gravity of fluid} = \frac{W - W'}{W'' - W'}.$$

Specific Gravities.

101. Cor.—After the same manner the specific gravity of atmospheric air, or any of the gases, or even fine powders, may be obtained.

102. Prop. X.—The specific gravities of two fluids may be compared by weighing the same solid in each.

Let the body weigh W in air, W_1 when immersed in the first fluid, W_2 in the second; then,

Weight of first fluid displaced = W − W_1 and
Weight of second fluid displaced = W − W_2.

But each of these expressions is the weight of equal volumes of different substances; therefore (Cor. 95) if S_1 and S_2 be the specific gravities of the first and second fluid;

Sp. gr. of first fluid : sp. gr. of second fluid = $W - W_1 : W - W_2$;
or, $S_1 : S_2 = W - W_1 : W - W_2$; or, $\frac{S_1}{S_2} = \frac{W - W_1}{W - W_2}$.

103. Prop. XI.—When several fluids are thrown together into the same vessel, they will either become a compound fluid, or remain unmixed, and superposed above each other, their surfaces being horizontal.

Let the fluids have volumes $V_1, V_2, V_3, \&c....V_n$, respectively, and corresponding specific gravities, $S_1, S_2, S_3, \&c....S_n$; then, when the fluids mix together, the specific gravity of the new fluid will be found by art. 98 to be

$$S = \frac{V_1S_1 + V_2S_2 + V_3S_3 + \ldots + V_nS_n}{V_1 + V_2 + V_3 + \ldots + V_n}.$$

104. If the fluids do not mix, then they will range themselves according to their specific gravities, and equilibrium will be attained when the common surface of any two of them is horizontal. For suppose that we have a vessel M (fig. 13), containing say two fluids, the heavier AB lowest, and its surface assuming the outline AB, and a lighter fluid above it. Take CAE and DBF, vertical lines, C and D being points in the horizontal surface of the lighter fluid, A and B points on the surface of the heavier, E and F horizontal points in the depth of the same fluid. Now, it is evident, that at points C and D, on the horizontal surface of the upper fluid, the pressures are equal; and if the same fluid had filled the vessel, those at E and F would also have been equal, being caused by the weight of a column extending from F or E to the surface. But the pressures at A and B of the heavier fluid are unequal, the former being pressed by a lighter column than the latter; and although the cylindrical columns DF, CE are of the same dimensions throughout, yet in the latter there is a greater quantity of the heavier fluid than in the former; the difference of weights of the columns cannot be compensated by the less heavy fluid, and consequently the pressures at the points E and F are unequal. Hence equilibrium cannot obtain; for before an equilibrium can subsist, it is necessary and sufficient that the points in the same horizontal plane should be pressed equally; this can only obtain when the surface A B is truly horizontal. It is not necessary that the differently dense and immiscible fluids should range themselves in the vessel according to their weights. It is quite possible for a heavy fluid to be uniformly distributed over the surface of a lighter fluid, but in such a position, the equilibrium would be unstable, and the slightest displacement of the vessel from one side to the other would cause the heavy fluid to descend and assume the lowest position in the vessel.



Fig. 13.

If, then, several fluids of different densities, and which do not mix, be thrown into a vessel, and the vessel shaken for any length of time, and then allowed to stand, the fluid

Of Specific Gravities.

particles of the same kind will gradually settle in the order of their specific gravities, and with plane horizontal surfaces.

SECTION III.—ON THE HYDROMETER.

105. In order to determine with expedition the strength of spirituous liquors, which are inversely proportional to their specific gravities, an instrument more simple, though less accurate, than the hydrostatic balance, has been generally employed. This instrument is called a *hydrometer*, sometimes an *areometer* and *gravimeter*, and very erroneously a *hygrometer* by some foreign authors. It seems to have been invented by Hypatia, the daughter of Theon Alexandrinus, who flourished about the end of the fourth century; though there is some foundation for the opinion that the invention is due to Archimedes.

106. The *Common Hydrometer* was invented by Fahrenheit, and is the simplest of this class of instruments. It consists of two hollow spheres, C and D (fig. 14); BFE is a delicate cylindrical stem, nicely graduated; and D is loaded with mercury or lead, that the centre of gravity of the instrument may be below that of the fluid displaced.

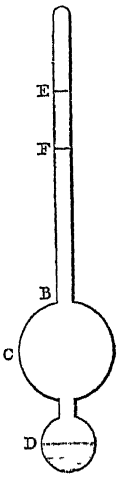


Fig. 14.

Let V = volume of this Common Hydrometer and k the section of the graduated stem. Let the instrument be placed in a fluid A of a density ρ, and let it sink to a depth E, while in another fluid, B, of a density ρ', it sinks to F; let also the depths of E and F from the zero point, or top of the stem, be x and y divisions respectively. Then, volume of fluid displaced of $A = (V - xk)$, and volume of fluid displaced of $B = (V - yk)$; the weights of which are respectively $(V - xk)g\rho$, and $(V - yk)g\rho'$. But as the weight of the fluid displaced is equal to the weight of the body immersed, we have $(V - xk)\, g\rho = (V - yk)\, g\rho'$; or, $(V - xk) : (V - yk) = \rho' : \rho$ = specific gravity of B : specific gravity of A (94).

$$\therefore \text{Specific gravity of A} = \text{specific gravity of B} \cdot \frac{V - yk}{V - xk}$$

$$= \frac{V - yk}{V - xk},$$ since B is regarded as the standard fluid of which the specific gravity is unity or 1.

Jones's hydrometer.

107. *Jones's Hydrometer* (fig. 16) is a simple and accurate instrument, requiring only three weights to discover the strengths of spirituous liquors from alcohol to water. It is adjusted to the temperature of 60° Fahr., and has an attached thermometer, so as to make due allowance for a variation of the temperature.

In fig. 16, the whole instrument is represented with the thermometer attached to it. Its length, AB, is about 9½ inches; the ball C is made of hard brass, and nearly oval, having its conjugate diameter about 1½ inches. The stem AD is a parallelopiped, on the four sides of which the different strengths of spirits are engraved: the three sides which do not appear in fig. 16 are represented in fig. 15, with the three weights numbered 1, 2, 3, corresponding with the sides similarly marked at the top. If the instrument, when placed in the spirits, sinks to the divisions on the stem without a weight, their strength will be shown on the side AD marked 0 at the top, and any degree of strength from 74 gallons in the 100 to 47 in the 100 above proof, will thus be indicated. If the hydrometer does not sink to the divisions without a weight, it must be loaded with any of the weights 1, 2, 3, till the ball C is completely immersed. If the weight No. 1 is the necessary, the side marked 1 will show the strength of spirits, from 46 to 13 gallons in the 100 above proof. If the weight No. 2 is employed, the corresponding side will indicate the remainder of over proof to *proof*, marked P in the instrument, and likewise every gallon in 100 under proof, down to 29. When the weight No. 3 is used, the side similarly marked will show any strength from 30 gallons in the 100 under proof, down to water, which is marked W in the scale. The small figures, as 4 at 66, 3½ at 61, 2½ at 48 (fig. 16) indicate the diminution of bulk which takes place when water is mixed with spirits of wine in order to reduce it to proof: thus, if the spirit be 61 gallons in the 100 over proof, and if 61 gallons of water are added in order to render it proof, the magnitude of the mixture will be 3½ gallons less than the sum of the magnitudes of the ingredients; that is, instead of being 161 it will be only 157½ gallons. The thermometer F connected with the hydrometer, has four columns engraved upon it, two on one side as seen in the figure, and two on the other side. When any of the scales upon the hydrometer, marked 0, 1, 2, 3, are employed, the column of the thermometer similarly marked must be used, and the number at which the mercury stands carefully observed. The divisions commence at the middle of each column which is marked 0, and is equivalent to a temperature of 60° of Fahrenheit; then, whatever number of divisions the mercury stands above the zero of the scale, the same number of gallons in the 100 must the spirit be reckoned weaker than the hydrometer indicates, and whatever number of divisions the mercury stands below the zero, so many gallons in the 100 must the spirit be reckoned stronger.

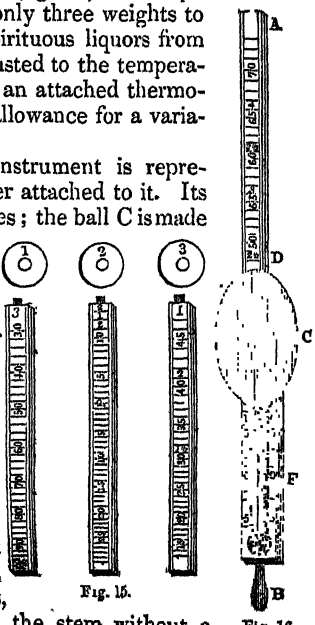


Fig. 15. Fig. 16.

108. *Nicholson's Hydrometer* (fig. 17) serves to determine the specific gravity of both solids and fluids. A hollow light body, A, is pierced by a graduated delicate stem D, carrying a dish, C, for weights, and a cup, B, loaded so as to insure a stable equilibrium in the instrument. The instrument is always sunk to the same depth by weights placed in the upper dish.

Nicholson's hydrometer.

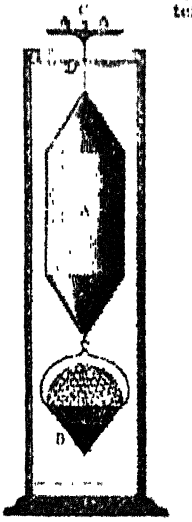


Fig. 17

1. To find the specific gravity of a body with this instrument, let W be the weight of the hydrometer, W' weight of fluid displaced when the stem is at D, w that weight placed in the dish so as to sink it to this depth. Let also X be the weight of the body, the specific gravity of which is required, and Y the weight of a corresponding volume of fluid equal to the bulk of the body. Then,

$$\text{Specific gravity of solid} = \frac{X}{Y}.$$

Let the body be put first in the upper cup, and let w' be the weight required to sink the instrument to D, then, when the body is not put on C, we have $W' = W + w$, but the body being on C, we have also $W' = W + X + w'$; $\therefore X = w - w'$.

Now, let the body be placed in the lower cup B, and let a weight w'' sink the instrument to D; then again, $W' + Y = W + X + w''$, from which if we subtract $W' = W + X + w'$, gives us $Y = w'' - w'$;

$$\therefore \text{Specific gravity of body} = \frac{X}{Y} = \frac{w - w'}{w'' - w}$$

2. In order to compare the specific gravity of two fluids with this instrument, let again W be its weight, and w that re-

Of Specific Gravities.

quired to sink the stem to D in the fluid A, and w' in the fluid B. Then,

Weight of the displaced fluid of A = W + w and

Weight of the displaced fluid of B = W + w'.

But these two weights being the same, and the specific gravities of two fluids being as the ratio of equal bulks of them; ∴ Sp. gr. of A : sp. gr. of B = W + w : W + w'. Let B be the standard fluid, and specific gravity of A = $\frac{W+w}{W+w'}$

Barometrical areometer.

109. The *Barometrical Areometer* is an instrument which is more useful for the purposes of illustration than of measurement. If two immiscible liquids are poured into a two-branched tube ACB, the one into the branch BC, and the other into the branch AC, till they balance each other, their specific gravities will be to one another inversely as the heights of each column. Thus, if we pour in mercury at A, and water at B, so that when the surface of the mercury is at D, that of the water is at E, we shall find that if the column of mercury DF is two inches, that of the water EG will be 27 inches, and their specific gravities will be as 27 to 2, or as 13½ to 1. If we pour in at B linseed oil in place of water, the height EG will be 29 inches, and the specific gravity of the oil 0·931; because 27 ft. : 2 in. = 13½ : 0·931. By thus using mercury as the balancing column, the specific gravities of all fluids that do not mix with it, or act upon it, may be readily ascertained. The results thus obtained are not affected by the admission of the air at the open ends A and B, because the same weight of air presses upon the two balancing columns. But if we pour in mercury at A till the bent tube ACB contains above thirty inches of it, and close up the end A, and remove the air from above the mercury in AC, the column of mercury, being no longer pressed down by the air in AC, will be pressed up to near the top of the tube A by the pressure of the column of air in BC, and the instrument becomes a barometer, a column of air balancing a column of mercury. In this case, the tube BI becomes unnecessary, and the mercury may be inclosed in a glass ball at I, with an opening to admit the air.

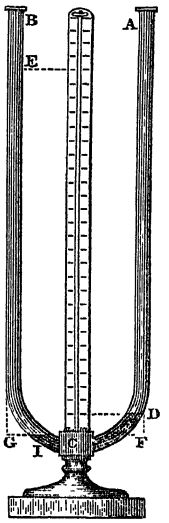


Fig. 18.

Say's stereometer.

110. *Say's Stereometer* (fig. 19) is for the purpose of determining the volumes, and from these the specific gravity of liquid bodies, soft bodies, porous bodies, and powders, as also solids. The instrument consists of a glass tube of uniform bore, ending in a cup PE, the mouth being ground truly plane, and capable of being rendered air-tight by the plate of glass E. The cup PE contains the substance B, the volume of which is wanted. Take off the covering plate E, and immerse the tube PC in a vessel D of mercury till the mercury reaches P. Now cover the cup with the plate E, and raise PC till the mercury is at M, and its level in D at C; the height of the mercurial column in PC is now CM.

As there is still so much air in PE, let its volume be u before B was put in, and v that of the solid in the cup, k the horizontal section of PC, h the altitude of the mercurial column in PC, and ρ the density of mercury. When the column reached P, the volume of air = $u - v$, and its pressure = $g\rho h$; when again it was at M, and in D at C, the air in EPM occupied a space = $u - v + k$. PM, and its pressure = $g\rho$ (h − CM). Since, then, the pressure of the air varies inversely as the space it occupies, we have $u - v + k$. MP : $u - v = h : h$ − CM;



Fig. 19.

Of Specific Gravities.

$$\therefore v = u - \frac{h - MC}{MC} k \text{ . PM.}$$

So also u may be found, the cup being empty: k will be found by weighing the mercury filling a certain portion of the tube. Thus, since a cubic inch of mercury weighs at 16° Fahr. 3429½ grains nearly; therefore, if the mercurial column in PC be a inches, and its weight be w grains, w = 3429½ . (volume of mercury in PC) = (3429·5) × k . a, where k is an area or square inches.

If then the solid B be a weight = w, its specific gravity = $\frac{W}{v}$.

The specific gravity of powders and soluble substances may be found in the same manner.

Brewster's staktometer.

111. The *Staktometer*, or *Drop-measurer*, is shown in fig. 20, where ABC is a glass vessel four or five inches long, having a hollow bulb, B, about half an inch in diameter. The instrument is filled by suction, and the fluid is discharged at C till it stands nearly at the point m, the zero of the scale. The fluid is then allowed to discharge itself at C by drops, and the number of them is counted till the surface of the fluid descends to another fixed point n. The experiment is then carefully repeated at different temperatures, till the number of drops of distilled water occupied by the cavity between m and n is accurately determined for various temperatures. The same experiment is made with alcohol. Thus, if N is the number of drops of distilled water whose specific gravity is S, and n the number of drops of alcohol whose specific gravity is s, and d the number of drops of any other mixture of alcohol and water contained in the same cavity mn, we shall have

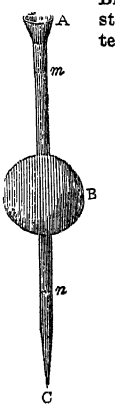


Fig. 20.

$$n - N : S - s = d - N : \frac{(d - N)(S - s)}{n - N};$$

and therefore

$$S - \frac{(d - N)(S - s)}{n - N}$$

will be the specific gravity of the mixture required.

With a small instrument, the number of drops of *water* between m and n was 724, whereas the number of drops of ordinary proof spirits was 2117 at 60° Fahr. Now, as the specific gravity of the spirits was ·920, and that of water 1·000, we have a scale of 1393 drops for measuring all specific gravities between ·920 and 1000, an unit in the fourth place of decimals corresponding to a variation of about two drops. From this experiment it follows that the bulk of a drop of water will be about 2·93 times as large as the bulk of a drop of the spirits.

Sikes' hydrometer.

112. *Sikes' Hydrometer* (fig. 21) is used in the collection of the revenue of the United Kingdom; it determines the relative quantity of alcohol and water which wine and spirituous liquors contain. If in the spirit to be tested there be more water than alcohol, the hydrometer will show that it is below proof; if the contrary, above proof. The only difference between Sikes' and the common hydrometer is that the stem of this is thin and flat; it has besides eight small weights which may be placed on the lower stem, D, so as to increase the weight of the instrument, since the specific gravity of light fluids would prevent it from sinking without the addition of one or more of these weights to the lowest division on the graduated stem in a heavy fluid.

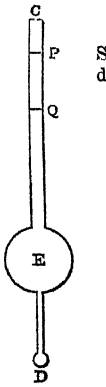


Fig. 21.

Of Specific Gravities.

Let V = volume of the instrument, W its weight, K the area of a section of CE. When placed in the fluid A let X be the weight at C, and P the surface of the fluid; when it floats in B, let Y be the weight at C, and Q the surface of the fluid, and let R, S be the respective volumes of X and Y; then,

Weight of fluid A displaced = W + X, and
... B ... = W + Y
Volume of fluid A displaced = V + R − K . CP, and
... ... B ... = V + S − K . CQ;

∴ W + X = specific gravity of A × (V + R − K . CP),
W + Y = specific gravity of B × (V + S − K . CQ);

∴ Specific gravity of A : specific gravity of B =
(W + X) (V + S − K . CQ) : (W + Y) (V + R − K . CP);
∴ Specific gravity of A = specific gravity of B ×

$$\frac{(W+X)\,(V+S-K\,.\,CQ)}{(W+Y)\,(V+R-K\,.\,CP)}$$
$$=\frac{(W+X)\,(V+S-K\,.\,CQ)}{(W+Y)\,(V+R-K\,.\,CP}\,,$$

the standard fluid being B.

Of Specific Gravities.

SECTION IV.—ON TABLES OF SPECIFIC GRAVITIES.

113. As the knowledge of the specific gravities of bodies is of great use in all the branches of mechanical philosophy, we have given the following table, computed by Mr Tod, civil engineer, and published in the second edition of his excellent work, entitled *Series of Tables*, and which ought to be in the hands of every engineer, architect, and country gentleman :— Tables of specific gravities.

The Specific Gravity of Bodies calculated to Avoirdupois Weight.

Name of Bodies.	Weight of a Cubic foot in ozs. and lbs.		Weight of a Cubic inch in ozs.	Number of Cubic inches in a lb.
METALS.	ozs.	lbs.	ozs.	Cubic ins.
Antimony, cast	6702	418·8750	3·8748	3·8866
Zinc, cast	7190	449·3750	4·1608	3·8431
Iron, cast	7207	450·4375	4·1707	3·8364
Tin, cast	7291	455·6875	4·2193	3·7920
Tin, hardened	7299	456·1875	4·2239	3·7878
Pewter	7471	466·9375	4·3234	3·7007
Iron, bar	7788	486·7500	4·5069	3·5500
Cobalt, cast	7811	488·1875	4·5202	3·5396
Steel, hard	7816	488·5000	4·5231	3·5373
Steel, soft	7833	489·5625	4·5329	3·5296
Iron, meteoric, hammered	7965	497·8125	4·6093	3·4792
Nickel, cast	8279	517·4375	4·7910	3·3395
Brass, cast	8395	524·6875	4·8582	3·2933
Brass, wire	8544	534·0000	4·9414	3·2359
Nickel, hammered	8666	541·6250	5·0150	3·1903
Gun metal	8784	549·0000	5·0833	3·1476
Copper, cast	8788	549·2500	5·0856	3·1461
Copper, wire	8878	554·8750	5·1377	3·1140
Copper, coin	8915	557·1875	5·1591	3·0959
Bismuth, cast	9822	613·8750	5·6840	2·8149
Silver, hammered	10510	656·8750	6·0821	2·6306
Silver, coin	10534	658·3750	6·0960	2·6246
Silver, pure, cast	10744	671·5000	6·2175	2·5733
Rhodium	11000	687·5000	6·3657	2·5134
Lead, cast	11352	709·5000	6·3694	2·4355
Palladium	11800	737·5000	6·8287	2·5134
Mercury (quicksilver), common	13568	848·0000	7·8518	2·0377
Mercury (do.), pure	14000	875·0000	8·1018	1·9748
Gold, trinket	15709	981·8125	9·0908	1·7600
Gold, coin	17647	1102·9375	10·2123	1·6124
Gold, pure, cast	19258	1203·6250	11·1446	1·4356
Gold, hammered	19316	1210·0625	11·2042	1·4280
Platinum, pure	19500	1218·7500	11·2847	1·4178
Platinum, hammered	20336	1271·0000	11·7685	1·3595
Platinum, wire	21041	1315·0625	12·1765	1·3140
Platinum, laminated	22069	1379·3125	12·7714	1·2528
Iridium, hammered	23000	1437·5000	13·3101	1·2021
EARTH, STONES, &c.				
Amber	1078	67·3750	0·62384	25·6474
Coal	1250	78·7500	0·72337	21·9428
Sand	1500	93·7500	0·86803	18·4320
Brick	2000	125·0000	1·15740	13·8240
Sulphur, native	2033	127·0625	1·17650	13·5996
Opal	2114	132·1250	1·22337	13·0785
Clay	2160	135·0000	1·25000	12·8000
Gypsum	2280	142·5000	1·31944	12·1263
Porcelain, Limoyes	2341	146·3125	1·35474	11·8103
Porcelain, China	2385	147·2500	1·38020	11·7351
Stone, paving	2416	151·4000	1·39814	11·4437

Name of Bodies.	Weight of a Cubic foot in ozs. and lbs.		Weight of a Cubic inch in ozs.	Number of Cubic inches in a lb.
EARTHS, STONES, &c.	ozs.	lbs.	ozs.	Cubic ins.
Stone, common	2520	157·5000	1·45833	10·9714
Flint	2594	162·1250	1·50115	10·6584
Spar	2594	162·1250	1·50115	10·6584
Pebble, English	2619	163·6875	1·51562	10·5566
Granite, Aberdeen	2625	164·0625	1·51909	10·5325
Quartz	2640	165·0000	1·52777	10·4727
Glass, green	2642	165·1250	1·52893	10·4648
Crystal, rock	2653	165·8125	1·53530	10·4214
Granite, red Egyptian	2654	165·8750	1·53587	10·4175
Granite, Cornish	2662	166·3750	1·53935	10·3861
Marble, Egyptian	2668	166·7500	1·54976	10·3628
Slate	2672	167·0000	1·54629	10·3473
Coral	2680	167·5000	1·55092	10·3164
Pearl, Oriental	2684	167·7500	1·55324	10·3010
Glass, bottle	2733	170·8125	1·58159	10·1163
Marble, green Campanian	2742	171·3750	1·58735	10·0831
Emerald of Peru	2775	173·4375	1·60590	9·9632
Chalk, British	2784	174·0000	1·61111	9·9310
Marble, Parian	2837	177·3125	1·64178	9·7455
Basalt, Giants' Causeway	2864	179·0000	1·65740	9·6536
Glass, white	2892	180·7500	1·67361	9·5601
Limestone	2960	184·3750	1·70717	9·3721
Asbestos	2996	187·2500	1·73379	9·2283
Hornblende	3000	187·5000	1·73611	9·2160
White lead	3160	197·5000	1·82870	8·7493
Glass, British flint	3329	208·0625	1·92650	8·3052
Diamond, average	3536	221·0000	2·04629	7·8190
Beryl, Oriental	3549	221·8125	2·05381	7·7903
Garnet, common	3576	223·5000	2·06944	7·7315
Topaz, average	3800	237·5000	2·19907	7·2800
Sapphire, Oriental	3994	243·3750	2·25347	7·1001
Garnet, precious	4230	264·3750	2·44791	6·5361
Ruby, Oriental	4283	267·6875	2·47858	6·4590
Jargon of Ceylon	4416	276·0000	2·55555	6·2608
Spar, heavy	4430	276·8750	2·56365	6·2410
Loadstone	4930	308·1250	2·85300	5·6081
The earth, or mean of the globe	5210	325·6250	3·01504	5·3067
RESINS, GUMS, &c.				
Gunpowder, loose heap	836	52·2500	0·48379	33·0717
Living men	891	55·6875	0·51562	31·0303
Wax	897	56·0625	0·51909	30·8227
Ice	930	58·1250	0·53819	29·7293
Gunpowder, close shaken	937	58·5625	0·54224	29·5069
Tallow	942	58·8750	0·54513	29·3503
Butter	942	58·8750	0·54513	29·2993
Bees-wax	956	59·7500	0·55324	28·9205
Sodium	972	60·7500	0·56250	28·4444

Of Specific Gravities.

The Specific Gravity of Bodies calculated by Avoirdupois Weight.—Continued.

Of Specific Gravities.

Name of Bodies.	Weight of a Cubic foot in ozs. and lbs.		Weight of a Cubic inch in ozs.	Number of Cubic inches in a lb.
Resins, Gums, &c.	ozs.	lbs.	ozs.	Cubic ins.
Camphor	989	61·8125	0·56655	27·9555
Rosin	1100	68·7000	0 63657	25·0909
Pitch	1150	71·8750	0·66550	24·0417
Opium	1337	83·5625	0·77372	20·6791
Gum Arabic	1452	90·7500	0·84027	19·0413
Honey	1456	91·0000	0·84259	18·9890
Bone of an Ox	1659	103·6875	0·96006	16·6654
Bone, dry	1660	103·7500	0·96064	16·6554
Phosphorus	1714	107·1250	0·99184	16·1307
Alum	1714	107·1250	0·99184	16·1307
Gunpowder, solid	1745	109·0625	1·00983	15·8441
Nitre (saltpetre)	1900	118·7500	1·09953	14·5515
Ivory	1917	119·8125	1·10937	14·4422
Woods.				
Cork	240	15·0000	0·13888	115·2000
Poplar	383	23·9375	0·22164	71·7660
Larch	544	34·0000	0·31481	50·8235
Fir, North of England	556	34·7500	0·32175	49·7266
Mahogany, Honduras	560	35·0000	0·32407	49·3714
Cedar, American	561	35·0625	0·32465	49·2833
Poon	579	36·1875	0·33506	47·7512
Willow	585	36·5625	0·33854	47·2615
Cedar	596	37·2500	0·34490	46·3892
Cypress	598	37·3750	0·34664	46·2341
Elm	600	37·5000	0·34722	46·0800
Pitch Pine	660	41·2500	0·38194	41·8909
Pear-tree	661	41·3125	0·38252	41·8275
Walnut	681	42·5625	0·39467	40·5991
Mar Forest Fir	694	43·3750	0·40162	39·8386
Elder-tree	695	43·4375	0·40219	39·7812
Orange-tree	705	44·0625	0·40798	39·2170
Cherry-tree	715	44·6875	0·41377	38·6685
Teak	745	46·5625	0·43113	37·1114
Riga Fir	750	46·8750	0·43402	36·8640
Maple	755	47·1857	0·43692	36·6198
Oak, Dantzic	760	47·5000	0·43981	36·3789
Yew, Dutch	788	49·2500	0·45590	35·0862
Apple-tree	793	49·5625	0·45891	34·8656
Yew, Spanish	807	50·4375	0·46701	34·2602
Ash	845	52·8125	0·48900	32·7195
Beech	852	53·2500	0·49305	32·4507
Oak, Canadian	872	54·5000	0·50694	31·7064
Logwood	913	57·0625	0·53125	30·2825
Oak, English	970	60·6250	0·56134	28·5030

Name of Bodies.	Weight of a Cubic foot in ozs. and lbs.		Weight of a Cubic inch in ozs.	Number of Cubic inches in a lb.
Woods.	ozs.	lbs.	ozs.	Cubic ins.
Box, French	1030	64·3750	0·59606	26·8427
Brazil Wood, red	1031	64·3125	0·59664	26·8680
Mahogany, Spanish	1063	66·4250	0·61516	26·0143
Oak, English, 60 years old	1170	73·1250	0·67708	23·6307
Ebony, American	1331	83·1875	0·77025	20·7723
Lignum-vitæ	1333	83·3125	0·77141	20·7411
Liquids.				
Ether, sulphuric	720	45·0000	0·41666	38·4000
Alcohol, absolute	796	49·7500	0·46064	34·7487
Brandy	837	52·3125	0·48437	33·0322
Bitumen, liquid	848	53·0000	0·49074	32·6037
Turpentine, oil of	870	54·3750	0·50347	31·9632
Ether, muriatic	874	54·6250	0·50578	31·6338
Olive oil	915	57·1875	0·52951	30·2163
Moselle wine	916	57·2500	0·53009	30·1834
Whale oil	923	57·6875	0·53414	29·9544
Proof spirit	930	58·1250	0·53819	29·7290
Linseed oil	940	58·7500	0·54398	29·4127
Castor oil	970	60·6250	0·56134	28·5030
Wine, red Port	990	61·8750	0·57291	27·9272
Wine of Burgundy	991	61·9375	0·57349	27·8990
Wine of Bordeaux	994	62·1250	0·57523	27·8148
Wine, white Champagne	997	62·3125	0·57696	27·7311
Water, distilled	1000	62·5000	0·57870	27·6480
Tar	1015	63·4375	0·58738	27·2396
Vinegar	1026	64·1250	0·59375	26·9473
Sea-water	1028	64·2500	0·59490	26·8949
Milk	1030	64·3750	0·59606	26·8427
Ale, the average of	1035	64·6875	0·59895	26·7130
Blood, human	1045	65·3125	0·60474	26·4574
Muriatic acid of commerce	1218	76·1250	0·70486	22·6995
Aqua regia	1234	77·1250	0·71412	22·4051
Water of the Dead Sea	1240	77·5000	0·71759	22·2580
Nitrous acid	1452	90·7500	0·84024	19·0082
Nitric acid, or aqua-fortis	1500	93·7500	0·86805	18·4000
Boracic acid	1830	114·3750	1·05902	15·1081
Sulphuric acid	1848	128·0000	1·06944	13·5000
Quicksilver. (See the metals.)				

Name of Bodies.	Weight of a Cubic Foot in ozs. and lbs.		Weight of a Cubic inch in ozs.	Number of Cubic inches in a lb.	Number of Cubic feet in a lb.
Gases.	ozs.	lbs.	ozs.	Cubic ins.	Cubic feet.
Hydrogen	0·069	·0043125	·0000399	400695·6	231·8840
Ammonia	0·590	·0368750	·0003414	46861·0	27·1186
Nitrogen	0·972	·0607500	·0005625	28444·4	16·4609
Olefiant	0·982	·0613750	·0005682	28154·7	16·2932
Atmospheric air	1·000	·0625000	·0005787	27648·0	16·0000
Nitrous	1·042	·0651250	·0006030	26633·5	15·3550
Oxygen	1·111	·0694375	·0006429	24885·6	14·4014
Muriatic acid	1·280	·0800000	·0007407	21600·0	12·5000
Carbonic acid	1·524	·0952500	·0008819	18141·7	10·4986
Cyanogen	1·805	·1128125	·0010445	15317·4	8·8642
Sulphurous acid	2·222	·1388750	·0012858	12442·8	7·2007
Chlorine	2·444	·1527500	·0014143	11312·6	6·5466
Fluosilicic acid	3·611	·2256875	·0020896	7656·6	4·4309
Hydriodic acid	4·300	·2687500	·0024884	6429·7	3·7209

CHAPTER III.—ON CAPILLARY ATTRACTION AND THE COHESION OF FLUIDS.

114. We have already seen, when discussing the equilibrium of fluids, that when water or any other fluid is poured into a vessel, or any number of communicating vessels, its surface will be horizontal, or it will rise to the same height in each vessel, whatever be its form or position. This proposition, however, only holds true when the diameter of these vessels or tubes exceeds the fifteenth of an inch: for if a system of communicating vessels be composed of tubes of various diameters, the fluid will rise to a level surface in all the tubes which exceed one fifteenth of an inch in diameter; but in the tubes of a smaller bore, it will rise above that level to altitudes inversely proportional to the diameters of the tubes. The power by which the fluid is raised above its natural level is called *capillary attraction*, and the glass tubes which are employed to exhibit its phenomena are named *capillary tubes*. These appellations derive their origin from the Latin word *capillus*, signifying a hair, because the bores of these tubes have the fineness of a hair.

115. When we bring a piece of clean glass in contact with water or any other fluid, except mercury and fused metals, and withdraw it gently from its surface, a portion of the fluid will not only adhere to the glass, but a small force is necessary to detach this glass from the fluid mass, which resists any separation of its parts. Hence it is obvious that there is an attraction of cohesion between glass and water, and that the constituent particles of water have also an attraction for each other. The suspension of a drop of water from the lower side of a plate of glass is a more palpable illustration of the first of these truths; and the following experiment will completely verify the second. Place two large drops of water on a smooth metallic surface, their distance being about the tenth of an inch. With the point of a pin unite these drops by two parallel canals, and the drops will instantly rush to each other through these canals, and fill the dry space that intervenes. This experiment shows that in capillary attraction there enters an attractive as well as a cohesive force.

116. Upon these principles many attempts have been made to account for the elevation of water in capillary tubes; but most of the explanations which have hitherto been offered, are founded upon hypothesis, and are very far from being satisfactory. Without presuming to substitute a better explanation in the room of those which have been already given, and so frequently repeated, we shall endeavour to illustrate that explanation of the phenomena of capillary attraction which seems liable to the fewest objections. For this purpose let a drop of water be laid upon a horizontal glass plate. Every particle of the glass immediately below that drop exerts an attractive force upon the particles of water. This force will produce the same effect upon the drop as a pressure in the opposite direction; the pressure of a column of air, for instance, on the upper surface of the drop. The effect of the attractive force, therefore, tending to press the drop to the glass will be an enlargement of its size, and the water will occupy a larger space; this increase of its dimensions will take place when the surface AB is held downwards; and that it does not arise from atmospheric pressure may be shown by performing the experiment *in vacuo*. Now, let AB (fig. 22) be a section of a plate of glass, which is held vertically, part of the water will descend by its gravity, and form a drop B, while a small film

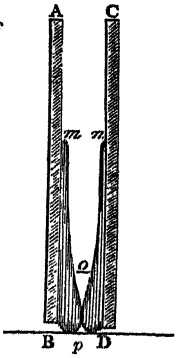


Fig. 22.

of the fluid will be supported at m by the attraction of the glass. Bring a similar plate of glass CD, into a position parallel to AB, and make them approach nearer and nearer each other. When the drops B and D come in contact, they will rush together from their mutual attraction, and will fill the space *op*. The gravity of the drops B and D being thus diminished, the films of water at m and n, which were prevented from rising by their gravity, will move upwards. As the plates of glass continue to approximate, the space between them will fill with water, and the films at m and n being no longer prevented from yielding to the action of the glass immediately below them (by the gravity of the water at *op*, which is diminished by the mutual action of the fluid particles), will rise higher in proportion to the approach of the plates. Hence it may be easily understood how the water rises in capillary tubes, and how its altitude is inversely as their internal diameters. For let A, a be the altitudes of the fluid in two tubes of different diameters, D, d; and let C, c be the two cylinders of fluid which are raised by virtue of the attraction of the glass. Now, as the force which raises the fluid must be as the number of attracting particles, that is, as the surface of the tube in contact with the water, that is, as the diameter of the tubes; and as this same force must be proportional to its effects on the cylinder of water raised, we shall have $D : d = C : c$. But (GEOMETRY, sect. viii., theor. xi.; sect. ix., theor. ii.) $C : c = D^2A : d^2a$, therefore $D^2A : d^2a = D : d$; hence $D^2A\ d = d^2a\ D$, and $DA = \frac{d^2aD}{Dd}$; or, $DA = da$, that is, $D : d = a : A$; or the altitudes of the water are inversely as the diameters of the tubes. Since $DA = da$, the product of the diameter by the altitude of the water will always be a constant quantity. In a tube whose diameter is 0·01, or 100th of an inch, the water has been found to reach the altitude of 5·3 inches; hence the constant quantity $5{\cdot}3 \times 0{\cdot}1 = 0{\cdot}053$ may fitly represent the attraction of glass for water. According to the experiments of Muschenbroek, the constant quantity is 0·039; according to Weitbrecht, 0·0428; according to Monge, 0·042; and according to Atwood, 0·0530. When a glass tube was immersed in melted lead, Gellert found the depression multiplied by the bore to be 0·0054.

117. Having thus attempted to explain the causes of capillary action, we shall now proceed to consider some of its more interesting phenomena. In fig. 23, MN is a vessel of water in which tubes of various forms are immersed. The water will rise in the tubes A, B, C, to different altitudes, m, n, o, inversely proportional to their diameters. If the tube B is broken at a, the water will not rise to the very top of it at a, but will stand at b, a little below the

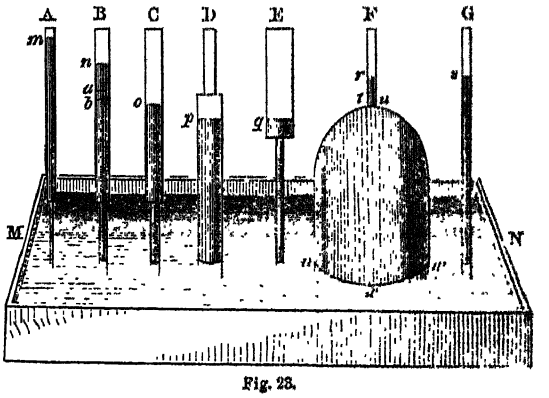


Fig. 23.

top, whatever be the length of the tube, or the diameter of its bore. If the tube be taken from the fluid and laid in a horizontal position, the water will recede from the end that was immersed.

118. If a tube D, composed of two cylindrical tubes of different bores, be immersed in water with the widest part downwards, the water will rise to the altitude p, and if another tube E of the same size and form be plunged in the fluid with the smaller end downwards, the water will rise to the same height q as it did in the tube D. This experiment seems to be a complete refutation of the opinion of Dr Jurin, that the water is raised by the action of the annulus of glass above the fluid column; for since the annular surface is the same at q as at p, the same quantity of fluid ought to be supported in both tubes, whereas the tube E evidently raises much less water than D. But if we admit the supposition in art. 116, that the fluid is supported by the whole surface of glass in contact with the water, the phenomenon receives a complete explanation; for since the surface of glass in contact with the fluid in the tube E is much less than the surface in contact with it in the tube D, the quantity of fluid sustained in the former ought to be much less than the quantity supported in the latter.

119. When a vessel, F*vw* (fig. 23), is plunged in water, and the lower part, *tuvw*, filled by suction till the fluid enter the part F*t*, the water will rise to the same height as it does in the capillary tube G, whose bore is equal to the bore of the part F*t*. In this experiment the portions of water *tvx* and *uxw* on each side of the column F*x* are supported by the pressure of the atmosphere on the surface of the water in the vessel MN; for if this vessel be placed in the exhausted receiver of an air-pump, these portions of water will not be sustained.

120. The preceding experiment completely overturns the hypothesis of Dr Hamilton and Dr Matthew Young, that the fluid was sustained in the tube by the lower ring of glass contiguous to the bottom of the tube, that this ring raises the portion of water immediately below it, and then other portions successively till the portion of water thus raised be in equilibrium with the attraction of the annulus in question.

121. Various experiments on the ascent of fluids in capillary tubes have been made by MM. Weitbrecht, Gellert, Lord Charles Cavendish, MM. Haüy and Tremery, Sir David Brewster, and M. Gay Lussac.

The following are the results obtained by M. Weitbrecht in the ascent of water:—

Diameter of the tube in English inches.	Height of ascent in inches.	Constant quantity.
0·065	0·72	0·0432
0·045	0·95	0·0427
0·08	0·53	0·0424
0·025	1·72	0·043
	Mean.....	0·04282

122. The most accurate experiments on the depression of mercury in capillary tubes are those made by Lord Charles Cavendish:—

Interior diameter of tube.	Mercury in one inch of tube.	Depression of the mercury.
0·6 inches.	972 grains.	0·005 inches.
0·5	675	0·007
0·4	432	0·015
0·3	243	0·036
0·2	108	0·067
0·1	27	0·140

The constant quantity deduced by Dr Thomas Young from the preceding experiments is 0·015.

123. The very great discrepancy in the preceding results, obtained by very accurate and skilful observers, induced Sir David Brewster to repeat the experiments with an instrument constructed for the purpose, and to take such precautions, that he could always obtain the same results after repeated trials.

Having obtained a glass tube 7·9 inches long, and of a uniform circular bore, he took a wire of a less diameter than the bore of the tube, and formed a small hook at one of its ends. This hook was fastened to the middle of a worsted thread, of such a size as, when doubled, to fill the bore of the tube. The wire was then passed through the tube, and the worsted thread drawn after it; and when the whole was plunged in an alkaline solution, the worsted thread was fixed at one end, and the tube was drawn backwards and forwards till it was completely deprived, by its friction on the thread, of any grease or foreign matter which might have adhered to it. The tube and thread were then taken to clean water, and the same operation was repeated.

When the tube was thus perfectly cleaned, it was fixed vertically, by means of a level, in the axis of a piece of wood D (fig. 24), supported by the arm AD, fixed upon

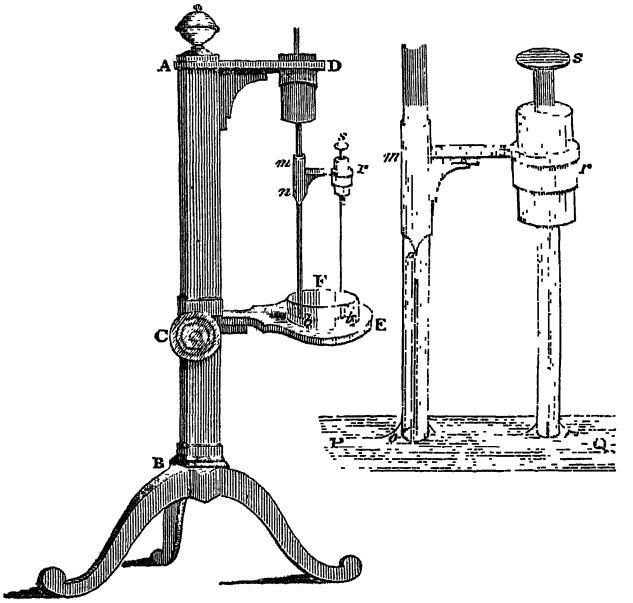


Fig. 24. Fig. 25.

a stand AB; and it was also furnished with an index *mn*, which was moveable to and from the extremity *b*. On the arm CE, moveable in a vertical direction by the nut C, was placed a glass vessel F, containing the fluid, and nearly filled with it. The nut C was then turned till the extremity *b* of the tube touched the surface of the fluid, which was indicated by the sudden rise of the liquor round its sides. The fluid then rose in the tube till it remained stationary, and the index *mn* was moved till its extremity *n* pointed out the exact position of the upper surface of the fluid. In this situation, the distance *nb* was a measure of the ascent of the liquid above its level in the vessel F. In order to ascertain, however, whether the fluid was stationary, in consequence of any obstruction in the tube, or of an equilibrium of the attracting forces, the vessel with the fluid was raised a little higher than its former position, by means of the nut C, and then depressed below it. If the fluid now rose a little above *n*, and afterwards sunk a little below it, so as always to rise and fall with facility and uniformity along with the surface of the fluid in the vessel, it was obvious that it suffered no obstruction in the tube, and that *nb* was the accurate measure of its height. By separating the extremity *b* of the tube from the surface of the fluid, the fluid always rises above *n*; but upon again bringing them into contact, the fluid resumes its position at *n*. If there should be any portion of fluid at the end *b* of the tube, when it is again brought in contact with the fluid surface the water would rise around it before it had reached the

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general level, and therefore the height of the fluid obtained by measuring from the end of the tube would be too small.

In order to avoid this source of error, the index should have a projecting arm *mn* (fig. 25), carrying a screw *st*, whose sharp point *t* can be easily brought on a level with the end *b* of the tube. When the extremity *t*, therefore, which can always be kept dry, comes in contact with the fluid surface PQ, the extremity *b* must also be exactly on the same level, even though the fluid had already risen around it. The tube was then cleaned, as formerly, for a subsequent observation. The results which were thus obtained for a great variety of fluids, and with a tube 0·0561 of an inch in diameter, are given in the following table:—

	Names of Fluids.	Height of ascent in inches.	Constant quantity.
	Water	0·587	0·0327
	Very hot water	0·537	0·0301
	Muriatic acid	0·442	0·0248
	Oil of boxwood	0·427	0·0240
5	Oil of cassia	0·420	0·0236
	Nitrous acid	0·413	0·0232
	Oil of rapeseed	0·404	0·0227
	Castor oil	0·403	0·0226
	Nitric acid	0·395	0·0222
10	Oil of spermaceti	0·392	0·0220
	Oil of almonds	0·387	0·0217
	Oil of olives	0·387	0·0215
	Balsam of Peru	0·377	0·0212
	Muriate of antimony	0·373	0·0209
15	Oil of rhodium	0·366	0·0205
	Oil of pimento	0·361	0·0203
	Cajeput oil	0·357	0·0200
	Balsam of capivi	0·357	0·0200
	Oil of pennyroyal	0·355	0·0199
20	Oil of thyme	0·354	0·0199
	Oil of bricks distilled from spermaceti oil	0·354	0·0199
	Oil of caraway seeds	0·353	0·0198
	Oil of rhue	0·353	0·0198
	Oil of spearmint	0·351	0·0197
25	Balsam of sulphur	0·349	0·0196
	Oil of sweet fennel seeds	0·349	0·0195
	Oil of hyssop	0·349	0·0195
	Oil of rosemary	0·344	0·0193
	Oil of bergamot	0·343	0·0192
30	Oil of amber	0·343	0·0192
	Oil of anise seeds	0·342	0·0192
	Oil of Barbadoes tar	0·341	0·0191
	Laudanum	0·340	0·0191
	Oil of cloves	0·334	0·0187
35	Oil of turpentine	0·333	0·0187
	Oil of lemon	0·333	0·0187
	Oil of lavender	0·328	0·0184
	Oil of camomile	0·327	0·0184
	Oil of peppermint	0·327	0·0184
40	Oil of sassafras	0·327	0·0184
	Highland whisky	0·327	0·0184
	Brandy	0·326	0·0183
	Oil of wormwood	0·326	0·0183
	Oil of dill seed	0·324	0·0182
45	Oil of ambergrease	0·323	0·0181
	Genuine oil of juniper	0·321	0·0180
	Oil of nutmeg	0·320	0·0180
	Alcohol[1]	0·317	0·0178
	Oil of savine	0·310	0·0174
50	Æther	0·285	0·0160
	Oil of wine	0·273	0·0153
	Sulphuric acid	0·200	0·0112

124. By means of an instrument similar in principle to the one above described,[2] M. Gay Lussac made a series of accurate experiments on the ascent of water and alcohol in capillary tubes. In these experiments the tubes were well wetted with the fluid.

Experiments with Water.

Diameter of the tube.	Height of ascent above lowest point of concavity.	Temp. of fluid. Centigrade.
1·29441 millim.	23·1634 millim.	
1·90381	15·5861	8°·5

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The constant quantity in English inches, as deduced from these two experiments, is 0·04622.

Experiments with Alcohol.

Diameter of the tube.	Height of ascent above lowest point of concavity.	Density of alcohol.
1·29441 millim.	9·18235 millim.	0·81961
1·90381	6·08397	0·81961
1·29441	9·30079	0·8595
1·29441	9·99727	0·94153
[3] 10·508	0·3835	0·81347

The temperature of the alcohol was 8°·5 centig., and the constant quantity for the two first experiments, reduced to English inches, is 0·01815, which agrees remarkably with 0·0178, the constant quantity in Sir David Brewster's experiments.

Experiments with Oil of Turpentine.

Diameter of tube.	Height of fluid.	Density.
1·29441 millim.	9·95159	0·869458

This result also coincides very nearly with that of Sir David Brewster.

125. The following table contains a general view of the results obtained by different philosophers, from the ascent of *water* in capillary tubes.

Names of observers.	Constant quantity, in English inches.
Sir Isaac Newton,[4]	0·020
MM. Haüy and Tremery	0·021
M. Carré, mean of three observations	0·022
M. Hallstrom	0·026
Sir David Brewster	0·033
Muschenbroek	0·039
M. Weitbrecht, average of his results	0·042
M. Gay Lussac, average of two observations	0·046
Benjamin Martin	0·048
Mr Atwood	0·053
James Bernouilli	0·064

Throwing aside the measure of James Bernouilli as obviously erroneous, we obtain 0·035 as the general average result of the preceding means; but the difference between this and the extreme measures of Newton and Atwood is so great, that there must be some cause, different from an error of observation, to which it is owing. The difference between the results obtained by Sir David Brewster and M. Gay Lussac, made with nice instruments founded on the same principle, leads to the same conclusion. Laplace indeed has ascribed, and we think justly, these differences to the *greater* or *less* degree of humidity on the sides of the tubes; and he informs us that Gay Lussac made his experiments with tubes *very much wetted*. Here, then, we have at once the cause of the difference above mentioned, because the experiments of Sir David Brewster were made with a tube *carefully cleaned and dried after each experiment*. A dry tube must necessarily raise the water to a less height than a wet one, and the difference must increase as the diameter of the tube employed is diminished. If we conceive a tube, indeed, with an exceedingly small bore, wetted over the whole of its interior, in the slightest degree, the *two* inner surfaces of the film would nearly meet in the axis, and the height of ascent would be infinite, or as high as the tube was long.

[1] Dr Young found the height of ascent of water and diluted spirit of wine to be as 100 to 64. [2] See Biot's *Traité de Physique*.
[3] This is a mean of *five* experiments. [4] *Optics*, p. 366, 3d edition.

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126. From these observations, the reader will be already prepared to draw the conclusion, that the ascent of fluids in glass tubes is a very equivocal measure of the force of capillary attraction, independent of its being applicable only to the single substance of glass.

With the view of removing this objection, Sir David Brewster long ago constructed an instrument, the object of which was to measure, upon an optical principle, the diameter of the circle of fluid which any cylindrical solid raises by capillary attraction above its general level. Thus, let MN (fig. 26) be the plan of a vessel filled with fluid, and A the section of a vertical cylinder of well cleaned and well dried glass, or any other substance not porous. This solid, A, will raise the fluid to a certain height around it, elevating a circular portion, CD, of the fluid above the general level; and it is manifest that the diameter CD of this elevated portion will be proportioned to the height of the fluid round the sides of the cylinder, or to the capillary force by which it is raised. In order to measure the diameter of this circle of fluid, a micrometer carries a small vertical frame along the edge FG of the vessel. Along this frame are stretched two fine parallel wires, whose images can be seen by reflection from the surface of the fluid, by an eye on the side PQ of the vessel, aided by a microscope with a distant focus. When the image of these wires is seen by reflection from any part of the fluid surface without the circle CD, it will suffer no change of form; but when it is seen by reflection from any portion of the elevated portion CD, the fibres will appear disturbed, and will indicate, by their return to the rectilineal form of accurate parallelism, the apparent termination of the circle CD. The same observation is made on the other side of A, at the boundary D, and a measure is thus obtained of the diameter of the circle CD, by means of the micrometer screw, by which the microscope on the side PQ, and the wire frame on the side FG, are moved (being fixed to the same frame) along the sides of the vessel. In this way solids of all kinds may be used, and their exterior or acting surfaces may be easily cleared from grease and other adhering substances.

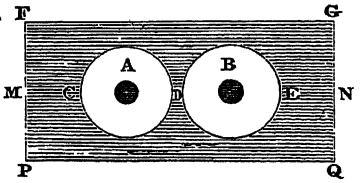


Fig. 26.

This apparatus may be improved by using two cylinders, A, B, in place of one, and by moving one of them, suppose B, from the other, A, till the two elevated circular portions CD, DE disturb the images of the wires, seen by reflection from the intermediate point at D. A telescope may be advantageously used to observe the disturbance of any image seen reflected from the fluid surface.

127. When water is made to pass through a capillary tube of such a bore that the fluid is discharged only by successive drops, the tube, when electrified, will furnish a constant and accelerated stream, and the acceleration is proportional to the smallness of the bore. A similar effect may be produced by employing warm water. Sir John Leslie found that a jet of warm water rose to a much greater height than a jet of cold water, though the water in both cases moved through the same aperture, and was influenced by the same pressure. A siphon also, which discharged cold water only by drops, furnished warm water in an uninterrupted stream.

128. Such are the leading phenomena of capillary tubes. The rise of fluids between two plates of glass remains to be considered; and while it furnishes us with a very beautiful experiment, it confirms the reasoning by which we have accounted for the elevation of fluids in cylindrical canals. Let ABEF and CDEF (fig. 27) be two planes of plate glass with smooth and clean surfaces, having their sides EF joined together with wax, and their sides AB, CD kept at a little distance by another piece of wax W, so that their interior surfaces, whose common intersection is the line EF, may form a small angle. When this apparatus is immersed in a vessel, MN, full of water, the fluid will rise in such a manner between the glass planes as to form the curve D*qom*F, which represents the surface of the elevated water. By measuring the ordinates *mn*, *op*, &c., of this curve, and also its abscissæ E*n*, E*p*, &c., Mr Hawksbee found it to be the common Apollonian hyperbola, having for its assymptotes the surface DE of the fluid, and EF the common intersection of the two planes. The following are the results which he obtained when the inclination of the planes was 20′:—

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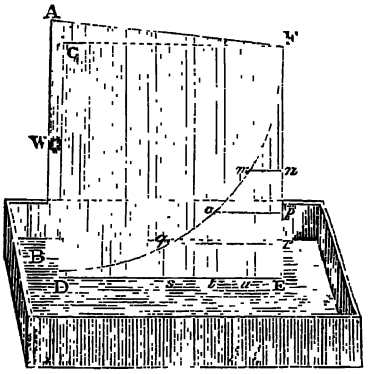


Fig. 27.

Distances from the touching ends of the planes.	Heights of the water at the preceding distances.
13 inches	1
9 ...	2
7 ...	3
5 ...	5
3 ...	9
2½ ...	12
1¾ ...	18
1¼ ...	27½
1 ...	35
¾ ...	50
½ ...	76

By repeating these observations at inclinations of 40′, and at various other angles, Mr Hawksbee found that the curve was an exact hyperbola in all directions of the planes. To the very same conclusion we are led by the principles already laid down; for as the distance between the plates diminishes at every point of the curve D*qom*F from D towards F, the water ought to rise higher at *o* than at *q*, still higher at *m*, and highest of all at F, where the distance between the plates is a minimum. To illustrate this more clearly, let ABEF and CDEF (fig. 28) be the same plates of glass (inclined at a greater angle for the sake of distinctness), and let F*mq*D, and F*os*B be the curves which bound the surface of the elevated fluid. Then, since the altitudes of the water in capillary tubes are inversely as their diameters, or the distances of their opposite sides, the altitudes of the water between two glass plates should at any given point be inversely as the distances of the plates at that point. Now, the distance of the plates at the point *m* is obviously *mo*, or its equal *np*, and the distance at *q* is *qs* or *rt*; and since *mn* is the altitude of the water at *m*, and *qr* its altitude at *q*, we have *mn* : *qr* = *rt* : *np*; but (GEOMETRY, Sect. IV.

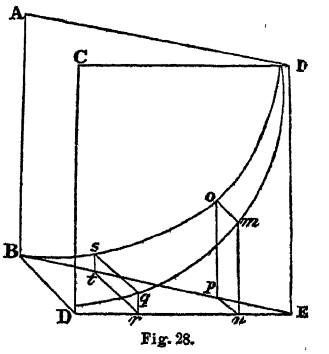


Fig. 28.

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Theor. xvii.) $En : Er = np : rt$; therefore $mn : qr = Er : En$, that is, the altitudes of the fluid at the points m, q, which are equal to the abscissæ En, Er (fig. 27), are proportional to the ordinates qr, mn, equal to the abscissæ Er, En, in fig. 27. But in the Apollonian hyperbola the ordinates are inversely proportional to their respective abscissæ, therefore the curve $DqmF$ is the common hyperbola.

129. Mr Hawksbee extended his experiments to plates of glass placed parallel to each other, and separated to different distances, and he obtained the following results :—

Distance of plates.	Height of ascent.	Constant quantity.
0·0625 of an inch.	0·166 of an inch.	0·0104
0·03125 ...	0·333 ...	0·0104
0·015625 ...	0·666 ...	0·0104
0·007802 ...	1·333 ...	0·0104

The following experiments on the same subject have been more recently made by M. Monge, MM. Haüy and Tremery, and M. Gay Lussac.

In those made by M. Monge, the plates were first cleaned with caustic alkali, and well washed. Their degree of separation was ascertained by silver wires of different thicknesses, and the fluid used was the filtered water of the Seine. The following were the results :—

Distance of plates in parts of a line.	Height of ascent.	Constant quantity.
$\frac{4}{5}$ or 0·0101 inch.	15·5 lines.	0·1565
$\frac{4}{25}$ 0·0068	33·5	0·2278
$\frac{1}{25}$ 0·0030	74	0·222

The following result was obtained by MM. Haüy and Tremery :—

Distance of plate.	Height of ascent.	Const. quantity.
1 millimètre	6·5 millimètres.	6·5

The following measures were obtained by M. Gay Lussac, with plates of glass ground perfectly flat :—

Distance of plates.	Height of ascent above lowest point of concavity.	Temp. centig.
1·069 millimètre.	13·574	16°

Here the constant quantity is 14·51, or 0·02251, when reduced to English inches for a distance of $\frac{1}{100}$th of an inch.

130. The phenomena which we have been considering are all referrible to one simple fact, that the particles of glass have a stronger attraction for the particles of water than the particles of water have for each other. This is the case with almost all other fluids except mercury, the particles of which have a stronger attraction for each other than for glass. When capillary tubes, therefore, are plunged in this fluid, a new series of phenomena present themselves to our consideration. Let MN (fig. 29) be a vessel full of mercury. Plunge into the fluid the capillary tube CD, and the mercury, instead of rising in the tube, will remain stationary at E, its depression below the level surface AB being inversely proportional to the diameter of the bore. This was formerly ascribed to a repulsive force supposed to exist between mercury and glass, but we shall presently see that it is owing to a very different cause.

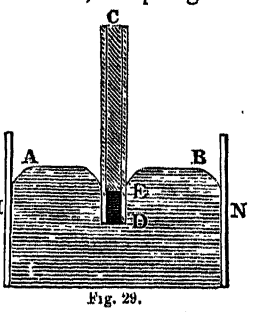


Fig. 29.

131. That the particles of mercury have a very strong attraction for each other, appears from the globular form which a small portion of that fluid assumes, and from the resistance which it opposes to any separation of its parts. If a quantity of mercury is separated into a number of minute parts, all these parts will be spherical; and if two of these spheres be brought into contact, they will instantly rush together, and form a single drop of the same form. There is also a very small degree of attraction existing between glass and mercury; for a globule of the latter very readily adheres to the lower surface of a plate of glass.

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Now, suppose a drop of water laid upon a surface anointed with grease, to prevent the attraction of cohesion from reducing it to a film of fluid, this drop, if very small, will be spherical. If its size is considerable, the gravity of its parts will make it spheroidal, and as the drop increases in magnitude, it will become more and more flattened at its poles, like AB in fig. 30. The drop, however, will still retain its convexity at the circumference, however oblate be the spheroid into which it is moulded by the force of gravity. Let two pieces of glass oAm, pBn, be now brought in contact with the circumference of the drop; the mutual attraction between the particles of water which enabled it to preserve the convexity of its circumference, will yield to their superior attraction for glass; the space $mnop$ will be immediately filled; and the water will rise on the sides of the glass, and the drop will have the appearance of AB in fig. 31. If the drop AB (fig. 30) be now supposed mercury instead of water, it will also, by the gravity of its parts, assume the form of an oblate spheroid; but when the pieces of glass oAm, pBn are brought close to its periphery, their attractive force upon the mercurial particles is not sufficient to counteract the mutual attraction of these particles; the mercury, therefore, retains its convexity at the circumference, and assumes the form exhibited in fig. 32. The small spaces o, p (fig. 30) being filled by the pressure of the superincumbent fluid, while the spaces below m, n still remain between the glass and the mercury. Now if the two plates of glass A, B be made to approach each other, the depressions m, n will still continue, and when the distance of the plates is so small that these depressions or indentations meet, the mercury will sink between the plates, and its descent will continue as the pieces of glass approach. Hence the depression of the mercury in capillary tubes becomes very intelligible. If two glass planes forming a small angle, as in fig. 27, be immersed in a vessel of mercury, the fluid will sink below the surface of the mercury in the vessel, and form an Apollonian hyperbola like DoF, having for its asymptotes the common intersection of the planes and the surface of mercury in the vessel.

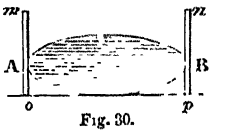


Fig. 30.



Fig. 31.

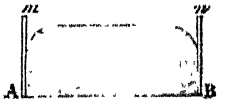


Fig. 32.

132. The depression of mercury in capillary tubes is evidently owing to the greater attraction which the particles of mercury have for each other than for glass. The difference between these two attractions, however, arises from an imperfect contact between the mercury and the capillary tube, occasioned by the interposition of a thin coating of water which generally lines the interior surface of the tube, and weakens the mutual action of the glass and mercury; for this action always increases as the thickness of the interposed film is diminished by boiling. In the experiments which were made by Laplace and Lavoisier on barometers, by boiling the mercury in them for a long time, the convexity of the interior surface of the mercury was often made to disappear. They even succeeded in rendering it concave, but could always restore the convexity by introducing a drop of water into the tube. When the ebullition of the mercury is sufficiently strong to expel all foreign particles, it often rises to the level of the surrounding fluid, and the depression is even converted into an elevation.

133. Between mercury and water there is likely to be some fluid in which the attraction of the glass for its particles is nearly equal to half the attraction of the fluid for itself. Sir David Brewster has observed that iodine dissolved in chloride of sulphur approximates to this condition; but not having the chloride by itself, he could not observe whether or not the effect is produced or influenced by the

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iodine. If it is, then a solution may be obtained in which the above condition is perfect. The solution of the iodine already mentioned scarcely rises on the sides of the glass ball which contains it.

134. As most philosophers seem to agree in thinking that all the capillary phenomena are referable to the cohesive attraction of the superficial particles only of the fluid, a variety of experiments has been made in order to determine the force required to raise a horizontal solid surface from the surface of a fluid. Mr Achard found that a disc of glass, $1\frac{1}{2}$ French inches in diameter, required a weight of 91 French grains to raise it from the surface of the water at 69° of Fahrenheit, which is only 37 English grains for each square inch. At $44\frac{1}{2}$° of Fahrenheit the force was $\frac{1}{14}$th greater, or $39\frac{1}{2}$ grains, the difference being $\frac{1}{143}$ for each degree of Fahrenheit. From these experiments Dr Young concludes that the height of ascent in a tube of a given bore, which varies in the duplicate ratio of the height of adhesion, is diminished about $\frac{1}{180}$th for every degree of Fahrenheit that the temperature is raised above 50°; and he conjectures that there must have been some considerable source of error in Achard's experiments, as he never found this diminution to exceed $\frac{1}{1000}$th.

135. According to the experiments of Morveau, the force necessary to elevate a circular inch of gold from the surface of mercury is 446 grains; a circular inch of silver, 429 grains; a circular inch of tin, 418 grains; a circular inch of lead, 397 grains; a circular inch of bismuth, 372 grains; a circular inch of zinc, 204 grains; a circular inch of copper, 142 grains; a circular inch of metallic antimony, 126 grains; a circular inch of iron, 115 grains; and a similar surface of cobalt required 8 grains. The order in which these metals are arranged is the very order in which they are most easily amalgamated with mercury.

The most recent experiments on the adhesion of surfaces to fluids have been made by M. Gay Lussac, who obtained the following results with a circular plate of glass 118·366 millimetres in diameter:—

Names of fluids.	Weight necessary to raise the plate from the glass.	Specific gravity.
Water	59·40 grammes.	1·000
Alcohol.....	31·08 ...	0·8196
Alcohol.....	32 87 ...	0·8595
Oil of turpentine.....	37·152 ...	0·9415

With a copper disc, 116·604 millimetres in diameter, the weight necessary to raise it from water, at the temperature of 18°·5 centigrade, was 57·945 grammes, differing very little, if at all, from glass; for the diminution of weight may be explained by the circumstance of the copper disc being nearly *two* millimetres less in diameter than the glass. In these experiments the discs were suspended from the scale of a balance, and the weights in the other scale successively increased till the force of adhesion was overcome at the instant when the disc detached itself from the fluid surface.

136. The approach of two floating bodies has been ascribed by some to their mutual attraction, and by others to the attraction of the portions of fluid that are raised round each by the attraction of cohesion. Dr Young, however, observes, that the approach of the two floating bodies is produced by the excess of the atmospheric pressure on the remote sides of the solids, above its pressure on their neighbouring sides; or, if the experiments are performed in a vacuum, by the equivalent hydrostatic pressure or suction derived from the weight and immediate cohesion of the intervening fluid. This force varies alternately in the inverse ratio of the square of the distance; for when the two bodies approach each other, the altitude of the fluid between them is increased in the simple inverse ratio of the distance; and the mean action, or the negative pressure of the fluid on each particle of the surface, is also increased in the same ratio. When the floating bodies are surrounded by a depression, the same law prevails, and its demonstration is still more simple and obvious.

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137. A different view of the subject has been given by Monge, who made a number of accurate experiments on the subject, and deduced from them the following laws:—

1*st*. If two floating bodies, capable of being wetted with the fluid on which they float, are placed near each other, they will approach as if mutually attracted.

In order to explain this law, let AB, CD (fig. 33) be two suspended plates of glass, placed at such distance that the

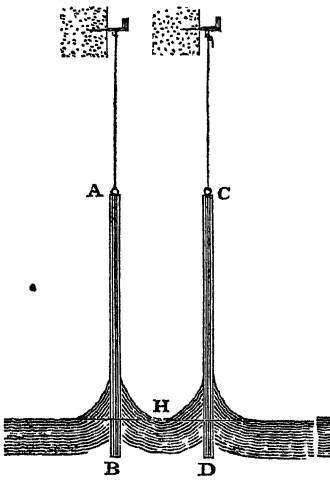


Fig. 33.

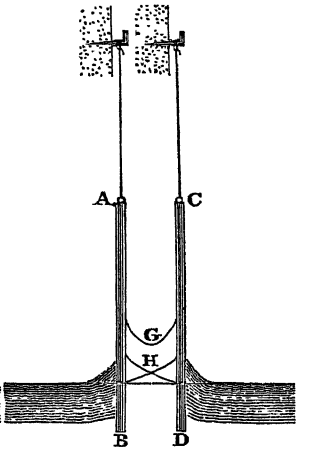


Fig. 34.

point H, where the two portions of elevated fluid meet, is on a level with the rest of the water, the two plates will remain stationary and in perfect equilibrium. But if they are brought nearer one another, as in fig. 34, the water will rise between them to a point H above the level, and by a nearer approximation, to the point G. The water thus elevated, acting like a curved chain hung to the two plates, attracts the sides of the plates, and brings them together in a horizontal direction. The very same thing takes place with the floating bodies A, B, placed at such a distance that the water rises between them above its level, and hence these bodies will approach by the attraction of the fluid on their inner sides.

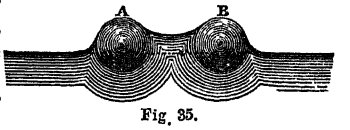


Fig. 35.

2*d*. When the two floating bodies A, B (fig. 36), are not capable of being wetted, they will approach each other as if mutually attracted, when they are placed near one another.

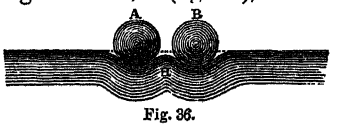


Fig. 36.

In this case the fluid is depressed between them below its natural level H, and the two bodies are pressed *inwards* or towards each other, which pressure being greater than the pressure *outwards* of the fluid between them, they will approach each other by the action of the difference of these pressures.

3*d*. If one of the bodies, A, is capable of being wetted, and the other, B, not, as shown in the fig. 37, they will recede from each other as if mutually repelled.

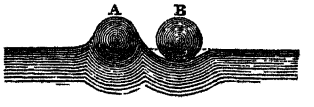


Fig. 37.

As the fluid rises round A, and is depressed round B, the depression round B will not be equal all round, and hence the body B, being placed as if on an inclined plane, will move to the right hand where the pressure is the least.

In this last case, Laplace was led by theory to believe

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that when B is placed very near A, the repulsion will be converted into attraction. M. Haüy tried this experiment with planes of ivory and talc, the former being incapable of being wetted with water and the latter not; and he found, in conformity with Laplace's prediction, that at a certain short distance the talc moved suddenly into contact with the ivory.

138. The phenomena of attraction and repulsion exhibited between small lighted wicks, swimming in a basin of oil, and the motions of floating evaporable substances like camphor, and also of potassium and light substances, such as cork, impregnated with ether, have been sometimes treated under this head. The first of these classes of phenomena arise from an unbalanced pressure upon the floating wick, arising from a difference of temperature of different parts of the oil; and the movements of the second class arise from the reaction of the currents of vapour which flow from the floating substances. A full account of these phenomena will be found in the *Edinburgh Transactions* (vol. iv., p. 44), in the *Mémoires presentées à l'Institut* (tom. i., p. 125), and the more recent observations of Matteucci, in the *Annales de Chimie* (June 1833, tom. liii., p. 216–219).

Theory of Capillary Attraction.

139. Dr Hook was one of the earliest speculators in capillary attraction. He believed that the phenomena were due to a diminution of pressure within the tube by reason of friction against its inner surface. Hawksbee, by means of the air-pump, showed that this was erroneous. Hawksbee was the first who made an approximation to the true theory of capillarity, by ascribing it to the attraction of the tube or plate. Dr Jurin corrected one of Hawksbee's experiments, together with its explanation. Newton also seems to have been in some measure acquainted with capillary attraction, if we may judge from the 31st query of the last edition of his *Optics*. But before Clairaut took up the subject, the prevalent theories on capillarity were defective in two respects; they contained no calculation founded on the hypothesis of an attraction, sensible only at insensible distances from the attracting centres, although Newton had then shown the existence of such forces; and no account of the cohesive attraction of the parts of the fluid for each other were recognised. Clairaut, then, was the first to see the necessity of taking into account the action of the fluid on itself; he was the first mathematician who attempted to analyze the forces which contribute to the ascent of fluids in capillary tubes.[1] After pointing out the insufficiency of preceding theories, he gives an analysis of the different forces which contribute to the suspension of fluids in capillary tubes.

Fig. 38.

Let ABCDEFGH (fig. 38) be the section of a capillary tube, MNP the surface of the water in the vessel, *Ii* the height of its ascent, viz., the concave surface of the fluid column, and IKLM an indefinitely small column of fluid reaching to the surface at M. Now the column ML is solicited by the force of gravity which acts through the whole extent of the column, and by the reciprocal attraction of the moleculæ, which, though they act the same in all the points of the column, only exhibit their effects towards the extremity M. If any particle *e* is taken at a less distance from the surface than the distance at which the attraction of the liquid generally terminates, and if *mn* is a plane parallel to MN, and at the same distance from the particle *e*, then this particle will be equally attracted by the water between the planes MN, *mn*. The water, however, below *mn*, will attract the particle downwards, and this effect will take place as far as the distance where the attraction ceases.

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The column IK, on the other hand, which is in a state of equilibrium with ML, is acted upon by the force of gravity through the whole extent of the column, also by other forces at the upper and lower extremities of the tube. The forces exerted at the upper part of the column are, the attraction of the tube upon the particles of water, and the reciprocal attraction of these particles; but as every particle is as much drawn upwards as downwards by the first of these forces, the consideration of it may be dropped. In order to estimate the other force, let a horizontal plane, VX, touch the concavity at I, a particle *p*, situated infinitely near to I, is attracted by all the particles above VX, and by all below it whose sphere of activity comprehends that particle; and as the particles above *p* are fewer than those below it, the result of these forces must be a force acting downwards.

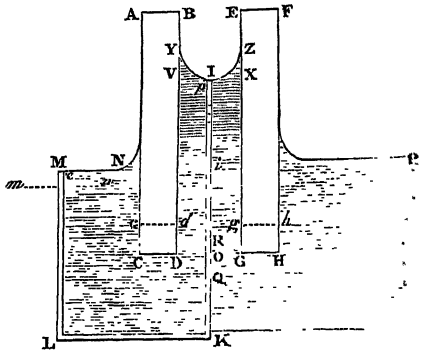


Fig. 38.

In order to estimate the value of the forces which act at the lower end O of the tube, let us suppose that the tube has a prolongation to the bottom of the vessel, formed of matter of the same density as the water. Let a particle R, be situated a little above the extremity of the tube, and another Q, as much below that extremity, they will be equally acted upon by the water above that plane, and by the water between the fictitious prolongation of the tube, and therefore these forces will destroy one another.

By applying to the case of the particle R the same reasoning that was used for the particle *e*, it will appear that the result of its attraction by the tube is an attraction upwards. The particle R is likewise attracted downwards by the supposed prolongation of the tube, and the difference between these is the real effect. The other particle Q is also drawn upwards by the tube with the same force as R, since, by the hypothesis, it is as far distant from the points D, G, as the particle R is from the points *d*, *g*, where, with respect to it, the real attraction of the tube commences. The particle Q is attracted also downwards, by the supposed prolongation of the tube, and the difference of these actions is the real effect. Hence the double of this force is the sum of all the forces that act at the lower part of the tube. These forces, when combined with those exerted at the top of the tube, and with the force of gravity, give the total expression, which should be combined with that of the forces with which the column ML is actuated.

The formula obtained by Clairaut for the altitude *Ii* (fig. 38) is

$$Ii = \frac{(2Q - Q')\int dx\,[b, x] + \int dx \left[b, x, Q, Q\right]}{p};$$

in which Q is the intensity of the attraction of the glass, Q′ the intensity of the attraction of the water, *b* the interior radius of the tube, and *p* the force of gravity.

Clairaut then observes, that there is an infinitude of pos-

[1] *Théorie de la Figure de la Terre*, chap. x. Paris, 1743, 1808.

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sible laws of attraction which will give a sensible quantity for the elevation of the fluid Ii above the level MN, when the diameter of the tube is very small, and a quantity next to nothing when the diameter is considerable; and he remarks, that we may select the law which gives the inverse ratio between the diameter of the tube and the height of the liquid, conformable to experiment.

140. It follows from the preceding formula, that if any solid, AB (fig. 39), possesses half the attracting power of the fluid CD, the surface of the fluid will remain horizontal; for the attraction being represented by DA, DE, and DC, DA and DE may be combined into DB, and DB and DC into DF, which is vertical. The water will therefore not be raised, since the surface of a fluid at rest must be perpendicular to the resulting direction of all the forces which act upon it.

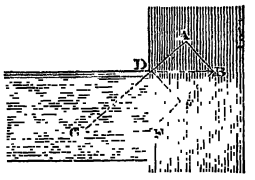


Fig. 39.

When the attracting power of the solid is more than half as great, the resultant of the forces will be GF (fig. 40), and therefore the fluid must rise towards the solid, in order to be perpendicular to GF. When the attractive power of the solid is less than that of the fluid, the resultant will be HF; and therefore, as in the case of mercury, the surface must be depressed, in order to be perpendicular to the force.

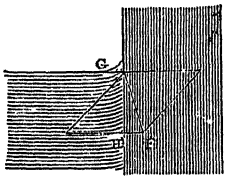


Fig. 40.

Segner, Monge, and Dr Young's views on capillarity.

141. In 1751, Segner, without having seen any of Clairaut's published memoirs, attempted theoretically the determination of the form of the surface of a water-drop resting on a horizontal plane, assuming that the particles of the fluid have an attraction for each other. The nature of this problem is the same as that of determining the form of the upper surface of a fluid column sustained in a capillary tube: neither of these problems had engaged the attention of mathematicians. Segner proposed a theory, but he owned that it is defective.

Monge, in 1787, attempted an explanation of the apparent attraction and repulsion of small bodies floating on fluids: the principle on which he grounds his explanations is the same as the more exact interpretations of the same phenomena by Young, Laplace, and Poisson. Monge did not follow up his investigations by analysis.

Dr Young's *Essay on the Cohesion of Fluids*, containing his theory of capillary attraction, was read before the Royal Society, December 1804. His views of the subject are similar to those of Segner and Monge. He refers the phenomena observed in capillary tubes to the cohesive attraction of the superficial particles of the fluid, in so far as it gives rise to a uniform tension of the surface. In support of his theory, he makes two assumptions—1*st*, that the tension of the fluid surface is known; 2*d*, that at the juncture of a fluid surface with the surface of a solid, there is an appropriate angle of contact between the two surfaces. This angle for glass and water is nearly evanescent, whereas for glass and mercury it is about 140°: on these two assumptions, he thinks that a theory of capillary attraction can be satisfactorily built. In the latter part of his essay, he shows how his assumptions may be derived from ulterior physical principles.

The subject of capillary attraction has more recently occupied the attention of the Marquis de Laplace, who published his theory in 1806. In 1807 he published a supplement to his theory, in which he compares his formula with the experiments of Gay Lussac and others.

Account of Laplace's theory.

In the first treatise published by M. Laplace, his method of considering the phenomena was founded on the form of the surface of the fluid in capillary spaces, and on the conditions of equilibrium of this fluid in an infinitely narrow canal, resting by one of its extremities upon this surface, and by the other on the horizontal surfaces of an indefinite fluid, in which the capillary tube was immersed. In his supplement to that treatise, he has examined the subject in a much more popular point of view, by considering directly the forces which elevate and depress the fluid in this space. By this means, he is conducted easily to several general results, which it would have been difficult to obtain directly by his former method.

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142. Let AB (fig. 41) be a vertical tube whose sides are perpendicular to its base, and which is immersed in a fluid that rises in the interior of the tube above its natural level. A thin film of fluid is first raised by the action of the sides of the tube; this film raises a second film, and this second film a third film, till the weight of the volume of fluid raised exactly balances all the forces by which it is actuated. Hence it is obvious, that the elevation of the column is produced by the attraction of the tube upon the fluid, and the attraction of the fluid for itself. Let us suppose that the inner surface of the tube AB is prolonged to E, and after bending itself horizontally in the direction ED, that it assumes a vertical direction DC; and let us suppose the sides of this tube to be so extremely thin, or to be formed of a film of ice, so as to have no action on the fluid which it contains, and not to prevent the reciprocal action which takes place between the particles of the first tube AB and the particles of the fluid. Now, since the fluid in the tubes AE, CD is in equilibrio, it is obvious that the excess of pressure of the fluid in AE is destroyed by the vertical attraction of the tube and of the fluid upon the fluid contained in AB. In analyzing these different attractions, Laplace considered first those which take place under the tube AB. The fluid column BE is attracted, 1*st*, by itself; 2*d*, by the fluid surrounding the tube BE. But these two attractions are destroyed by the similar attractions experienced by the fluid contained in the branch DC, so that they may be entirely neglected. The fluid in BE is also attracted vertically by the fluid in AB; but this attraction is destroyed by the attraction which it exercises in the opposite direction upon the fluid in BE, so that these balanced attractions may likewise be neglected. The fluid in BE is likewise attracted vertically upwards by the tube AB, with a force which we shall call Q, and which contributes to destroy the excess of pressure exerted upon it by the column BF raised in the tube above its natural level.

Analysis of the capillary forces.

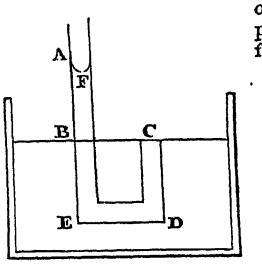


Fig. 41.

Now, the fluid in the lower part of the round tube AB is attracted, 1. By itself; but as the reciprocal attractions of a body do not communicate to it any motion if it is solid, we may, without disturbing the equilibrium, conceive the fluid in AB frozen. 2. The fluid in the lower part of AB is attracted by the interior fluid of the tube BE, but as the latter is attracted upwards by the same force, these two actions may be neglected as balancing each other. 3. The fluid in the lower part of BE is attracted by the fluid which surrounds the ideal tube BE, and the result of this attraction is a vertical force acting downwards, which we may call $-Q'$, the contrary sign being applied, as the force is here opposite to the other force Q. As it is highly probable that the attractive forces exercised by the glass and the water vary according to the same function of the distance, so as to differ only in their intensities, we may employ the constant coefficients ρ, ρ' as measures of their intensity, so that the forces Q and $-Q'$ will be proportional to ρ, ρ'; for the interior surface of the fluid which surrounds the tube

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BE, is the same as the interior surface of the tube AB. Consequently, the two masses, viz., the glass in AB, and the fluid round BE, differ only in their thickness; but as the attraction of both these masses is insensible at sensible distances, the difference of their thicknesses, provided their thicknesses be sensible, will produce no difference in the attractions. 4. The fluid in the tube AB is also acted upon by another force, namely, by the sides of the tube AB in which it is inclosed. If we conceive the column FB divided into an infinite number of elementary vertical columns, and if at the upper extremity of one of these columns we draw a horizontal plane, the portion of the tube comprehended between the plane and the level surface BC of the fluid will not produce any vertical force upon the column; consequently, the only active vertical force is that which is produced by the ring of the tube immediately above the horizontal plane. Now, the vertical attraction of this part of the tube upon BE, will be equal to that of the entire tube upon the column BE, which is equal in diameter, and similarly placed. This new force will therefore be represented by $+Q$. In combining these different forces, it is manifest that the fluid column BF is attracted upwards by the two forces $+Q$, $+Q$, and downwards by the force $-Q'$; consequently the force with which it is raised upwards will be $2Q-Q'$. If we represent by V the volume of the column BE, by D its density, and by g the force of gravity, then gDV will represent the weight of the elevated column; but as this weight is in equilibrio with the forces by which it is elevated, we have the following equation:—

$$g\mathrm{D}V=2Q-Q'.$$

If the force $2Q$ is less than Q', then V will be negative, and the fluid will sink in the tube; but as long as $2Q$ is greater than Q', V will be positive, and the fluid will rise above its natural level; as was long before shown by M. Clairaut.

Since the attractive forces, both of the glass and the fluid, are insensible at sensible distances, the surface of the tube AB will act sensibly only on the column of fluid immediately in contact with it. We may therefore neglect the consideration of the curvature, and consider the inner surface as developed upon a plane. The force Q will therefore be proportional to the width of this plane, or what is the same thing, to the interior circumference of the tube. Calling c, therefore, the circumference of the tube, we shall have $Q=\rho c$; ρ being a constant quantity, representing the intensity of the attraction of the tube AB upon the fluid, in the case where the attractions of different bodies are expressed by the same function of the distance. In every case, however, ρ expresses a quantity dependent on the attraction of the matter of the tube, and independent of its figure and magnitude. In like manner we shall have $Q'=\rho' c$; ρ' expressing the same thing with regard to the attraction of the fluid for itself, that ρ expressed with regard to the attraction of the tube for the fluid. By substituting these values of Q, Q', in the preceding equation, we have

$$g\mathrm{D}V=c(2\rho-\rho').$$

If we now substitute, in this general formula, the value of c in terms of the radius if it is a capillary tube, or in terms of the sides if the section is a rectangle, and the value of V in terms of the radius and altitude of the fluid column, we shall obtain an equation by which the heights of ascent may be calculated for tubes of all diameters, after the height, belonging to any given diameter, has been ascertained by direct experiment.

Application of the formula to cylindrical tubes;

143. In the case of a cylindrical tube, let π represent the ratio of the circumference to the diameter, h the height of the fluid column reckoned from the lower point of the meniscus, q the mean height to which the fluid rises, or the height at which the fluid would stand if the meniscus were to fall down and assume a level surface, then we have πr^3 for the solid content of a cylinder of the same height and radius as the meniscus; and as the meniscus, added to the solid contents of the hemisphere of the same radius, must be equal to πr^3, we have $\pi r^3-\frac{2\pi r^3}{3}$, or $\frac{\pi r^3}{3}$, for the solid content of the meniscus. But since $\frac{\pi r^3}{3}=\pi r^2\times\frac{r}{3}$, it follows that the meniscus $\frac{\pi r^3}{3}$ is equal to a cylinder whose base is πr^2, and altitude $\frac{r}{3}$. Hence, we have

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$$q=h+\frac{r}{3};$$

or what is the same thing, the mean altitude q in a cylinder is always equal to the altitude h of the lower point of the concavity of the meniscus increased by one-third of the radius, or one-sixth of the diameter of the capillary tube. Now, since the contour c of the tube $=2\pi\rho$, and since the volume V of water raised is equal to $q\times\pi r^2$, we have, by substituting these values in the general formula,

$$g\mathrm{D}q\pi r^2=2\pi r(2\rho-\rho'). \quad \text{(No. 1.)}$$

and dividing by πr and gD, we have,

$$rq=2\frac{2\rho-\rho'}{g\mathrm{D}} \text{ and } q=2\frac{2\rho-\rho'}{g\mathrm{D}}\times\frac{1}{r}. \quad \text{(No. 2.)}$$

Application of the formula to Gay Lussac's experiments on water;

144. In applying this formula to Gay Lussac's experiments, we have the constant quantity,

$$2\frac{2\rho-\rho'}{g\mathrm{D}}=rq=\cdot647205\times\overline{23\cdot1634+0\cdot215735}=15\cdot1311,$$

for Gay Lussac's first experiment. In order to find the height of the fluid in his second tube by means of this constant quantity, we have

$$r=\frac{1\cdot90381}{2}=0\cdot951905, \text{ and } 2\frac{2\rho-\rho'}{g\mathrm{D}}\times\frac{1}{3}=q=\frac{15\cdot1311}{0\cdot951095}$$

$=15\cdot8956$, from which, if we subtract one-sixth of the diameter, or 0·3173, we have 15·5783 for the altitude h of the lower point of the concavity of the meniscus, which differs only 0·0078 from 15·861, the observed altitude.

to Gay Lussac's experiments on alcohol;

If we apply the same formula to Gay Lussac's experiments on alcohol, we shall find the constant quantity $2\frac{2\rho-\rho'}{g\mathrm{D}}=6\cdot0825$ as deduced from the first experiment, and $h=6\cdot0725$, which differs only by 0·0100 from 6·08397, the altitude observed.

From these comparisons, it is obvious that the mean altitudes, or the values of q, are very nearly reciprocally proportional to the diameters of the tubes; for, in the experiments on water, the value of q deduced from this ratio is 15·895, which differs little from 15·9034, the value found from experiment; and that, in accurate experiments, the correction made by the addition of the sixth part of the diameter of the tube is indispensably requisite.

to rectangular capillary spaces.

145. If the section of the pipe in which the fluid ascends is a rectangle, whose greater side is a, and its lesser side d, then the base of the elevated column will be $=ad$, and its perimeter $c=2a+2d$. Hence, the value of the meniscus will be

$$\frac{ad^2}{2}-\frac{a\pi d^2}{8}=\frac{ad^2}{2}\left(1-\frac{\pi}{4}\right), \text{ that is } q=h+\frac{d}{2}\left(1-\frac{\pi}{4}\right).$$

Hence, if in the general equation No. 1 we substitute for c its equal $2a+2d$, and for V its equal adq, we have

$$g\mathrm{D}qad=\overline{2\rho-\rho'}\times\overline{2a+2d},$$

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and dividing by a and by g D, we have

$$dq = 2\,\frac{2\rho-\rho'}{g\mathrm{D}} \times \sqrt{1+\frac{d}{a}}, \text{ and}$$

$$q = 2\,\frac{2\rho-\rho'}{g\mathrm{D}} \times \frac{\sqrt{1+\frac{d}{a}}}{d}.$$

In applying this formula to the elevation of water between two glass plates, the side a is very great compared with d, and therefore the quantity $\frac{d}{a}$, being almost insensible, may be safely neglected. Hence the formula becomes

$$q = 2\,\frac{2\rho-\rho'}{g\mathrm{D}} \times \frac{1}{d}.$$

Comparison of the formula with Gay Lussac's experiments.

By comparing this formula with the formula No. 2, it is obvious that water will rise to the same height between plates of glass as in a tube, provided the distance d between the two plates of glass is equal to r, or half the diameter of the tube. This result was obtained by Newton, and has been confirmed by the experiments of succeeding writers.

As the constant quantity $2\,\frac{2\rho-\rho'}{g\mathrm{D}}$ is the same as already found for capillary tubes, we may take its value, viz., 15·1311, and substitute it in the preceding equation, we then have

$$q = \frac{15{\cdot}1311}{1{\cdot}060} = 14{\cdot}1544\text{; and since}$$

$$h = q - \frac{d}{2}\left(1-\frac{\pi}{2}\right), \text{ subtracting}$$

$$\frac{d}{2}\left(1-\frac{\pi}{4}\right) = 0{\cdot}1147, \text{ we have}$$

$h = 14{\cdot}0397$, which differs very little from 13·574, the observed altitude, and $d = 1{\cdot}060$.

It will be seen from the formula No. 2, that of all tubes that have a prismatic form, the hollow cylinder is the one in which the volume of fluid raised is the least possible, as it has the smallest perimeter. It appears, also, that if the section of the tube is a regular polygon, the altitudes of the fluid will be reciprocally proportional to the homologous lines of the similar base, a result which, as we have seen, M. Gellert obtained from direct experiment. Hence, in all prismatic tubes whose sections are polygons inscribed in the same circle, the fluid will rise to the same mean height. If one of the two bases is, for example, a square, and the other an equilateral triangle, the altitudes will be as $2 : 3\frac{3}{4}$, or very nearly as 7 : 8.

Fluids may be in a state of stable and unstable equilibrium in the same tube.

146. M. Laplace has remarked that there may be several states of equilibrium in the same tube, provided its width is not uniform. If we suppose two capillary tubes communicating with one another, so that the smallest is placed above the greatest, we may then conceive their diameters and lengths to be such that the fluid is at first in equilibrium above its level in the widest tube, and that in pouring in some of the same fluid, so as to reach the smaller tube, and fill part of it, the fluid will still maintain itself in equilibrio. When the diameter of a capillary tube diminishes by insensible gradations, the different states of equilibrium are alternately stable and unstable. At first the fluid tends to raise itself in the tube, and this tendency diminishing, becomes nothing in a state of equilibrium. Beyond this it becomes negative, and consequently the fluid tends to descend. Thus the first equilibrium is stable, since the fluid, being a little removed from this state, tends to return to it. In continuing to raise the fluid, its tendency to descend diminishes, and becomes nothing in the second state of equilibrium. Beyond this it becomes positive, and the fluid tends to rise, and consequently to remove from this state which is not stable. In a similar manner it will be seen, that the third state is stable, the fourth unstable, and so on.

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Connexion between the rise of fluids and the curvature of their surface.

147. Although the preceding method of considering the phenomena of capillary attraction is extremely simple and accurate, yet it does not indicate the connexion which subsists between the elevation and depression of the fluid, and the concavity or convexity of the surface which every fluid assumes in capillary spaces. The object of M. Laplace's first method, contained in his first supplement, is to determine this connexion.

By means of the methods for calculating the attraction of spheroids, he determines the action of a mass of fluid terminated by a spherical surface, concave or convex, upon a column of fluid contained in an infinitely narrow canal, directed towards the centre of this surface. By this action Laplace means the pressure which the fluid contained in the canal would exercise, in virtue of the attraction of its entire mass upon a plane base situated in the interior of the canal, and perpendicular to its sides, at any sensible distance from the surface, this base being taken for unity. He then shows that this action is smaller when the surface is concave than when it is plane, and greater when the surface is convex. The analytical expression of this action is composed of two terms. The first of these terms, which is much greater than the second, expresses the action of the mass terminated by a plane surface; and the second term expresses the part of the action due to the sphericity of the surface, or, in other words, the action of the meniscus comprehended between this surface and the plane which touches it. This action is either additive to the preceding, or subtractive from it, according as the surface is convex or concave. It is reciprocally proportional to the radius of the spherical surface; for the smaller that this radius is, the meniscus is the nearer to the point of contact.

From these results relative to bodies terminated by sensible segments of a spherical surface, Laplace deduces this general theorem: "In all the laws which render the attraction insensible at sensible distances, the action of a body terminated by a curve surface upon an interior canal infinitely narrow, perpendicular to this surface in any point, is equal to half the sum of the actions upon the same canal of two spheres, which have for their radii the greatest and the smallest of the radii of the osculating circle of the surface at this point."

148. By means of this theorem, and the laws of hydrostatics, Laplace has determined the figure which a mass of fluid ought to take when acted upon by gravity, or contained in a vessel of a given figure. The nature of the surface is expressed by an equation of partial differences of the second order, which cannot be integrated by any known method. If the figure of the surface is one of revolution, the equation is reduced to one of ordinary differences, and is capable of being integrated by approximation, when the surface is very small. Laplace next shows, that a very narrow tube approaches the more to that of a spherical segment as the diameter of the tube becomes smaller. If these segments are similar in different tubes of the same substance, the radii of their surfaces will be inversely as the diameter of the tubes. This similarity of the spherical segments will appear evident, if we consider that the distance at which the action of the tube ceases to be sensible is imperceptible; so that if, by means of a very powerful microscope, this distance should be found equal to a millimetre, it is probable that the same magnifying power would give to the diameter of the tube an apparent diameter of several metres. The surface of the tube may therefore be considered as very nearly plane, in a radius equal to that of the sphere of sensible activity; the fluid in this interval will therefore descend, or rise from this surface very

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nearly as if it were plane. Beyond this, the fluid being subjected only to the action of gravity and the mutual action of its own particles, the surface will be very nearly that of a spherical segment of which the extreme planes, being those of the fluid surface, at the limits of the sphere of the sensible activity of the tube, will be very nearly in different tubes equally inclined to their sides. Hence it follows that all the segments will be similar.

149. The approximation of these results gives the true cause of the ascent or descent of fluids in capillary tubes in the inverse ratio of their diameter. If in the axis of a glass tube we conceive a canal infinitely narrow, which bends round like the tube ABEDC in fig. 41, the action of the water in the tube in this narrow canal will be less, on account of the concavity of its surface, than the action of the water in the vessel on the same canal. The fluid will therefore rise in the tube to compensate for this difference of action; and as the concavity is inversely proportional to the diameter of the tube, the height of the fluid will be also inversely proportional to that diameter. If the surface of the interior fluid is convex, which is the case with mercury in a glass tube, the action of this fluid on the canal will be greater than that of the fluid in the vessel, and therefore the fluid will descend in the tube in the ratio of their difference, and consequently in the inverse ratio of the diameter of the tube.

Fig. 41.

In this manner of viewing the subject, the attraction of capillary tubes has no influence upon the ascent or depression of the fluids which they contain, but in determining the inclination of the first planes of the surface of the interior fluid extremely near the sides of the tube, and upon this inclination depends the concavity or convexity of the surface, and the length of its radius. The friction of the fluid against the sides of the tube may augment or diminish a little the curvature of its surface, of which we see frequent examples in the barometer. In this case the capillary effects will increase or diminish in the same ratio.

The differential equation of the surfaces of fluids inclosed in capillary spaces of revolution, conducts Laplace to the following general result: That if into a cylindrical tube we introduce a cylinder which has the same axis as that of the tube, and which is such that the space comprehended between its surface and the interior surface of the tube has very little width, the fluid will rise in this space to the same height as in a tube whose radius is equal to this width. If we suppose the radii of the tube and of the cylinder infinite, we have the case of a tube included between two parallel and vertical planes, very near each other. This result has been confirmed, as we have already seen, by the experiments of Newton, Haüy, and Gay Lussac. Laplace then applies his theory to the phenomena presented by a drop of fluid, either in motion or suspended in equilibrio either in a conical capillary tube, or between two plates, and inclined to each other, as discovered by Mr Hawksbee; to the mutual approximation of two parallel and vertical discs immersed in a fluid; to the phenomena which take place when two plates of glass are inclined to each other at a small angle; and to the determination of the figure of a large drop of mercury laid upon a horizontal plate of glass.

M. Gauss's correction of Laplace's theory.

150. Laplace has failed in giving a satisfactory proof of the constancy of the *angle of contact*, or that angle which the free surface of the fluid makes with its surface of contact. Gauss, in 1830, endeavoured to rectify the defect by forming his equations of equilibrium on the principle of *virtual velocities* (see MECHANICS) which he applies to the whole mass of fluid, and not to a differential element, as Lagrange has done. By this method he obtains a sextuple integral, which extends to the whole mass, and which is to be a minimum; if the fluid be supposed homogeneous and incompressible, the integral becomes quadruple. Further, the integral may become single, if the only forces acting be gravity and the molecular attractions of the fluid and containing solid, and if the sphere of activity of the two attractions be insensible. He also arrived at two equations, one relative to the free surface, and which is Laplace's fundamental equation; the other relative to the angle of contact, and which corresponded with Dr Young's result.

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151. Poisson's first memoir on the theory of capillary attraction was read before the Paris Academy, November 1828. In it his object is to form the equations of equilibrium of fluids on physical principles, *i.e.*, by assuming that a mass of fluid is made up of distinct molecules, separated one from another by spaces excessively small, and void of ponderable matter.

Poisson's theory of capillary attraction, first memoir.

As a preliminary to the discussion, the magnitude of these molecules, as also the spaces between them, are assumed to be so small, that a line which may be supposed to be a great multiple of them is of insensible magnitude. The molecules are attractive of each other, and at the same time are repulsive, owing to their proper heat: their action and reaction are equal; the force decreases rapidly as the distance increases, and it is only sensible at insensible distances. The influence of these attractive centres is felt at distances very great when compared with the molecular spaces, and the rapid decrease to commence only at distances which are large multiples of these small intervals.

By *molecular action* is to be understood the excess of the repulsion over the attraction of the molecules, and this force is supposed to be different for different points of any two molecules. The mean value is called the *principal force*, and the *secondary force* is the variation from this normal value, according as different points of the molecules are directed towards each other. The secondary force is important in solids, inasmuch as it gives rise to their rigidity and resistance to the lateral motion of their molecules; the want of this force in fluids causes their particles to be very mobile. It is thus that a fluid is distinguished by Poisson from a solid: If a point be taken anywhere in the interior of a fluid mass, and a straight line of insensible length, but a great multiple of the mean intervals between the molecules, be drawn in any direction from that point, the mean interval between the molecules that lie in the line is constant, though the particles may be irregularly disposed along it.

Reasoning on the ground of these suppositions, Poisson forms equations relative to the pressure in the interior of a fluid mass, which are the same as if he had started from the supposition of the equality of pressure in every direction. His reasoning on the above suppositions leads him to the explanation of a known fact; but for all this, his assumptions cannot be declared true until they satisfy all the facts which are known to depend on the intimate constitution of fluids. He afterwards finds the equations of equilibrium relative to the surface of separation of two fluids incumbent on one another, and one of the fluids being suppressed, the equation of the free surface of a single fluid. His first memoir closes with this principal conclusion: Capillary phenomena are due to the molecular action resulting from the calorific repulsion, and an attractive force, and modified not only by the form of the surfaces, as in Laplace's theory, but, moreover, by a particular state of compression of the fluid at its superficies. He shows that the variation of density near the surface is extremely rapid, and also that the molecular attractions in fluids as well as in solids extends farther than the calorific repulsion.

Poisson's second memoir.

152. In the year 1834, Poisson confirmed the above conclusion, and the consequences which flow from it with respect to capillary phenomena, in his *Nouvelle Theorie de l'Action Capillaire*, published in *L'Institut* for May that year. The object of Poisson in this treatise, is to bring the theory of capillary attraction to the greatest degree of perfection that the power of analysis, and the knowledge of

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facts will admit. In the first chapter it is proved that if the rapid variation of density near the surface were neglected, the fluid within the tube would be horizontal, and there would be neither elevation nor depression. He shows also that we must take account of the variable compression to which the fluid is subject near the surface of the tube, and reaching to the extent of the action due to the solid. From this it would appear that Laplace's theory is somewhat defective, although it explains phenomena. When the fluid is supposed to be incompressible, he finds the equation for the angle of contact to be of the same value as what Dr Young found for it, as also Gauss from the theory of Laplace. If, however, the variation of density be taken into account, the equation will no longer hold.

He next finds the equation of the free surface of a fluid in equilibrium in a capillary space, by taking into account any variation of density that may exist at the fluid surface, although the exact law of variation be unknown; and afterwards he determines on the same principles the equation relative to the contour of the capillary surface.

Comparison of theory with experiment.

153. In this theory of Poisson are two principal equations which are the same in form as those of Laplace's theory, and which lead to like results. Generally, however, Poisson has carried his analysis farther than Laplace had done, and so has obtained results more conformable with experiment. Thus, Gay Lussac showed by experiment that the elevation of the lowest point of the capillary surface in a tube 1·9038 mill. (= ·075 in.) in diameter, is 15·5861 mill.; on Poisson's theory, it is 15·5829 mill.; and on that of Laplace, 15·5787 mill. In investigating the case where two fluids are superincumbent the one on the other in the same tube, the formulæ of Laplace and Poisson agree, and they are applied to the solution of a curious phenomenon observed by Dr Young. Into a capillary tube containing water, a drop of oil was inserted, when Dr Young saw that the superior surface of the oil depressed itself below the original height of the water. The depression, doubtless, refers to the centre of the capillary surface where it cuts the axis of the tube. If it be assumed that the oil in descending moistened the tube, and that the water did not wet it originally throughout its whole extent, Poisson's theory accounts for the fact.

154. The pressure of fluids modified by capillary action receives considerable attention; he determines both vertical and horizontal pressures on a solid partly immersed in a fluid; and from the calculation of the latter it appears, that when a plate which has its two parallel faces of different substances is the solid immersed, the horizontal pressures on the opposite faces counterbalance each other, and so the solid can have no motion of translation.

155. Various problems which had engaged the attention of previous mathematicians receive more correct solutions by means of Poisson's theory, and are more carefully compared with experiment. The following is one of these results:—When two plates having parallel surfaces are immersed in a fluid, which rises against the surface of one, and is depressed near that of the other, it is found that the fluid surface between them may assume two different forms when the plates are near each other. There is a point of inflection in one which is retained, however near the plates be brought to each other, and in this case they are mutually repulsive, the force being independent of the interval between them; the other is the form noted by Laplace, which contains no inflection, and when it subsists the repulsive changes to an attractive force on making the plates approximate. Poisson explains this by saying, that the first form obtains when the plates, originally at a great distance, are gradually brought near each other; and that the second takes place when, one plate having been previously immersed, the other is inserted into the curved portion of the fluid contiguous to it.

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156. Besides the usual problems which this theory solves, Poisson has given the solutions of two which no former mathematician ever attempted; one relates to the form of fluid poured upon another fluid of greater specific gravity; the other has reference to the adhesion of the base of a capillary solid cylinder to a fluid, from which it is raised with its axis vertical. This is perhaps similar to the adhesion of a fluid to a disc, but requiring a different analytical treatment.

Poisson solves two new problems.

157. The last chapter of the treatise contains notes, additions, and a comparison of new experiments. In it are contained the author's views respecting the interior constitution of bodies, particularly fluids, and the nature of molecular forces; as also the treatment of the general equations of the equilibrium of fluids. In this same chapter are several notices of other subjects which are worthy of attention. Thus, the depression of mercury in the barometer cannot be conveniently calculated by the theory unless the ratio of the radius of the tube to one of the constants be either small or great. In other cases the method of *Quadratures* must be resorted to.

Casbois, professor of physics at Metz, pointed out a method of making barometers with plane or concave surfaces, having observed that, by boiling mercury, the convexity of its capillary surface was diminished, and, by continuing the boiling a sufficient length of time, the mercurial surface in the capillary tube might become concave. Dulong explains this phenomenon. When the mercury is boiling, the surface layer in contact with the air is oxidized, and, mingling with the whole mass, changes its properties so that the action of the particles of mercury on each other, and on those of the tube, or rather on the particles of a thin coating of water which is always interposed between the mercury and the tube, is not the same as before, the change being greater in proportion to the greater quantity of metal oxidized, *i.e.*, in proportion to the boiling (132).

Endosmose.

158. Poisson lastly applies his theory to explain the phenomenon of *endosmose*. He supposes that the two fluids meet *without mixing* in the capillary tubes which permeate the membrane, and, by the relation of the molecular forces at their common surface of separation, one prevails over the other, and so passes through to the opposite side of the membrane. But the corresponding phenomenon of *exosmose* is unaccounted for (163).

Prof. Challis's estimate of the theories of Laplace and Poisson.

159. With respect to the theories of Laplace and Poisson, Professor Challis says that M. Poisson's theory will engage the attention of the speculative philosopher, and the simpler theory of Laplace will be made the vehicle of conveying to the younger students of science, in an elementary form, the explanation of a numerous and interesting class of phenomena. The same distinguished philosopher makes the following statement in his *Report of the British Association for* 1836, respecting the views of Laplace and Poisson on capillary phenomena. It does not appear that any exception can be taken to the reasoning in any part of Laplace's theory. The principles may indeed be objected to on the ground that Poisson takes up, viz., that if the molecular constitution of bodies be admitted, there must be a superficial variation of density which that theory takes no account of; as, however, experiment has not yet detected any such variation, and we have no means of assigning the amount of its influence, it would be premature to reject the theory on that ground, especially as the probability is, that the effects which this consideration has on the numerical results of the calculations will at all events be small.

Link's experiments on capillarity.

160. In the year 1834 M. Link made several experiments on capillarity.[1] His object was to determine the

[1] *Annalen der Physik und Chemie*, bd. xxix., 1833, p. 404.

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comparative ascents of different fluids by capillary attraction. Instead of using *tubes*, he employed plates, as in fig. 27, inclined at a small angle with the line of junction vertical, and so arranged the same two plates that they could be dipped and dried, and again placed in the different fluids, and the ascents of the rectangular hyperbola taken. M. Link found that when he used distilled water, nitric acid, a solution of *Kali causticum*, spirit of wine, sulphuric ether, and rectified sulphuric acid, the ascents were equal between the same two plates. This gentleman in 1836 published in the *Annalen* experiments which were made on the same subject, but not coinciding with the former, for it was found that different fluids did not ascend to equal heights between the same two plates, and the experiments only partially confirmed the law to which theory leads, of equal ascents of the same fluid between plates of different material well moistened.

Frankenheim's experiments.

161. About the same time Dr Frankenheim of Breslau made experiments on the ascents of fluids in capillary glass tubes, to determine the *synaphia*, or cohesion of fluid bodies. Let h = height of ascent, r = radius of tube, then the *specific synaphia* varies as $r\,(h+\frac{1}{3}\,r)^{\frac{1}{2}}$.

Illustrations of Capillary Attraction.

Examples of capillary attraction.

162. Many natural phenomena are due to capillary attraction, as, *e.g.*, if the foundation of a building be moist, the moisture will ascend the fine capillary tubes of the stones and mortar, and cause the walls to be damp. So also if a tract of sand or shingle have a hard impermeable base, the rain will, unless drained off, render the district damp and marshy. An excellent illustration of the fact is to be found in the expansion of wood by water. Thus, in the south of France, a large cylinder of freestone, of a proper diameter, and several feet in length, has a number of circular grooves made round its surface; into these grooves wedges of dry wood are driven, and then well soaked with water. After a few hours, the solid cylinder breaks up into rough millstones, which require very little labour to render them fit for the market. Again, it is well known that on a line of rail the rails are secured to the *sleepers* by means of *chairs*, and a wooden *key* binds both rail and chair firmly together. The key must remain immoveable in its position; and in order to do this it is first thoroughly steamed, then subjected to a pressure of 12 lbs. on the square inch. The key is now kept in the drying-house till required, when it is easily driven into its cavity, while the moisture, entering its capillary tubes, causes it to expand, and hold rail and chair together with great tenacity. This expansive power of the key has been known to burst asunder its iron chair. Similarly also tight ropes may be rendered still tighter by water being thrown upon them, and consequently may become very serviceable in the arts.

Endosmose and exosmose.

163. But one beautiful application of the principle is to be found in the ascent and descent of sap in trees and plants. M. Dutrochet has named this inward and outward movement *endosmose* (ἔνδον, inwards, and ὠσμὸς, impulsion), and *exosmose* (ἔξω, outwards), respectively. All plants and trees possess cells, which contain liquids of different densities, and which are continually interchanging their contents. When the walls of the cells are thin, the fluid is drunk up very rapidly. The fluids on either side of the membrane differ from each other in density, but have some affinity for the membrane between them as well as for each other. By the endosmotic process, then, a thin liquid passes rapidly upwards in considerable quantity, mixing in its progress with liquids of a denser sort, while, by the exosmotic movement, the latter liquids pass outwards with a slower motion, and in smaller quantity than the former enters. These movements take place in both the living and dead tissue, and they are influenced by the nature of the fluids and of the membrane; they are nicely shown in the case of a unicellular plant Thus, when one of the cells of the Yeast plant is placed in a dense liquid, it rapidly loses, by an outward movement, its liquid contents, since the cell becomes more or less collapsed; but if in a thin liquid, that liquid will rush up the cell and swell it. It is supposed that the bursting of the seed-vessels of several plants is due to the distention of the cells by endosmose, which causes a curvature in the parts, and ultimately rupture. Endosmose, however, is modified in the living plant by the vital actions going on within the cells, and to these actions are due the continued movements of fluids through the cell walls.

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Experiment with two fluids.

164. The whole process of the endosmotic and exosmotic movement may be shown by the following experiment. Take a glass vessel filled with alcohol, having its open end covered tight with a bladder, which has been previously well soaked in water, and is now in close contact with the alcohol. Let this apparatus be immersed in a vessel containing water, the bladder being under the surface. At the end of a few hours, it will be found that so much water has penetrated the bladder-covering and mixed with the alcohol, while a smaller quantity of the latter has made its escape and mingled with the water. On taking up the glass vessel, the surface of the bladder, instead of being flat, will now be puffed outwards and highly convex, so that, if pricked with a needle, a fine column of liquid will be seen ascending to a height of several feet. The ascent of the one is partly caused by capillary attraction, partly also by the chemical affinity of the two fluids, while the greater penetration of the water is owing to the less powerful attraction of the capillary tubes of the bladder on that fluid. The alcohol, being more strongly attracted by the tubes of the bladder, flows out less readily.

Experiment with two gases.

The principle may also be illustrated with two different gases; thus, take a common glass tumbler full of air, and tie carefully over its open end an india-rubber covering. Place it now under a large bell-glass full of hydrogen, and resting in a dish of water, and it will be found that the hydrogen will gradually penetrate the rubber covering, and mix with the confined air. Such a quantity of hydrogen will mix with the air that the rubber will be much distended, and at last burst. If we reverse the experiment, and put hydrogen in the tumbler, surrounded by air, the rubber will become concave instead of convex.

Intensity of the forces.

We may have an idea of the intensity of the forces which take place during these endosmotic and exosmotic movements from the simple fact, that if a glass or porcelain vessel, capable of resisting a pressure of 700 lbs. on the square inch, have its neck well stoppled with a dry piece of wood, and if the projecting end be allowed to dip into water, the liquid will rush up the capillary tubes of the wood, and in a short time break the vessel to pieces. Dutrochet estimated that with a vessel filled with fluid of a density 1·3, and placed in water, the endosmotic force would be equal to a pressure of $4\frac{1}{2}$ atmospheres.

On the Form of Drops.

Monge on the form of drops.

165. It was observed by M. Monge, that when drops of alcohol fall upon a surface of the same fluid, they do not at first mix with it, but roll over its surface, impinge against each other, and are reflected like billiard balls. He observed also an analogous phenomenon in the drops of water which fall from the oars during the rowing of a boat, and during the condensation of the vapour of warm fluids.

In repeating the experiments of Monge, Sir David Brewster found that the phenomena were most beautiful when the capillary tube discharged the drops upon the inclined plane of fluid which is elevated by the attraction of the edge of the cup. They ran down the inclined plane

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with great velocity, and sometimes even ascended the similar plane on the opposite side of the vessel. When the drop was discharged at the distance of one or two tenths of an inch from the surface of the water, they had always the same magnitude when the tube was held in the same position; but when the point of the tube was brought within a tenth of an inch of the surface of the spirit of wine, this surface, instead of attracting the drop to it instantly, as Saussure would have predicted, actually resisted the gravity or weight of the drop, and allowed it to attain a diameter nearly twice as great as it would have had, if it had been discharged in the ordinary manner. This swollen globule floated upon the surface in the same manner as the smaller drops, surrounded with a depression of the fluid surface similar to what is produced by a glass globule floating on mercury, or by the feet of particular insects, that have the power of running upon the surface of water. The floating globules are often produced even when they are discharged from a height of three or four inches; and by letting them fall upon the inclined plane of the fluid formerly mentioned, they will often rebound from the surface, and fall over the sides of the cup.

Opening in a fluid film.

166. In a phenomenon the very reverse of the formation of a drop, which was first noticed by Sir David Brewster, the cohesion of fluids is shown in a very interesting manner. If we take a phial, with a wide mouth, half filled with Canada balsam, and allow the balsam to flow to the mouth of the phial and fill it up, then when the phial is placed on its bottom, a fine transparent film of balsam will be seen extending over the mouth of the phial. If we now take a piece of slender wire, and touch the film near the middle, so as to tear away a little part of it, the remaining part of the film which has been elevated by this force will descend to its level position, and the ragged aperture from which the balsam has been torn will be seen to assume a form perfectly circular, having its edge in a slight degree thickened, like a circle with a raised margin turned out of a piece of wood. This fine circular aperture grows wider and wider, and continues to preserve its circular form till the mouth of the phial is again opened.

Experiment by Sir D. Brewster.

167. We shall now conclude the subject of capillary attraction with an account of an experiment made by Sir David Brewster, and intimately connected with the subject. Above a vessel MNOP (fig. 42), nearly filled with water, a convex lens, LL, was placed at the distance of the tenth of an inch, and rays R, R, R, were incident upon its upper surface. The focus of these rays was at F, a little beyond the bottom of the vessel, so that a circular image of the luminous object was seen on the bottom of the vessel, having AB for its diameter. If the lens is now made to descend gradually towards the surface of the water, and the eye kept steadily upon the luminous image AB, a dark spot will be seen at D in the centre of AB, a little while before the lens attracts and elevates the water MN. Sometimes this spot may be seen playing backwards and forwards by the slight motion of the hand, so that the lens can even be withdrawn from the fluid surface without having actually touched it. In general, however, the sudden rise of the water to the lens follows the appearance of the black spot. When the water is in contact with the glass, the focus of the rays R, R, is now transferred to *f*, and the circular image on the bottom is now *ab*, and the intensity of the light in this circle is to that in the circle AB, as $AB^2 : ab^2$. Now it is obvious, that the darkish spot at D is just the commencement of the transference of the focus from F to *f*; or when the dark spot is produced, the progress of the rays is the same as if the focus were transferred to *f*. This remarkable effect may arise from two causes. 1*st*. The approach of the lens to the surface MN, may occasion a depression *mon* in the surface of the fluid of the same curvature as L*l*L, which would have the effect of transferring the focus from F to *f*. 2*d*. The transference of the focus from F to *f* may arise from the optical contact of the glass and water taking place at a greater distance from the lens than that at which capillary attraction commences.

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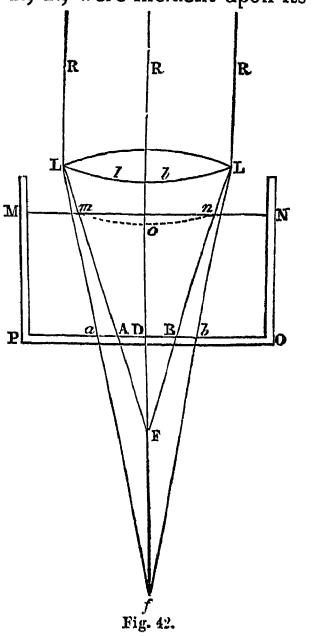


Fig. 42.

PART II.—HYDRAULICS.

Definition.

168. Hydraulics is that branch of the science of Hydrodynamics which relates to fluids in motion. It comprehends the theory of running water, whether issuing from orifices in reservoirs by the pressure of the superincumbent mass, or rising perpendicularly in *jets d'eaux* from the pressure of the atmosphere; whether moving in pipes and canals, or rolling in the beds of rivers. It comprehends also the resistance or the percussion of fluids, and the oscillation of waves.

CHAPTER I.—THEORY OF FLUIDS ISSUING FROM ORIFICES IN RESERVOIRS, EITHER IN A LATERAL OR A VERTICAL DIRECTION.

Preliminary observations.

169. If water issues from an orifice either in the bottom or side of a reservoir, the surface of the fluid in the reservoir is always horizontal till it reaches within a little of the bottom. When a vessel, therefore, is emptying itself, the particles of the fluid descend in vertical lines, as is represented in fig. 43; but when they have reached within three or four inches of the orifice *mn*, the particles which are not immediately above it change the direction of their motion, and make for the orifice in directions of different degrees of obliquity. The velocities of these particles may be decomposed into two others, one in a horizontal direction, by which they move parallel to the orifice, and the other in a vertical direction, by which they approach that orifice. Now, as the particles about C and D move with greater obliquity than those nearer E, their horizontal velocities must also be greater, and their vertical velocities less. But the particles near E move with so little obliquity that their vertical are much greater than their horizontal velocities, and very little less than their absolute ones. The different particles of the fluid, therefore, will rush through the orifice *mn* with very different velocities, and in various directions, and will arrive at a certain distance from the orifice in different times. On account of the mutual adhesion of the fluid particles, however, those which have the greatest

Cause of the vena contracta.



Fig. 43.

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velocity drag the rest along with them; and as the former move through the centre of the orifice, the breadth of the issuing column of fluid will be less at *op* than the width of the orifice *mn*.

170. That the preceding phenomena really exist when a vessel of water is discharging its contents through an aperture, experience sufficiently testifies. If some small substances specifically heavier than water be thrown into the fluid when the vessel is emptying itself, they will at first descend vertically, and when they come within a few inches of the bottom they will deviate from this direction, and describe oblique curves similar to those in the figure. The contraction of the vein or column of fluid at *op* is also manifest from observation. It was first discovered by Sir Isaac Newton, and denominated the *vena contracta*.

171. When the orifice is in a thin plate this will be the case, and the contracted part being outside the reservoir may be clearly seen and accurately measured. When the orifice is circular, the vein having attained its least section continues cylindrical in form and has a velocity nearly equal to that due to the charge. Hence the discharge will be the product of the contracted section into the velocity, so that the effect of the contraction is limited to the reduction of the value of the section which enters into the expression of the discharge. The flow will take place as if the real circular opening in the vessel were replaced by one the diameter of which would be equal to the section of contraction, but in which imaginary opening no contraction takes place in the vein issuing out of it. But if to the circular orifice we attach a cylindrical pipe the fluid threads converge on arriving at the junction of the pipe and the wall of the vessel, and so the section of contraction takes place at the entrance of the pipe. But now beyond this section of contraction the sides of the tube attract, and therefore cause the fluid threads to dilate on all sides; and these issuing parallel to each other and to the axis of the pipe, wholly fill the tube, so that the section of the vein equals at its exit the orifice in the vessel's side, but the velocity is not that due to the charge. Were the flow produced solely by the pressure of the fluid, then the velocity at the section of contraction would be that due to the charge, and would diminish in proportion as the fluid vein enlarged itself in virtue of the hydraulic axiom,—that when an incompressible fluid in motion forms a continuous mass, the velocity at all its diverse sections is inversely proportional to the area of the section; the velocity then would cease to diminish when the diverging vein had reached the sides of the tube. Again, when the orifice is at the lowest part of the vertical side of a vessel, the lower edge coinciding with the floor of the vessel, the contraction is then destroyed on that side, and the discharge is somewhat increased. If, instead of a cylindrical adjutage, we make use of a conical mouth-piece, or one converging to a point exterior to the side of the reservoir, then there will be two distinct contractions of the vein, one at the entrance of the adjutage, which will necessarily diminish the velocity due to the charge, and the other at a small distance beyond the issue, the breadth of which will be less than that of the external mouth. Such an adjutage is very regular, throws the water to a greater distance or height, and has a greater flow than that through an orifice in a thin plate. These conical or truncated pyramidal adjutages are frequently used in large manufactories for discharging water upon mill-wheels. The case of the adjutage having its narrow mouth fitted into the side of the reservoir, gives us the largest flow from any kind of tube: it will necessarily have one contracted part at the orifice.

This last kind of adjutage was known to the ancient Romans; several citizens had been granted the privilege of drawing a certain volume of water from the public reservoirs, but as they increased their supply by using this kind of tube, the fraud was detected, and the use of these tubes legally forbidden except at a distance of 52 feet or upwards from the reservoir.

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Form of contracted vein.

172. Since the direction and velocity of the fluid particles constituting a vein are symmetrical around the parts of the circular orifice, the contracted vein must also be symmetrical in form, and therefore some solid of revolution; it is found to be a conoidal figure. It is actually so, as we shall afterwards see, from observations that have been made upon it. Beyond *op* (fig. 43), the narrowest section of contraction, this contraction ceases, and the vein continues sensibly cylindrical for some distance till the resistance of the air and the weight of each particle, together with other causes, entirely destroys the form of the curve.

173. The three principal parts of the vein were early investigated, and their ratios determined. Thus the diameters *mn* and *op*, and the length *mo*, are in the ratio of the numbers 1·00 : 0·79 : 0·39, *i.e.*, on this supposition the distance of the contracted vein is about one-half the diameter of the smaller section, and 0·39 of the orifice. But Michelotti, from a mean of more recent experiments, has ranked them in the ratio of 1·00 : 0·787 : 0·498, which D'Aubuisson follows. The ratio, then, of *mn* to *op* being as 1·00 : 0·787, the sectional areas of each will be $1^2 : (0{\cdot}787)^2 = 1^2 : {\cdot}619$. The distance also of the contracted vein from the orifice will be a very little more than half the diameter of the orifice, or $mo = \frac{mn}{2}$ nearly: If s, now, be the contracted section, and S that of the orifice, $s = 0{\cdot}619$ S.

174. We proceed now to find the ratio subsisting between the velocities of the particles in the vessel and at the orifice.

We may suppose that the mass of fluid is divided into infinitely small horizontal laminæ or layers, as NM*gh* (fig. 43), each particle in the same section having the same velocity, and all descending parallel to each other. Let each particle in the vessel have a velocity v; V, the velocity of escape; A, the horizontal section of the vessel; S or mS, that of the orifice at the bottom, where m is the *coefficient of contraction*. During a time, t, a volume will escape $= m\text{S} \,.\, \text{V} \,.\, t$, but during this same time, the fluid surface of the water will descend through a space M*g*, say = velocity of particles into time $= v \,.\, t$, and the corresponding volume will be $\text{A} \,.\, v \,.\, t$, which must be the same volume as that discharged at the orifice during time t. Therefore $\text{A} \,.\, v \,.\, t = m\text{S} \,.\, \text{V} \,.\, t$; or $\text{A} \,.\, v = m\text{S}\text{V}$, *i.e.*, $v : \text{V} = m\text{S} : \text{A}$; or the velocities are inversely as the sections. Hence, if the area mS of the orifice be infinitely small with respect to the area A of the horizontal section of the laminæ, the mean velocity of escape will be infinitely greater than that of the laminæ; that is, while the velocity at the orifice is finite, that of the laminæ will be infinitely small.

175. Before applying these principles to the theory of hydraulics, it may be proper to observe, that several distinguished philosophers have founded the science upon the same general law from which we have deduced the principles of hydrostatics (48). In this way they have represented the motion of fluids in general formulæ; but these formulæ are so complicated from the very nature of the theory, and the calculations are so intricate, and sometimes impracticable from their length, that they can afford no assistance to the practical engineer.

176. *Definition.*—If the water issue at *m n* with the same velocity V, that a heavy body would acquire by falling freely through a given height H, this velocity is said to be due to the height H, and inversely the height H is said to be due to the velocity V. The quantity H is also termed the *head* or *charge* under which the flow takes place. Fig. 43.

177. PROP. I.—The velocity with which a fluid escapes from a small orifice in the bottom or side of a vessel kept constantly full, equals that attained by a

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heavy body falling freely from the surface of the fluid to the orifice.

It will be proved in MECHANICS, that, when a heavy body is projected obliquely upwards, the composition of the accelerating force of gravity, and the uniform velocity V of projection, will cause the body, during a time, t, to move in a curve called a *parabola*, the equation to which is found to be $y^2 = 4hx$, where h = height due to velocity, x the abscis in the direction of gravity, y the ordinate parallel to the direction of projection, or x and y are the co-ordinates for any point of the curve.

Now, this is true, whatever be the nature of the body; and, therefore, also for a jet of water issuing from an orifice. Let the orifice be opened in the side at A (fig. 44), then

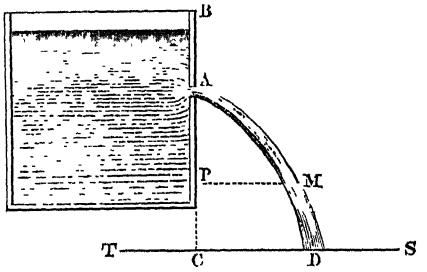


Fig. 44.

the jet will assume the form AMD. The equation $y^2 = 4hx$ gives us $h = \frac{y^2}{4x}$ = height due to velocity of exit. This value of h may be easily calculated by placing a vertical graduated stick alongside the vessel, and having its zero point at the centre of the orifice, with another moving at right angles, and also graduated; this last will give us any ordinate, as PM or CD; and therefore, also, the corresponding abscissa AP or AC. Wherefore, by measuring the ordinate and its corresponding abscis, the height h due to the velocity of exit may be determined from the equation to the parabola. But the velocity which a body (by mechanics) falling freely attains, after passing through a certain height h, is represented by $V = \sqrt{2gh}$. Therefore, the velocity of issue at the orifice is that due to the height BA.

If the orifice be at the bottom, the velocity will be that due to a fall from the surface to the orifice.

178. COR. 1.—As fluids press equally in all directions, the preceding proposition will hold true when the orifices are at the sides of vessels, and when they are formed to throw the fluid upwards, either in a vertical or an inclined direction, provided that the orifices are in these several cases at an equal distance from the upper surface of the fluid.

COR. 2.—When the fluid issues vertically, it will rise to a height equal to the perpendicular distance of the orifice from the surface of the fluid; owing to the resistance of the air, however, and the friction of the issuing fluid upon the sides of the orifice, jets of water do not exactly rise to this height.

179. If H be the height from which a falling body is dropped, then the velocity which it acquires after a certain time, will be equal to that of any particle of the fluid as it issues from an orifice, or $V = \sqrt{2gH}$, where g = the velocity, which a body falling freely would attain at the end of a unit of time. If the mean velocity of all the particles be that due to a *charge* H, then the theoretic velocity is $V = \sqrt{2gH}$. Supposing, then, that the fluid threads issue from the orifice parallel to each other, and knowing the velocity of the charge of one particle, the theoretic discharge, or that volume which escapes in a unit of time, will evidently be the volume of a prism, having for its base that of the orifice, and that velocity for height. Calling then S the area of the orifice. S . V represents the theoretic discharge, or $S \cdot V = S\sqrt{2gH}$.

But the actual discharge is always less than that theoretically determined; and in order to have an exact idea of this, take a perpendicular section of the fluid vein at a small distance from the orifice; then since the discharge is manifestly equal to the sectional area into the mean velocity of any thread at the instant it is crossing that section, it is clear that if this section were equal to that of the orifice, and if the velocity were that due to the charge, then the actual would be equal to the theoretic discharge. But, whether from the section of the vein being less than that of the orifice, as in the case of a flow through a thin plate, or from the velocity being less than that due to the charge, as in cylindrical pipes; or from a diminution in both section and velocity, as in the case of conical adjutages, the result always is, that the actual is less than the theoretic discharge, and so the latter must always be multiplied by some fractional number, so as to obtain the former. Let this fractional number be m, the coefficient of contraction, then the actual volume discharged $= mS\sqrt{2gH}$.

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180. The reader will probably be surprised when he finds in some of our elementary works on hydrostatics, that the velocity of the water at the orifice is only equal to that which a heavy body would acquire by falling through *half* the height of the fluid above the orifice. This was first maintained by Sir Isaac Newton, who found that the diameter of the *vena contracta* was to that of the orifice as 21 to 25. The area therefore of the one was to the area of the other as 21^2 to 25^2, which is nearly the ratio of 1 to $\sqrt{2}$. But by measuring the quantity of water discharged in a given time, and also the area of the *vena contracta*, Sir Isaac found that the velocity at the *vena contracta* was that which was due to the *whole* altitude of the fluid above the orifice. He therefore concluded, that since the velocity at the orifice was to that at the *vena contracta* as $1 : \sqrt{2}$, and the latter velocity was that which was due to the whole altitude of the fluid, the former velocity, or that at the orifice, must be that which is due to only *half* that altitude, the velocities being as the square roots of the heights. Now the difference between this theory and that contained in the preceding proposition may be thus explained. The velocity found by the preceding proposition is evidently the vertical velocity of the filaments at any point, which being immediately above the centre of the aperture are not diverted from their course, and have therefore their vertical equal to their absolute velocity. But the vertical velocity of the particles below and above the former is much less than their absolute velocity, on account of the obliquity of their motion, and also on account of their friction on the sides of the orifice. The mean vertical velocity, consequently, of the issuing fluid will be much less than the vertical velocity of the first particle, that is, than the velocity found by the above proposition, or that due to the full height. Now the velocity found by Sir Isaac Newton from measuring the quantity of water discharged, was evidently the mean velocity, which ought to be less than the velocity given by the preceding proposition; the two velocities being as $1 : \sqrt{2}$, or as 1 : 1·414. The theorem of Newton therefore may be considered as giving the mean velocity at the orifice, while the proposition gives the velocity of the particles at the surface, or the velocity at the *vena contracta*.

181. PROP. II.—To find the volume discharged from a very small orifice in the side or bottom of a reservoir kept constantly full, the time of discharge and the altitude of the fluid being given.

Let S = area of orifice, Q = volume discharged in time T, and call H the height of the fluid, or the constant charge due to the constant height. Then, since the actual discharge in a unit of time or one second, is $Q = mS\sqrt{2gH}$

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(179), therefore, the volume discharged during T units or seconds, will be QT, or $Q' = m\,S\,T\,\sqrt{2gH}$.

Wherefore, Q', m, S, T or H, may be easily determined, all the others being given.

The diminution of discharge conceived as arising from the sectional area or velocity diminishing, is always a consequence of the contraction of the vein in passing through the orifice. It is the variation in the actual, from the theoretical discharge, that gives rise to m, the *coefficient of contraction*, equal to the ratio of the actual to the theoretical discharge. It is a very important number, for, on its exactness depends the accuracy of formulæ when practically applied to the flow of water; m is always determined experimentally.

182. It is supposed in the preceding proposition that the orifice in the side of the vessel is so small, that every part of it is equally distant from the surface of the fluid. But when the orifice is large, like M (fig. 45), the depths of different parts of the orifice below the surface of the fluid are very different, and consequently the preceding formula will not give very accurate results. If we suppose the orifice M divided into a number of smaller orifices, a, b, c, it is evident that the water will issue at a with a velocity due to the height Da, the water at b, with a velocity due to the height Eb, and the water at c, with a velocity due to the height Fc. When the whole orifice, therefore, is opened, the fluid will issue with different velocities at different parts of its section. Consequently, in order to find new formulæ expressing the quantity of water discharged, we must conceive the orifice to be divided into an infinite number of areas or portions by horizontal planes; and by considering each area as an orifice, and finding the quantity which it will discharge in a given time, the sum of all these quantities will be the quantity discharged by the whole orifice M.

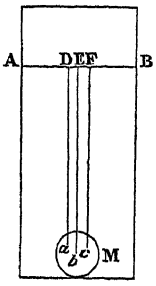


Fig. 45.

183. PROP. III.—To find the volume discharged by a rectangular slit in the vertical side of a vessel, kept constantly full.

Let M (fig. 46) be the vessel, of a vertical height AB, equal to the depth, and l the width of the slit. If now we have a series of elementary rectangular orifices placed vertically in the side of M, then if the lowest be at a depth AB or H, below the fluid surface, the velocity with which the fluid issues from this orifice will be $\sqrt{2gH}$. Now we may make BG equal to this quantity, and this ordinate will represent the velocity, while the abscis does the depth; so also we may take any other point C, at a depth C or AC $= x$, and the velocity of issue will be represented by CD $= y = \sqrt{2gx}$; the same will be the case for all other points in AB, and, evidently, if we join all the ordinate points as C, D, &c., we shall have a parabolic curve; and as $y^2 = 2gx$, where $2g$ or 64·4 feet is the parameter, we shall have the velocity of a fluid thread issuing from a reservoir at any point equal to the ordinate of a parabola, the parameter of which is twice the measure of the accelerating force of gravity, with a depth under the surface as the abscissa.

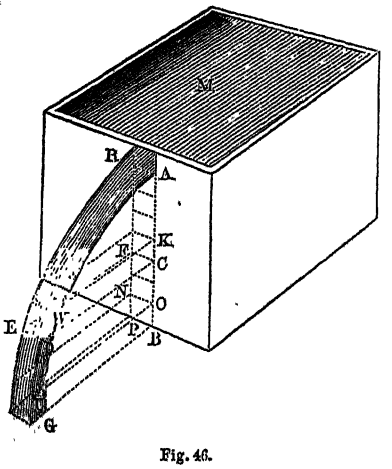


Fig. 46.

Suppose now that all the rectangular orifices in the depth AB were opened, making a rectangular slit ABPR, with a width of l units, the discharge through this opening may thus be obtained. Since the surface of the jet has been proved to be parabolic, we shall evidently have a volume of water which shall be the frustum of a paraboloid, the side of which will be ABGDA, and width l; and since the area of a parabola $= \frac{2}{3}$ds of the rectangle contained by AB and BG, and AB.BG $= H.\sqrt{2g.H}$, therefore the volume, or the discharge for the rectangular opening, is $= \frac{2}{3}.l.H.\sqrt{2gH} = \frac{2}{3}\,l.H\,\sqrt{H}.\sqrt{2g}$.

184. PROP. IV.—To find the volume discharged from a rectangular orifice.

This volume may be deduced from the last. Let the rectangular orifice have a width equal to l, and a depth, $=$OB; call AO $= h$, therefore, the volume of discharge by the frustal paraboloid AOUA $= \frac{2}{3}\,l.h.\sqrt{2gh}$, or $= \frac{2}{3}\,l.h.\sqrt{h}.\sqrt{2g}$. Hence the discharge by the rectangular orifice OBPN = the discharge by ABPR, less that by AONR $= \frac{2}{3}\,l.H.\sqrt{H}.\sqrt{2g} - \frac{2}{3}\,l.h.\sqrt{h}.\sqrt{2g} = \frac{2}{3}\,l.\sqrt{2g}\,(H\sqrt{H} - h\sqrt{h})$.

185. PROP. V.—To determine the mean velocity from the above slit (Prop. III.)

The mean velocity of the fluid from the rectangular opening ABPR, may be thus obtained. Let K be the point from which would issue a fluid thread with the mean velocity; and making the depth AK $= z$, the mean velocity for this thread will be $= \sqrt{2gz}$, which, multiplied by the area or l.H, will give the volume discharged with the mean velocity from the opening ABPR, $= l.H.\sqrt{2g}.\sqrt{z}$. But we have already seen, that the total discharge from the opening itself $= \frac{2}{3}\,l.H.\sqrt{H}.\sqrt{2g}$;

$$\therefore\ l.H.\sqrt{2g}.\sqrt{z} = \tfrac{2}{3}\,l.H\sqrt{H}.\sqrt{2g};$$

or, $\sqrt{z} = \frac{2}{3}\sqrt{H}$, or $z = \frac{4}{9}$ H. Consequently, since the mean velocity, which call V, $= \sqrt{2gz}$;

$$\therefore\ V = \sqrt{2g}.\tfrac{4}{9}.H = \tfrac{2}{3}\sqrt{2gH},$$

that is to say, that the mean velocity is $\frac{2}{3}$ds that with which the lowermost fillet issues; and so KW, which represents the former velocity, will be $\frac{2}{3}$ds of BG, which represents the latter.

186. PROP. VI.—To determine the mean velocity of the rectangular orifice OBPN of last figure.

The mean velocity of the fluid from the rectangular orifice OBPN, the depth being $(H - h)$, and width l, may also be found. Call z' the depth of that point from which would issue a fluid thread with the mean velocity; then the discharge from OBPN with the mean velocity $= (H - h).l.\sqrt{2gz'}$; but the total velocity from this orifice is $\frac{2}{3}\,l.\sqrt{2g}\,(H\sqrt{H} - h\sqrt{h})$;

$$\therefore\ (H-h).l.\sqrt{2g}\sqrt{z} = \tfrac{2}{3}\,l\sqrt{2g}\,(H\sqrt{H} - h\sqrt{h});$$

or, $(H - h)\sqrt{z} = \frac{2}{3}\,(H\sqrt{H} - h\sqrt{h})$;

$$\therefore\ z' = \tfrac{4}{9}\left(\frac{H\sqrt{H} - h\sqrt{h}}{H - h}\right)^2.$$

187. We have hitherto supposed that the fluid surface has always been maintained at the same level, but suppose now that the vessel receives no supply, or receives less than it discharges by an orifice in the bottom, it is clear that the fluid will gradually near the bottom of the tank and empty itself. The laws of discharge then will be somewhat different from those previously considered. The vessels con-

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taining the fluid may be either prismatic, or the sides may slope at a known inclination.

188. PROP. VII.—Find the height due to the velocity of the fluid at its point of discharge, when the fluid surface is not maintained always at the same level.

Here V is dependent on a constantly varying height, and on v, the velocity acquired in the descent of the layers. Let then H_1 be the generating height due to the velocity V of the fluid at the point of discharge, and H always the actual height in the vessel; hence,

$$H_1 = H + \frac{v^2}{2g} = H + \frac{m^2 . S^2 . V^2}{2g . A^2} \text{ (by 174)} = H + H_1 \frac{m^2 . S^2}{A^2};$$

$$\therefore H_1 = H + H_1 \frac{m^2 . S^2}{A^2}, \text{ or } H_1 \left(1 - \frac{m^2 S^2}{A^2}\right) = H, \text{ and } H_1 \text{ is}$$

known. $m . S$ is generally small when compared with A, so also much smaller will $m^2 . S^2$ be in comparison with A^2, and therefore $\frac{m^2 S^2}{A^2}$ may be neglected; hence, $H_1 = H$, *i.e.*, the velocity of escape at any given instant is that due to the actual height of water in the vessel at that moment; a result similar to that arrived at when the fluid surface was maintained at a constant level. But the above is true only in the case of those layers or sections which are supposed to remain parallel during their descent. As soon as the parallel laminæ come within the sphere of action of the orifice, the nature of the motion is very complicated, and indeed unknown.

189. PROP. VIII.—To determine the nature of the motion which goes on within a vessel emptying itself.

Let AD (fig. 47) be a vessel filled with fluid to the brim AB, having an orifice D in the side BD; suppose BD to be divided into equal parts, Ba, ab, bc, &c.; also let P be taken opposite the centre of the orifice, and take a vertical line, PII = BD, dividing it into the same number of equal parts as BD. Now, that a body be projected from P vertically so as to reach H, it must have the same velocity impressed upon it as the body would acquire on arriving at P, when dropped freely from H, for the velocity which the body has at P in ascending, is the same as it has when descending from H. Hence, on arriving at the points a', b', c', &c., the velocities will be respectively $\sqrt{2g . Ha'}$, $\sqrt{2g . Hb'}$, $\sqrt{2g . Hc'}$... &c...0; or as $\sqrt{Ha'}$, $\sqrt{Hb'}$, $\sqrt{Hc'}$ ...&c...0. Wherefore, also, as the surface AB passes the points a, b, c, &c., the velocities of escape at the orifice will be proportional to $\sqrt{Da}$, $\sqrt{Db}$, $\sqrt{Dc}$...&c....0; that is, as the corresponding equal velocities $\sqrt{Ha'}$, $\sqrt{Hb'}$, $\sqrt{Hc'}$,...&c....0. Hence, as the vessel empties itself, the velocity of discharge gradually decreases from a maximum, $\sqrt{2g . DB}$, to a minimum as zero, following the same law as does a body when thrown vertically upwards. Each is an example of uniformly retarded motion: the velocity of escape is governed by the same law.

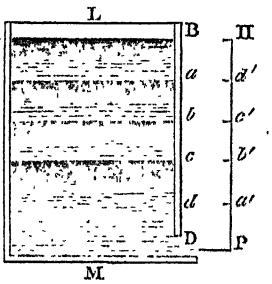


Fig. 47.

190. COR. 1.—As the velocities of falling bodies are as the square roots of the heights through which they fall (see MECHANICS), the velocities of fluids issuing from a very small orifice are as the square roots of the altitude of the water above these orifices. As the quantities of fluids discharged are as the velocities, they will also be as the square roots of the altitude of the fluid. This corollary holds true of fluids of different specific gravities, although Belidor (*Architect. Hydraul.*, tom. i., p. 187) has maintained the contrary; for though a column of mercury presses with fourteen times the force of a similar column of water, yet the column of mercury which is pushed out is also fourteen times as heavy as a similar column of water; and as the resistance bears the same proportion to the moving force, the velocities must be equal.

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191. COR. 2.—When a vessel is emptying itself, if the area of the laminæ into which we may suppose it divided, be everywhere the same, the velocity with which the surface of the fluid descends, and also the velocity of efflux, will be uniformly retarded. For as the velocity V with which the surface descends is to the velocity v at the orifice, as the area a of the orifice to the area A of the surface, then $V : v = a : A$; but the ratio of $a : A$ is constant, therefore V varies as v, that is, $V : V' = v : v'$; but, $v : v' = \sqrt{h} : \sqrt{h'}$, h being the height of the surface above the orifice, therefore $V : V' = \sqrt{h} : \sqrt{h'}$. But this is the property of a body projected vertically from the earth's surface, and as the retarding force is uniform in the one case (see MECHANICS), it must also be uniform in the other.

192. With respect to the volume discharged, we know from mechanics that when a body starts with a certain velocity which is gradually lost altogether, it describes one-half the space only that it would have described in the same time had it continued to move uniformly with the velocity with which it began. Similarly, also, the volume of fluid in the vessel may be looked upon as a cylindrical or prismatic mass, having its base equal to the dimensions of the orifice, and its height, the space which the first issuing particle would describe with a motion uniformly retarded, and identical with that by which the discharge takes place; if, now, the particle had retained its first velocity it would have doubled its space, or the height of the cylindrical or prismatic mass would have been doubled, and therefore also the volume of discharge from the orifice would have been doubled. Hence, then, it appears that the volume of fluid passing through an orifice at the bottom of a prismatic or cylindrical vessel, the surface of which is gradually nearing the orifice till the vessel empties itself, having received no supply, is equal to one-half that which would be given during the time of complete discharge, if the flow had taken place under a constant charge equal to the primary.

193. COR. 3.—If a cylindrical vessel be kept constantly full, twice the quantity contained in the vessel will run out during the time in which the vessel would have emptied itself. For the space through which the surface of the fluid at L would descend if its velocity continued uniform, being 2LM, double of LM, the space which it actually describes in the time it empties itself, the quantity discharged in the former case will also be double the quantity discharged in the latter; because the quantity discharged when the vessel is kept full, may be measured by what the descent of the surface would be, if it could descend with its first velocity,—M being regarded as the only orifice in and at the bottom of the vessel (fig. 47).

194. PROP. IX.—To find the time required to empty a vessel.

Suppose that H is its charge, A the horizontal section of the vessel, and T the time of complete discharge. The volume of water contained in the vessel above the orifice, and therefore the whole quantity discharged during the time, will be A.H. But (by 192) the volume which would have been discharged in the same time under the constant charge H would have been 2A.H. This same volume of discharge during time T equals $mST\sqrt{2gH}$, where again S or mS is the area of the orifice; whence $2A . H = mST\sqrt{2gH}$; or,

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$$T=\frac{2A.H}{mS\sqrt{2gH}}=\frac{A}{mS}\sqrt{\frac{2H}{g}}=2.\frac{A}{mS}\sqrt{\frac{H}{2g}}.$$

195. Cor.—If T′ be the time that the volume A.H would take to flow out, when the head H was constant, then (by 181),

$$A.H=mST'\sqrt{2gH};\ \therefore\ T'=\frac{A.H}{mS\sqrt{2gH}}=\frac{A}{mS}\sqrt{\frac{H}{2g}};$$

$\therefore$ from the above $T=2T'$; that is, the time which a prismatic vessel takes to be completely discharged, is double that in which the same volume would flow out, if the head had remained constantly the same as it was at the commencement of the discharge.

196. Prop. X.—To find the time that the fluid surface takes to pass through a given depth.

Let t be this time for the level to descend a vertical depth a. Now we have already seen that the time during which the whole volume will discharge itself $=\frac{2A}{mS}\sqrt{\frac{H}{2g}}$, the charge at the beginning of the flow being H; and by putting $H-a=h$ for the charge or head at the end of the time t, the time during which the volume hA would be entirely discharged $=\frac{2A}{mS}\sqrt{\frac{h}{2g}}$. Now, we have the time in which the whole volume with a head H, and that in which a head equal to h or $(H-a)$, will be discharged; therefore the time in which a head equal to a will be discharged, is the difference between these two times; or,

$$t=\frac{2A}{mS}\sqrt{\frac{H}{2g}}-\frac{2A}{mS}\sqrt{\frac{h}{2g}}=\frac{2A}{mS}\frac{1}{\sqrt{2g}}(\sqrt{H}-\sqrt{h}).$$

197. Cor.—The quantity of fluid discharged in the given time t may be found by measuring the contents of the vessel between the planes, the descent of the surface, or the depth a, being known.

198. Prop. XI.—To find the volume discharged in a given time, and the depth that the level reaches after a certain time.

From the last expression for the time required to empty a vessel, we have $\frac{tmS\sqrt{2g}}{2A}=\sqrt{H}-\sqrt{h}$; or,

$$\frac{tmS\sqrt{2g}}{2A}+\sqrt{h}=\sqrt{H},\text{ and, by squaring each side,}$$

$$\left(\frac{tmS\sqrt{2g}}{2A}\right)^2+2\left(\frac{tmS\sqrt{2g}}{2A}\right)\sqrt{h}+h=H;$$

$$\therefore\ \frac{tmS\sqrt{2g}}{A}\left(\frac{tmS\sqrt{2g}}{4A}+\sqrt{h}\right)=H-h=a=\text{the depth}$$

that the level reaches in a certain time.

If now we multiply this depth by A, the horizontal section of the vessel, we shall have the volume discharged in the time t; $\therefore$ volume discharged, say,

$$Q'=(H-h)A=tmS\sqrt{2g}\left(\frac{tmS\sqrt{2g}}{4A}+\sqrt{h}\right).$$

199. Prop. XII.—To find the mean hydraulic charge.

The prismatic vessel fig. 48 receives no supply, but discharges water through an orifice, the area of which is S; the water at the commencement of the flow has a head H, and at the end of the time T has a head equal to h; the mean hydraulic charge H′ is required, by which, *ceteris paribus*, the same volume of water would have been discharged.

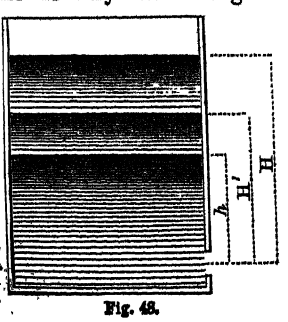


Fig. 48.

The volume with this mean head H′ will, in time T, be $Q'=mST\sqrt{2g}\sqrt{H'}=(H-h)A$; and the time in which this took place was $T=\frac{2A}{mS\sqrt{2g}}(\sqrt{H}-\sqrt{h})$. Substitute this value of T in the above expression for the volume, then,

$$Q'=mS\sqrt{2g}.\frac{2A}{mS\sqrt{2g}}(\sqrt{H}-\sqrt{h})\sqrt{H'}=(H-h)A;$$

$$\therefore\ \sqrt{H'}=\frac{H-h}{2\sqrt{H}-\sqrt{h})}=\frac{\sqrt{H}+\sqrt{h}}{2}.$$

200. Cor.—If $h=0$ $\therefore H'=\frac{H}{4}$.

Dr Young made use of this proposition in determining by experiment the coefficient of contraction at an orifice. See his experiments (383).

201. Prop. XIII.—If a prismatic vessel receive a constant supply, less however than that discharged, to find the time that the surface will take to fall through a given height.

Let the letters stand for the same things as before, and further, let the volume of water entering the basin in one second be q, and x the height through which the water descends in a given time t, then dx will be the height in the infinitely small time dt, and Adx would represent the volume during the time dt if the vessel received no supply; but since in one second it receives a supply q, it will in time dt receive qdt of a supply. Therefore the actual discharge during time $dt=Adx+qdt$; but this same volume (by 181) is expressed by $mSdt\sqrt{2g(H-x)}$; hence

$$Adx+qdt=mSdt\sqrt{2g(H-x)};\text{ let } H-x=h,$$

then $-dx=dh$, since H is constant. Wherefore,

$$qdt-Adh=mSdt\sqrt{2g}\sqrt{h};\ \therefore dt=\frac{-Adh}{mS\sqrt{2g}\sqrt{h}-q}=\frac{-Adh}{y},$$

where $mS\sqrt{2g}\sqrt{h}-q=y$: by differentiating, we have,

$$\frac{mS\sqrt{2g}}{2\sqrt{h}}=\frac{dy}{dh};\text{ or, }dh=\frac{2\sqrt{h}.dy}{mS\sqrt{2g}}=\frac{2dy}{mS\sqrt{2g}}\left(\frac{y+q}{mS\sqrt{2g}}\right);$$

$$\text{or, }dh=\frac{dy(y+q)}{m^2S^2g};\ \therefore dt=\frac{-Ady(y+q)}{y.m^2S^2g}=\frac{-A}{m^2S^2g}\left(dy+q\frac{dy}{y}\right).$$

Therefore,

$$\int dt=\frac{-A}{m^2S^2g}\int\left(dy+q\frac{dy}{y}\right);\text{ or, }t=-\frac{A}{m^2S^2g}(y+q\text{ hyp. log. }y)+C.$$

Since when $t=0$, $x=0$, and so H will $=h$;

$$\therefore\ C=\frac{A}{m^2S^2g}(y+q\text{ hyp. log. }y),\text{ and by substitution}$$

$$=\frac{2A}{(mS\sqrt{2g})^2}\left\{mS\sqrt{2g}\sqrt{H}-q+q\text{ hyp. log. }(mS\sqrt{2g}\sqrt{H}-q)\right\};$$

Therefore $t=$

$$-\frac{2A}{(mS\sqrt{2g})^2}\left(mS\sqrt{2g}\sqrt{h}-q+q\text{ hyp. log. }(mS\sqrt{2g}\sqrt{h}-q)\right)$$

$$+\frac{2A}{(mS\sqrt{2g})^2}\left(mS\sqrt{2g}\sqrt{H}-q+q\text{ hyp. log. }(mS\sqrt{2g}\sqrt{H}-q)\right)$$

$$=\frac{2A}{(mS\sqrt{2g})^2}\left(mS\sqrt{2g}(\sqrt{H}-\sqrt{h})+q\text{ hyp. log.}\left(\frac{mS\sqrt{2g}\sqrt{H}-q}{mS\sqrt{2g}\sqrt{h}-q}\right)\right).$$

Make $q=0$, then the expression becomes identical with 196.

202. If the converse question were required, viz., given the time, to find the height to which the level of the water would descend; we should be doing the same thing as if we were to determine the charge h at the end of the given time, and deduct it from H, the head at the beginning of the charge. In order to find h, successive values of it *i.e.*, $H-x$, must be substituted in the above equation, and by the process of trial and error, that value which satisfies the equation will be the one required.

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203. PROP. XIV.—To find the time of discharge from a vessel other than prismatic.

The determination of the time in this case is much more complicated than for any other form of vessel, and it is sometimes impossible. The fundamental equation, however, for this purpose is

$$A \cdot dx = mS dt\sqrt{2g(H-x)}; \quad \therefore dt = \frac{A \cdot dx}{mS\sqrt{2g(H-x)}}.$$

The form of the vessel, or a horizontal section a of its area, is variable. In order, therefore, that the above value for dt may be integrable, a must be known in terms of x, which can only be the case when the interior curvature of the basin is given. If this cannot be ascertained, we must proceed by approximations and by parts. For this purpose, the basin must be divided into horizontal sections of small depth, each of which is to be regarded as a prism, and the time determined that any one of these takes to pass out, making use of the above-mentioned formulæ. The sum of all these partial times will give the required time that the surface takes to descend a height equal to the sum of the heights of the prisms.

204. PROP. XV.—Water is discharged from one reservoir into another, find the volume discharged and the time required to fill up to different levels in one of the reservoirs.

Three cases will require to be considered.

First Case.—Suppose the orifice covered with water on both sides or faces, the levels in the reservoirs M and N (fig. 49) remaining constant; then, since the charge is $H-h$, where H is the charge for M, and h that for N, the volume discharged will be the same as if it had issued out into the open air with a velocity equal to the difference of the charges on each face. Hence, volume discharged in one unit, as a second, is $Q = mS\sqrt{2g(H-h)}$, where again S or mS is the area of the orifice.

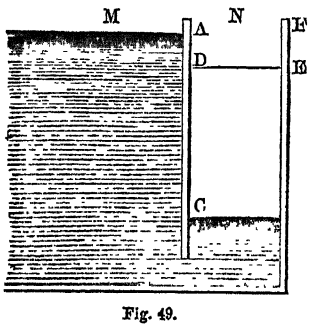


Fig. 49.

Second Case.—Let the level in M, the upper basin, be constant, while the lower basin N of a given area receives it without any loss, to determine the time that the level of N will reach the level of the upper basin, or a given height. This problem is the converse of 196, where the discharge took place in air, and the surface of the water above the orifice descended with a uniformly retarded motion. Here, however, the surface of the basin is urged from below upwards by a force equal to the difference between the levels of the two basins, decreasing in the same proportion as the charge decreased in the former case, but at the same time, rises with a motion uniformly retarded, and it will require the same time to traverse the same space, under these similar pressures.

Suppose, then, that H is the pressure or charge AC, at the commencement, and h the charge at the end of the time t; let also A be the horizontal section of the vessel being filled up, and m and S as before. In order, therefore, that the water may fill N up to DE, $t = \frac{2A}{mS\sqrt{2g}}(\sqrt{H}-\sqrt{h})$; and for the time up to AF, the level of M, we have $T = \frac{2A}{mS\sqrt{2g}}\sqrt{H}$. These formulæ are important, more especially in determining the time in which canal locks, &c., may be filled; and also for assigning the area of sluice-way required to fill in a given time.

Third Case.—Suppose that the level of the water is variable in each vessel. This case is that of two reservoirs of different levels, in communication with each other, each limited in area and receiving no supply, so that as one surface falls the other rises.

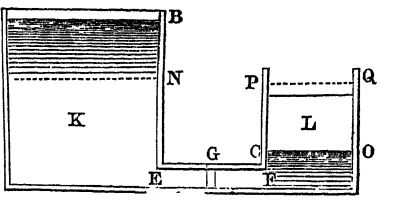


Fig. 50.

Let K and L (fig. 50) be two such tanks, communicating with each other by the wide pipe EF, a cock or sluice-door being at G. Let the cock G be unopened, then the level of K is AB, and that of L is CO. Suppose now, that G is open, then, at the end of a certain time, AB has fallen to MN, while the corresponding rise in L is PQ. We want, then, to determine the relation between the two heights at a given time, and, conversely, from the given difference of height in the two vessels, to deduce the time corresponding to a given discharge.

Let t be the time, $BE = H$, $CF = h$, $NE = x$, $PF = y$, while the horizontal sections of K, L, and the communicating pipe, are respectively denoted by A, B, and s, and the coefficient of contraction, together with the resistance of the water passing through the pipe EF, are represented by m. Now, while during the very small time dt, the level of K has lowered by the quantity dx, and that of L has risen by dy; and since as x diminishes while y and t increase, we have $A dx = -B \cdot dy$; $\therefore A dx = -ms \cdot dt \cdot \sqrt{2g(x-y)}$ (by 181); the one being positive while the other is negative; hence $dt = -\frac{A dx}{ms\sqrt{2g(x-y)}}$, hence also $\int A dx = -\int B \cdot dy$; or $Ax + By = AH + Bh$, since in the limit $x = H$, and $y = h$; $\therefore y = \frac{A(H-x)}{B} + h$. Let this value for y be substituted in the value for dt, and we have $dt = -\frac{A dx}{ms\sqrt{2g\left(x - \frac{AH+Bh-Ax}{B}\right)}} = -\frac{A\sqrt{B}\,dx}{ms\sqrt{2g}\sqrt{(B+A)x - AH - Bh}}$;

$$\therefore t = \frac{2A\sqrt{B}}{ms\sqrt{2g(A+B)}}\left\{\sqrt{B(H-h)} - \sqrt{(A+B)x - AH - Bh}\right\}$$

by integration; since $x = H$ in the limit, and $t = 0$.

Let the time required be now that in which the levels of K and L form a straight line, then $x = y$;

$$\therefore (A+B)x = (A+B)y = AH + Bh; \text{ or, } x = y = \frac{AH+Bh}{A+B};$$

and if this value of x be substituted in the value of t, we have $t = \frac{2AB\sqrt{H-h}}{ms\sqrt{2g(A+B)}}$. Hence, for the same value of $(H-h)$, t is the same whether A be the horizontal section of the basin that lowers, and B that of the other, the surface of which rises, or *vice versa*, B that which falls, and A that which rises.

205. PROP. XVI.—To find the velocity and volume discharged, of water issuing from an orifice in the side of a vessel, when the fluid has an antecedent velocity.

When water is continuously poured into a vessel containing fluid, or if the water in the vessel be moving in the direction of the orifice, then, the particles will approach to and issue from the orifice in virtue of the pressure of the fluid mass above it, together with the additional velocity that they had while they entered into the sphere of action of the orifice. Therefore, the additional velocity will be that arising from the height of a column, which would exert the same effect as that which the fluid previously had. Let

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this velocity be equal to u, which is $\frac{u^2}{2g}$, or that due to the height of a column h'; call the depth of the fluid h, then the velocity of efflux for one particle or thread will be that due to the vertical height $h+h'$. Hence, velocity of escape is

$$V=\sqrt{2g(h+h')}=\sqrt{2g\left(h+\frac{u^2}{2g}\right)}=\sqrt{2gh+u^2}.$$

Call S, or m . S, the area of orifice, then volume discharged in a unit of time is

$$Q=mS\sqrt{2gh+u^2}=mS\sqrt{2g\left(h+\frac{u^2}{2g}\right)};$$

the volume discharged in T units of time will be,

$$Q\,.\,F,\text{ or }Q'=mST\,.\,\sqrt{2g\left(h+\frac{u^2}{2g}\right)}.$$

206. Cor.—Take $h'=34$ feet, or a water column which would balance the atmospheric column, then $V=\sqrt{2g(h+34)}$, which expresses the velocity with which water is projected into a vacuum, the column being h.

207. Prop. XVII.—If two cylindrical vessels be filled with water, the times in which the fluid surfaces will fall through given heights will be directly as the compound ratio of their bases, and the difference between the square roots of the altitudes of each surface at the beginning and end of its motion, and inversely as the areas of the orifices.

Let A and A′ be the areas of the cylindrical vessels, a and a' the spaces passed through by the fluid surfaces in the corresponding times T and T′, a being $=H-h$; $a'=H'-h'$; where H, H′ and h, h' are the heights of the fluid surfaces respectively at the beginning and end of the times; S and S′ or mS and mS′ the areas of the orifices of A and A′, the coefficients being regarded as equal: then, by Prop. X. 196,

$$T=\frac{2A}{mS}\cdot\frac{1}{\sqrt{2g}}(\sqrt{H}-\sqrt{h}),\text{ and }T'=\frac{2A'}{mS'}(\sqrt{H'}-\sqrt{h'});$$

$$\therefore T:T'=\frac{2A}{mS}\cdot\frac{1}{\sqrt{2g}}(\sqrt{H}-\sqrt{h}):\frac{2A'}{mS'}\cdot\frac{1}{\sqrt{2g}}(\sqrt{H'}-\sqrt{h'})$$

$$=\frac{A}{S}(\sqrt{H}-\sqrt{h}):\frac{A'}{S}(\sqrt{H'}-\sqrt{h'}).$$

208. Cor.—Hence the time in which two cylindrical vessels full of water will empty themselves, will be directly as the compound ratio of their bases, and the square roots of their altitudes, and inversely as the areas of their orifices. For, in the last article, $\sqrt{h}=\sqrt{h'}=0$, therefore,

$$T:T'=\frac{A}{S}\sqrt{H}:\frac{A'}{S}\sqrt{H'},$$

which is the same ratio as would have been obtained had we used the formula of Prop. IX. 194.

209. Prop. XVIII.—To find the horizontal distance to which water will spout from an orifice made in the side of a vessel, when projected horizontally.

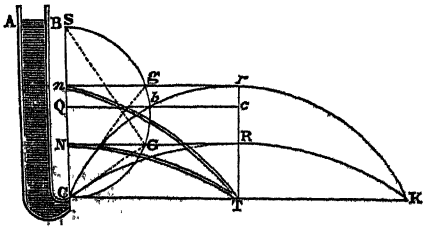


Fig. 51.

Let AC be the vessel full of fluid; suppose that N is an orifice in its side, at a depth BN below AB; NT the path of the jet. Let also v be the velocity with which water issues from N, and t the time of its falling down the perpendicular distance NC. Then

$v=\sqrt{2g\,.\,BN}$ (Prop. I. 177), and $t=\sqrt{\frac{2\,.\,NC}{g}}$.

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But the time that the body takes to move in the parabolic path NT, is the same as its falling down through NC; hence

$$CT=v\,.\,t=\sqrt{2g\,.\,BN}\,.\,\sqrt{\frac{2CN}{g}}=2\sqrt{BN\,.\,NC}.$$

Now, if we describe a semicircle on SC as diameter, we have (by Euc. III. 35) BN . NC = NG², where NG is perpendicular to SC; wherefore CT = 2 NG; that is, the horizontal distance or *range* is twice GN, the ordinate of the semicircle.

210. Cor. 1.—The horizontal range will evidently be a maximum when the orifice is at the middle point Q of the diameter; and, therefore, the range will in this case be equal to the height of the vessel, or BC = CT.

211. Cor. 2.—If the orifice should be at n, and Sn = NC, then the jet will assume the path nT, and its range will be CT, the same as when the orifice was at N.

212. Cor. 3.—If the orifice be at C, and the direction of projection be CG, inclined to the horizon at an angle of 45°, then we shall have the greatest range, CK, that the fluid vein can possibly take when projected under the charge SC.

213. Cor. 4.—If the direction of projection be Cg, inclined at an angle of 75° to the horizon, its range will also be CK.

214. If the inclination be either less or more than 45° or 75° respectively, the ranges will be less than CK; resistances and all retarding causes whatsoever being neglected.

R and r are called the greatest heights of the paths CrK, and CRK respectively, being the middle points of these paths.

215. Prop. XIX.—If water flow through a pipe which is kept constantly full, then the velocities of the fluid particles in different sections will vary inversely as the areas of these sections.

It is presumed that each particle in the same transverse section has the same velocity. Let then Q = volume of fluid passing through any portion of the pipe in one second, and v = the velocity of water in the same time while passing through that section of the pipe the area of which is a. Hence $a\,.\,v=Q$; $\therefore v=\frac{Q}{a}\propto\frac{1}{a}$, since the volume passing through every second is constant.

216. Cor.—The volume which passes through the pipe in a time $T=a\,.\,v\,.\,T$.

217. Prop. XX.—To determine the pressure exerted upon pipes by the water which flows through them.

Let us suppose the column of fluid CD divided into an infinite number of laminæ EF, *fa*. Then friction being abstracted, every particle of each lamina will move with the same velocity when the pipe CD is horizontal. Now, the velocity at the *vena contracta*, *mn*, may be expressed by $\sqrt{A}$, A being the altitude of the fluid in the reservoir. Fig. 52.

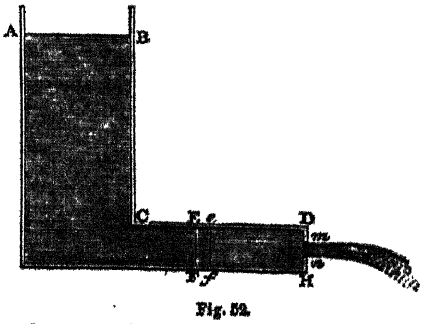


Fig. 52.

But the velocity at the *vena contracta* is to the velocity in the pipe as the area of the latter is to the area of the for-

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mer. Therefore, δ being the diameter of the *vena contracta*, and d that of the pipe CD, the area of the one will be to the area of the other, as $\delta^2 : d^2$ (GEOMETRY, Sect. VI. Prop. IV.), consequently we shall have $d^2 : \delta^2 = \sqrt{A} : \frac{\delta^2\sqrt{A}}{d^2}$, the velocity of the water in the pipe. But since the velocity $\sqrt{A}$ is due to the altitude A, the velocity $\frac{\delta^2\sqrt{A}}{d^2}$ will be due to the altitude $\frac{\delta^4 A}{d^4}$. Now, as each particle of fluid which successively reaches the extremity DH of the pipe, has a tendency to move with the velocity $\sqrt{A}$, while it moves only with the velocity $\frac{\delta^2\sqrt{A}}{d^2}$, the extremity D$n$ of the pipe will sustain a pressure equal to the difference of the pressures produced by the velocities $\sqrt{A}$ and $\frac{\delta^2\sqrt{A}}{d^2}$, that is, by a pressure $A - \frac{\delta^4 A}{d^4}$, A representing the pressure which produces the velocity $\sqrt{A}$, and $\frac{\delta^4 A}{d^4}$ the pressure which produces the velocity $\frac{\delta^2\sqrt{A}}{d^2}$. But this pressure is distributed through every part of the pipe CD, consequently the pressure sustained by the sides of the pipe will be $A - \frac{\delta^4 A}{d^4}$.

218. COR. 1.—If a very small aperture be made in the side of the pipe, the water will issue with a velocity due to the height $A - \frac{\delta^4 A}{d^4}$. When the diameter δ of the orifice is equal to the diameter d of the pipe, the altitude becomes A − A or nothing; and if the orifice is in this case below the pipe, the water will descend through it by drops. Hence we see the mistake of those who have maintained, that when a lateral orifice is pierced in the side of a pipe, the water will rise to a height due to the velocity of the included water.

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219. COR. 2.—Since the quantities of water, discharged by the same orifice, are proportional to the square roots of the altitudes of the reservoir, or to the pressures exerted at the orifice, the quantity of water discharged by a lateral orifice may be easily found. Let W be the quantity of water discharged in a given time by the proposed aperture under the pressure A, and let w be the quantity discharged under the pressure $A - \frac{\delta^4 A}{d^4}$. Then $W : w = \sqrt{A} : \sqrt{A - \frac{\delta^4 A}{d^4}}$; consequently, $w \times \sqrt{A} = W \times \sqrt{A - \frac{\delta^4 A}{d^4}}$, and $w = \frac{W \times \sqrt{A - \frac{\delta^4 A}{d^4}}}{\sqrt{A}} = W\sqrt{\frac{d^4 - \delta^4}{d^2}}$. Therefore, since W may be determined by the experiments in the following chapter, w is known.

CHAPTER II.—ACCOUNT OF EXPERIMENTS ON THE MOTION OF FLUIDS DISCHARGED FROM VESSELS, EITHER BY ORIFICES OR BY ADDITIONAL TUBES, OR RUNNING IN PIPES OR OPEN CANALS OR RIVERS.

220. We have already seen in our theoretical part (from 169 to 214), that the reservoir, out of which issues the water, may be always maintained at the same level; or, receiving no supply, may be exhausted; or, lastly, the escape, instead of taking place in air, may do so into another reservoir more or less full. These are the three principal cases to which experimenters on this subject have generally turned their attention.

Before detailing any experiments, let the following important definitions be remembered:—

221. Water may escape from a vessel, reservoir, or tank, by a horizontal opening in the bottom or in one of its lateral sides; when the latter is the case, the opening is known as an *orifice*. The orifice is frequently said to be in a *thin plate* or *wall*, that is, in a wall the thickness of which is scarcely one-half the least dimension of the opening; it is also at times furnished with an *adjutage*, or short pipe, either *cylindrical*, or *conical*, converging towards, or diverging from, the basin. It is clear that an orifice in a thin wall, but furnished with a pipe, would be equivalent to an orifice in a thick wall. When the upper border is away, and the issuing fluid is in contact with the containing vessel on three sides only, the orifice is then said to be a *deversoir*, a *notch*, a *weir*, or *waste-board*; such are the waste-boards of canals and reservoirs, and weirs in rivers, which may be seen stretched across their course, so that the water being intercepted by them, must rise and flow over the crest or summit. A fluid vein in passing through a complete opening suffers a *contraction*, the phenomena of which will be fully explained in the following pages. The vertical distance of the fluid surface in the vessel above the centre of gravity of the orifice, is called the *height of the reservoir*, or the *charge* of water over the orifice, or it is that charge under which the escape takes place.

The *waste*, or *real effective waste* of an orifice, is that volume of fluid discharged in one unit of time, as a second. The *theoretical waste* is that volume per unit of time which theory assigns. The former is always less than the latter. The quotient or ratio of the real to the theoretical waste is termed the *coefficient of contraction*, or that fractional number which multiplies the theoretical to obtain the real waste.

222. Mariotte, 150 years ago, showed that in the case of fluids the velocities are as the square roots of the charges (Cor. 1. Prop. VIII.) Many succeeding experiments have proved the same principle, and although it is not rigidly true, it may still be admitted.

The following table of results will exhibit the proportionality. The charges are as 1 : 200 and more, and the section of the orifices are as 1 : 500, still in each the velocity has followed the square root of the charge; minute errors, causing small differences, arise, but these may be neglected. Such experiments have for their object the determination of the waste per unit of time; but it is clear that so long as the orifice remains of the same area the discharge or waste is *exactly* proportional to the velocity; and, therefore, a column denoting the relations of the one, must also give those of the other.

Observer.	Diameter of orifice in metres.	Charge above orifice in metres.	Series of Roots of charges.	Series of Wastes or velocities.
Daubisson and Castel..	0·01	0·026	1·000	1·000
		0·03	1·074	1·064
		0·04	1·241	1·244
		0·05	1·386	1·393
		0·06	1·509	1·524
Bossut.....	0·027	1·30	1·000	1·000
		2·92	1·500	1·497
		3·81	1·713	1·707
Michelotti.....	0·081	2·34	1·000	1·000
		3·81	1·305	1·301
		6·76	1·738	1·692
...	0·162	2·11	1·000	1·000
		3·66	1·316	1·315
Poncelet and Lesbros..	Square of 20 centimetres...	0·40	1·000	1·000
		0·70	1·323	1·330
		1·00	1·581	1·590
		1·30	1·803	1·806
		1·60	2·000	2·000

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223. It has been shown by experiment that the principle holds for all fluids whatever, as mercury, oils, &c., and even for aeriform gases; so that any one of them issuing from an orifice will do so with a velocity independent of the nature and density of the substance; it will only depend on the charge. The same principle has also been detected in the case of discharges *in vacuo*, as well as in the atmosphere; the velocity will always be the same with the same head, whatever be the pressure on the free surface of the fluid, provided only that the jet at the orifice is also subjected to an equal exterior pressure. But if these pressures be unequal, then the velocities differ.

224. We have seen (in 173) the relation of the several parts of the contracted vein to each other; it may be interesting to know the values which the older experimenters gave for the same parts. Newton concluded that the ratio of the contracted section *op* (fig. 43), and the area of the orifice *mn*, was $1 : \sqrt{2}$, and consequently that the diameters of these sections respectively were as 0·841 : 1·0. If *mn* be 1, Poleni found that *op* would be 0·79; Borda, 0·804; Michelotti, 0·792; Bossut, from 0·812 to 0·817; Eytelwein, 0·80; Venturi, 0·798; Brunacci, 0·78. The mean of all these values for the same thing, *op*, is 0·80. But from a mean of more recent experiments by Ignazio Michelotti, the son of F. D. Michelotti, we have the relation of 1 to 0·787 as the ratio of the area of the orifice and that of the contracted section. Since the latter experiments are regarded as very accurate, Daubisson has followed the ratio 1 : 0·787.

225. Were the velocity at the contracted section really that due to the height of the reservoir, and were the escape to take place through an adjutage of the same form as the contracted vein, then on introducing into the expression for the waste the area S of the exterior orifice of this adjutage, the calculated would be equal to the actual waste, and the ratio of the coefficients would be 1. Michelotti,[1] in one of his experiments, employed a cycloidal adjutage, and obtained a coefficient of 0·984. In all probability he would have arrived at 1, if the walls of the adjutage had been more accurately adapted to the form of the fluid vein, and if the resistance of these walls, and also that of the air, had not somewhat retarded the motion.

226. The coefficient, or the ratio mentioned above, is not always a constant quantity. It varies with the form and position of the orifice, with the thickness of the plate in which the orifice is made, as well as the form of the vessel and the weight of the superincumbent fluid. This variable quantity, therefore, must not be neglected in practice.

SECTION I.—ON THE VOLUME OF WATER DISCHARGED FROM VESSELS KEPT CONSTANTLY FULL, BY ORIFICES IN THIN PLATES.

(a.) *Flow of Water through an Orifice in a Thin Plate.*

227. We proceed now to determine directly that fractional number, or coefficient, which will enable us to reduce the theoretical to the actual waste. As this is a mere tentative process, we must gauge with care the volume of water flowing out of a given orifice, under a constant charge, and in a given time, from which is found the volume in one second, or the real waste for that time; on dividing this by the volume which theory gives as issuing from the same orifice, and under the same circumstances, we find the coefficient required. Thus, let the orifice be 3·185 inches in diameter, then the head of 4·012 feet of water issues out of it with a velocity of 16·07 feet per second. Now, area of orifice $= \pi . r^2 = (3{\cdot}1416)\ (1{\cdot}5925)^2 = 7{\cdot}97$ square inches, which, if multiplied into the velocity of each particle of water, or 4·012, gives the volume of a prism or cylinder equal to that of the water discharged, or $\frac{7{\cdot}97}{144} \cdot (16{\cdot}07) = {\cdot}8894$ cubic feet per second. But the real discharge in $1\frac{1}{2}$ minutes was found to be 49·68 cubic feet, which is at the rate of ·552 cubic feet per second; hence, coefficient $= \frac{0{\cdot}552}{0{\cdot}8894} = 0{\cdot}620$. A considerable number of experimental philosophers since the time of Newton have endeavoured to determine its true value. Daubisson, in his *Traité d'Hydraulique à l'usage des Ingénieurs*, 1840, gives a table containing the principal results which several eminent experimenters have arrived at. They include circular, square, and rectangular orifices:—

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Circular Orifices.

Observer.	Diameter.	Charge.	Coefficient.
	Metres.	Metres.	
Mariotte...	0·0068	1·79	0·692
Do. ...	0·0068	7·90	0·692
Castel.....	0·01	0·65	0 673
Do.	0·01	0·31	0·654
Do.	0·015	0·138	0·632
Do.	0·015	0·30	0·617
Eytelwein	0·261	0·723	0·618
Bossut.....	0·271	1·30	0·619
Michelotti	0·0271	2·23	0·618
Castel.....	0·03	0·168	0·629
Venturi....	0·041	0·88	0·622
Bossut.....	0·054	3·81	0·618
Michelotti	0·054	2·20	0·607
Do. ...	0·081	2·24	0·613
Do. ...	0·081	3·81	0·612
Do. ...	0·081	6·76	0·597
Do. ...	0·162	2·11	0·619
Do. ...	0·162	3·66	0·619

Square Orifices.

Observer.	Side of square.	Charge.	Coefficient.
	Metres.	Metres.	
Castel.....	0·01	0·65	0·655
Bossut.....	0·027	3·81	0·616
Michelotti	0·027	3·81	0·607
Do. ...	0·027	6·83	0·606
Bossut.....	0·054	3·81	0·618
Michelotti	0·054	2·24	0·603
Do. ...	0·054	3·83	0·603
Do. ...	0·054	6·78	0·602
Do. ...	0·082	2·26	0·616
Do. ...	0·081	3·83	0·619
Do. ...	0·081	6·82	0·616

Rectangular Orifices.
(Bidone.)

Rectangle.		Charge.	Coefficient.
Height.	Base.		
0·0092	0·0185	0·33	0·620
0·0092	0·0370	0·33	0·620
0·0092	0·0739	0·33	0·621
0·0092	0·1478	0 33	0·626

The most remarkable of these experiments, of which the above table is the result, were those of the elder Michelotti, performed in the year 1764, at about 3 miles from Turin. The internal dimension of the reservoir was a square of 0·97 met., and 8 met. in height; it was supplied with water from the River Dora by a canal of derivation. On one of the faces of this reservoir was arranged a series of adjutages at different, yet convenient depths; on the surface of the ground, also, were arranged different vessels for measuring the actual discharges. Ignazio Michelotti performed these same experiments in 1784, the results of which—the five last—are tabulated as above. It will be observed from the table that the coefficients from the large orifices are higher than the others, although contrary to the rule that would be deduced from the experiments in general; some particular circumstance must have produced this anomaly.[2] With respect to the experiments of M. Castel, engineer to the Water-works of Toulouse, they were carried on by him in company with M. Daubisson at Toulouse, and in spite of all the care which they took in their operations, the smallness of the orifices would only permit them to come within $\frac{1}{100}$th of the value of the coefficient. They principally occupied themselves on the orifice 0·01 met., as being in a manner the starting point in a distribution of water, made after the metrical system of weights and measures.

228. In the year 1782, the engineer Lespinasse made several experiments in the canal of Languedoc, in order to to determine the coefficient when water issues from a sluice-gate. The width of the sluice was 1·3 met., the area

[1] *Mémoire Physico-Mathématique contenant les résultats d'expériences Hydrauliques. Dans les Mémoires de l'Académie des Sciences de Turin*, 1784–1785.

[2] *Sperimenti Idraulici, &c., de F. D. Michelotti, Torino*, 1767 et 1771.

of the opening varied from 0·7194 to 0·6240 sq. met., and the height from 0·55 to 0·48 met., the charge over the centre being from 4·436 to 1·975 met., and the form of the orifice was not exactly rectangular; the mean results of all the coefficients was 0·625, which has been regarded as large; but it is accounted for from the fact that the escape did not take place in a thin wall or plate, and that the contraction on some point was suppressed; the wood work around the opening of the sluice was 0·27 met. thick, and on the lower edge it was even 0·54 met. Further, the coefficient, which was 0·641 met. for an opening of 0·46 met., rose to 0·803 met. when the paddle over the opening was raised 0·12 met. Six years after, M. Pin, engineer on the same canal, performed a series of similar experiments, with similar results, and which may be seen in the *Anciens Mémoires de l'Académie des Sciences de Toulouse*, tom. ii., 1784; see also *Histoire du Canal du Midi ou de Languedoc*, par le Général Andréossy, tom. i., p. 251. A coefficient of the above value was found from an experiment on the sluice-gate of the basin of Hâvre (see *Architecture Hydraulique*, par Belidor et Navier, tom. i., p. 289).

229. But the most remarkable fact connected with the experiments of Lespinasse and Pin, is that when two equal openings are made, one in each of the wings of a sluice-gate, the waste of the first diminishes on the second commencing to flow, and the combined volume of discharge for both orifices during a certain time, is less than double the volume escaping by one of the openings in half that time; consequently, also, the coefficient for each case must be different, for different discharges are given. The distance between the openings was 2·92 met., and their plane formed an angle of 60° with the direction of the canal. The difference in the discharges was about one-eighth, and the difference in the coefficients will be seen from the annexed table.

Coefficient,	
With one opening.	With two openings.
0·641	0·550
0·689	0·555
0·616	0·554
0·594	0·526
0·621	0·555
Mean.	
0·632	0·548

This was regarded as true till 1836, when Daubisson and Castel showed its falsity. They had, from one side and another of a sluice-gate, three rectangular orifices of 0·10 met. in width, and 0·01 met. in height, separated by 0·01 met. The volume discharged by the middle orifice was first obtained, then the volume from two, and lastly, the discharge from the whole three. The mean results are contained in the following table:—

Charge on orifice.	Waste of middle orifice.			Coefficient.
	Middle single opening.	Middle, with one side opening.	Middle with two side openings.	
Met.	Cub. met.	Cub. met.	Cub. met.	
0·02	0·000455	0·000455	0·000457	0·728
0·03	0·000551	0·000551	0·000550	0·720
0·04	0·000635	0·000636	0·000637	0·719
0·05	0·000707	0·000707	...	0·715
0·06	0·000771	0·000769	...	0·710

As these resulting coefficients were considerably larger than those of Lespinasse and Pin, Daubisson and Castel thought that the difference was owing to the too small distance separating one orifice from another; this difference was now made five times greater, and yet the coefficients remained constant. As the difference was still matter of surprise, M. Daubisson, in 1836, requested M. Castel to undertake a series of experiments on a more extensive scale than they had previously done. For this purpose M. Castel stopped up a canal in width 0·74 met. by a thin copper plate, in which he opened three rectangular orifices on the same horizontal base, each 0·10 met. wide, and 0·06 high, and the distance betwixt each was 0·08 met. The escape was produced under a constant charge of 0·107 met. above the centre, and the coefficients of contraction were as under:—

One orifice open.....	the middle.....	0·6193
	that on the right.....	0·6193
	that on the left.....	0·6194
Two orifices open.....	the right and left..	0·6205
	middle and right.....	0·6205
	middle and left.....	0·6207
The whole three orifices open.....		0·6230

We here see that as more of the orifices were opened, the coefficients increased instead of diminished in value. As it belongs to a particular cause, a greater velocity of water in the canal, followed by a greater waste, M. Castel inferred that although new orifices should be made by the side of an already existing orifice, whether in a sluice-gate, reservoir, or stopped-up course of water, no diminution of waste will take place on this account.

230. It was supposed, however, that although this was shown to hold good in the case of orifices in a plane wall or plate, yet a difference would be found in those of planes making a certain angle, as in the case of flood-gates. M. Castel has also fully resolved this question. He joined two planes, making an angle of 120°, a flood-gate being 10° more open, and in each he made two rectangular orifices of 0·10 by 0·06 met.—one at 0·12, the other at 0·28 met. distance from the plane of junction; this kind of barrier was erected at the extremity of a canal, and the escape took place under a charge of 0·14 met. Each of the orifices was successively opened at first; then two at a time, combining them in different ways; then three similarly combined; and last of all, the whole four. The annexed table shows the mean results.

No. of orifices.	Coefficients.
1	0·618
2	0·619
3	0·620
4	0·622

M. Castel also adapted on his experimental apparatus, described in 253, two orifices of 0·05 by 0·03 met., and found the following results, from which it will be seen that the same coefficient is always found with an insignificant augmentation, due to the number of open orifices.

Charge.	No. of orifices.	Coefficients.
Metres. 1·03	1	0·621
	2	0·622
2·04	1	0·619
	2	0·621

231. The following table contains the results obtained by Michelotti when the orifices were vertical, and of a *square* or *circular* form, the altitude of the head of water varying from 6 to about 22 feet:—

Height of water above centre of orifice.				Size and form of orifice.	Time of flow.	Volume discharged.		
Ft.	in.	lin.	pts.		Minutes.	Ft.	in.	lin.
6	7	4	3	square of 3 inches	10	463	7	3
11	8	1	6		8½	516	9	5
21	8	3	6		5	415	5	3
6	7	6	0	square of 2 inches	15	329	9	8
21	5	3	7		10	385	4	0
6	9	1	0	square of 1 inch	30	158	6	7
21	6	1	0		60	562	11	4
6	8	4	0	circular, 3 inches diameter	15	542	10	6
21	7	4	0		8	521	3	7
6	9	5	0	circular, 2 inches diameter	30	488	8	3
21	10	10	0		20	575	5	10
6	10	6	0	circular, 1 inch diameter	60	247	4	3
22	0	2	0		60	444	6	5

The mean coefficient from Michelotti's experiments is 0·625.

232. Messrs Brindley and Smeaton found that 20 cubic feet of water were discharged from orifices 1 inch square, in the following times, varying with the height of the water:—

Height of water in feet.	Time of discharging 20 cubic feet.
1	562 seconds.
3	320
5	254

When the height of the water was 6 feet, and the orifice

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$\frac{1}{2}$ an inch square, 20 cubic feet were discharged in 17 minutes 33 seconds. The coefficient obtained from these experiments is 0·63.

233. In the following experiments by the Abbé Bossut, which were frequently repeated, the orifice was pierced in a plate of copper about half a line thick :—

Quantity of Water discharged in one minute, by Orifices differing in form and position.

Altitude of the fluid above the centre of the orifice.	Form and position of the orifice.	The orifice's diameter.	No. of cub. in. discharged in a minute.
Ft. in. lin.			
11 8 10	Circular and Horizontal ...	1 inch	9281
...	Circular and Horizontal ...	2 inches	37203
...	Horizontal and Square	1 inch, side	11817
...	Horizontal and Square	2 inch, side	47361
9 0 0	Lateral and Circular.....	6 lines	2018
...	Lateral and Circular.....	1 inch	8135
4 0 0	Lateral and Circular.....	6 lines	1353
...	Lateral and Circular.....	1 inch	5436

234. From the results contained in the preceding table, we may draw the following conclusions :—

1. That the quantities of water discharged in equal times by different apertures, the altitudes of the fluid being the same, are very nearly as the areas of the orifices. That is, if A and a represent the areas of the orifices, and W, w the quantities of water discharged,

$$W : w = A : a.$$

2. The quantities discharged in equal times by the same aperture, the altitude of the fluid being different, are to one another very nearly as the square roots of the altitudes of the water in the reservoir, reckoning from the centres of the orifices. That is, if H, h be the different altitudes of the fluid, we shall have $W : w = \sqrt{H} : \sqrt{h}$.

3. Hence we may conclude in general, that the quantities discharged in the same time by different apertures, and under different altitudes in the reservoir, are in the compound ratio of the areas of the orifices, and the square roots of the altitudes. Thus, if W, w be the quantities discharged in the same time from the orifices A, a, under the same altitude of water; and if W', w be the quantities discharged in the same time by the same aperture a, under different altitudes, H, h : then, by the first of the two preceding articles,

$W : w = A : a$, and by the second

$w : W' = \sqrt{H} : \sqrt{h}$. Multiplying these analogies together, gives us—

$$Ww : W'w = A\sqrt{H} : a\sqrt{h}, \text{ and by dividing by } w,$$
$$W : W' = A\sqrt{H} : a\sqrt{h}.$$

This rule is sufficiently correct in practice; but when great accuracy is required, the following remarks must be attended to.

4. Small orifices discharge less water in proportion than great ones, the altitude of the fluid being the same. The circumferences of the small orifices being greater in proportion to the issuing column of fluid than the circumferences of greater ones, the friction, which increases with the area of the rubbing surfaces, will also be greater, and will therefore diminish the velocity, and consequently the quantity discharged.

5. Hence of several orifices whose areas are equal, that which has the smallest circumference will discharge more water than the rest under the same altitude of fluid in the reservoir, because in this case the friction will be least. Circular orifices, therefore, are the most advantageous of all, for the circumference of a circle is the shortest of all lines that can be employed to inclose a given space.

6. In consequence of a small increase which the contraction of the vein of fluid undergoes, in proportion as the altitude of the water in the reservoir augments, the quantity discharged ought also to diminish a little as that altitude increases.

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By attending to the preceding observations, the results of theory may be so corrected, that the quantities of water discharged in a given time may be determined with the greatest accuracy possible.

235. The Abbé Bossut has given the following table, containing a comparison of the theoretical with the real discharges, for an orifice one inch in diameter, and for different altitudes of the fluid in the reservoir. The real discharges were not found immediately by experiment, but were determined by the precautions pointed out in the preceding articles, and may be regarded to be as accurate as if direct experiments had been employed :—

Comparison of the Theoretic with the Real Discharges from an Orifice one inch in diameter (from Prony's *Arch. Hydraul.* i., 369).

Constant altitude of the water in the reservoir above the centre of the orifice.	Theoretical discharges through a circular orifice *one* inch in diameter.	Real discharges in the same time through the same orifice.	Ratio of the theoretical to the real discharges.
Paris feet.	Cubic inches.	Cubic inches.	
1	4381	2722	1 to 0·62133
3	7589	4710	1 to 0·62064
5	9797	6075	1 to 0·62010
7	11592	7183	1 to 0·61965
9	13144	8135	1 to 0·61892
11	14530	8990	1 to 0·61873
13	15797	9764	1 to 0·61810
15	16968	10472	1 to 0·61716
1	2	3	4

236. It is evident from the preceding table, that the theoretical, as well as the real discharges, are nearly proportional to the square roots of the altitudes of the fluid in the reservoir.

The fourth column of the preceding table also shows us that the theoretical are to the real discharges nearly in the ratio of 1 to 0·62, or more accurately, as 1 to 0·61938; therefore 0·62 is the number by which we must multiply the discharges as found by the formulæ in the preceding chapter, in order to have the quantities of water actually discharged.

237. In order to find the quantities of fluid discharged by orifices of different sizes, and under different altitudes of water in the reservoir, we must use the table in the following manner :—Let it be required, for example, to find the quantity of water furnished by an orifice three inches in diameter, the altitude of the water in the reservoir being 30 feet. As the real discharges are in the compound ratio of the area of the orifices, and the square roots of the altitudes of the fluid (art. 234, No. 3), and as the theoretical quantity of water discharged by an orifice one inch in diameter, is, by the second column of the table, 16968 cubic inches in a minute, we shall have this analogy,—$1\sqrt{15} : 9\sqrt{30} = 16968 : 215961$ cubic inches, the quantity required. This quantity being diminished in the ratio of 1 to ·62, being the ratio of the theoretical to the actual discharges, gives 133896 for the real quantity of water discharged by the given orifice. But (by No. 5 of art. 234), the quantity discharged ought to be a little greater than 133896, because greater orifices discharge more than small ones; and by No. 6 the quantity ought to be less than 133896, because the altitude of the fluid is double that in the table. These two causes therefore having a tendency to increase and diminish the quantity deduced from the preceding table, we may regard 133896 as very near the truth. Had the orifice been less than one inch, or the altitude less than

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15 feet, it would have been necessary to diminish the preceding answer by a few cubic inches. Since the velocities of the issuing fluid are as the quantities discharged, the preceding results may be employed also to find the real velocities from those which are deduced from theory.

238. As the velocity of falling bodies is 16·087 feet per second, the velocity due to 16·087 feet will be 32·174 feet per second; and as the velocities are as the square roots of the height, we shall have $\sqrt{16{\cdot}087} : \sqrt{H} = 32{\cdot}174 : V$, the velocity due to any other height; consequently $V = \frac{32{\cdot}174\sqrt{H}}{\sqrt{16{\cdot}087}} = \frac{32{\cdot}174\sqrt{H}}{4{\cdot}011} = 8{\cdot}016\sqrt{H}$, so that 8·016 is the coefficient by which we must always multiply the altitude of the fluid in order to have its theoretical velocity.

We have already seen that the jet takes a *parabolic* path, and that the abscissæ and ordinates of its various points can be determined (177). Both Bossut and Michelotti took special care in obtaining true values for these lines so as to find the value of the height due to the velocity of exit ($h = \frac{y^2}{4x}$) (177); and for this velocity we have $v = \sqrt{2gh}$: from which relations we may compare the real with the theoretical velocity, and h with H the charge. The following table from Michelotti's experiments will let us see the near coincidence of these quantities:—

Curve of jet.		Height due to velocity of exit.	Charge.	Velocity.		Difference betwixt third and fourth col.
Absc.=x.	Ordi.=y.			Real.	Theoretical.	
Met.	Met.			Min.	Min.	
6·28	7·53	2·257	2·29	6·65	6·70	0·033
4·66	8·45	3·83	3·93	8·67	8·78	0·100
1·41	6·25	6·92	7·19	11·67	11·88	0·17

From the above it appears that the difference between the third and fourth columns increases with the charge, the cause of this difference being the resistance of the air increasing as the square of the velocity, and consequently nearly as the charge. Were it not for this, the difference would be very nearly equal to zero, and the velocity at the contracted section would have been equal to that due to the charge. Hence it may be said that water escaping through an orifice in a thin plate issues with a velocity which is very nearly equal to that due to the height of the reservoir or charge, and is not sensibly diminished by the contraction.

SECTION II.—ON THE QUANTITY OF WATER DISCHARGED FROM VESSELS CONSTANTLY FULL, BY SMALL TUBES ADAPTED TO CIRCULAR ORIFICES.

(β.) *Flow through Cylindrical Adjutages.*

239. The difference between the actual discharges, and those deduced from theory, arises from the contraction of the fluid vein, and from the friction of the water against the circumference of the orifice. If the operation of any of these causes could be prevented, the quantities of water actually discharged would approach nearer the theoretical discharges. There is no probability of diminishing friction in the present case by the application of unguents; but, if a short cylindrical tube be inserted in the orifice of the vessel, the water will follow the sides of the tube, the contraction of the fluid vein will be in a great measure prevented, and the actual discharges will approximate much nearer to those deduced from theory than when the fluid issues through a simple orifice.

240. If a cylindrical tube, 2 inches long and 2 inches in diameter, be inserted in the reservoir, and if this orifice be stopped by a piston till the reservoir is filled with water, the fluid, when permitted to escape, will not follow the sides of the tube, that is, the tube will not be filled with water, and the contraction in the vein of fluid will take place in the same manner as if the orifice were pierced in a thin plate. When the cylindrical tube was 1 inch in diameter and 2 inches long, the water followed the sides of the tube, and the vein of fluid ceased to contract. While M. Bossut was repeating this experiment, he prevented the escape of the fluid by placing the instrument MN (see fig. 55), consisting of a handle and a circular head, upon the interior extremity of the tube, and found, to his great surprise, that when he withdrew the instrument MN, to give passage to the water, it sometimes followed the sides of the tube, and sometimes detached itself from them, and produced a contraction in the fluid vein similar to that which took place when the first tube was employed. After a little practice, he could produce either of these effects at pleasure. The same phenomenon was exhibited when the length of the tube was diminished to 1 inch 6 lines; only it was more difficult to make the fluid follow the circumference of the tube. This effect was still more difficult to produce when its length was reduced to 1 inch; and when it was so small as half an inch, the water uniformly detached itself from its circumference, and formed the *vena contracta*.

241. The coefficient of reduction of the theoretical to the actual waste, with such small tubes, will be found in the following table. It will be seen that the *additional tube*, that is, a *cylindrical adjutage*, does not cause much variation:—

Observer.	Adjutage.		Charge.	Coefficient.
	Diameter.	Length.		
	Metres.	Metres.	Metres.	
Castel.....	0·0155	0·040	0·20	0·827
Do.	0·0155	0·040	0·48	0·829
Do.	0·0155	0·040	0·99	0·829
Do.	0·0155	0·040	2·00	0·829
Do.	0·0155	0·040	3·03	0·830
Bossut	0·023	0·054	0·65	0·788
Do.	0·023	0·054	1·24	0·787
Eytelwein...	0·026	0·078	0·72	0·821
Bossut	0·027	0·041	3·85	0·804
Do.	0·027	0 054	3·87	0·804
Do.	0·027	0·108	3·92	0·804
Venturi.....	0·041	0·128	0·88	0·822
Michelotti ..	0·081	0·216	2·18	0·815
	Square.			
Do. ..	0·081	0·216	3·80	0·803
Do. ..	0·081	0·216	6·71	0·803

Bossut's two first observations are looked upon as anomalous, but the mean of all the others is 0·817, and may be regarded as 0·82.

242. *Quantities of Water discharged by Cylindrical Tubes one inch in diameter with different lengths.*

Constant altitude of the fluid above the superior edge of the tube being 11 feet 8 inches and 10 lines.	Variable length of the tubes expressed in lines.	Cubic inches discharged in a minute.
The tube being filled with the issuing fluid.	48	12274
	24	12188
	18	12168
The tube not filled with the issuing fluid.	18	9282

The experiments in the preceding table were made with tubes inserted in the bottom of the vessel. When the tubes were fixed horizontally in the side of the reservoir, they furnished the very same quantities of fluid, their dimensions and the altitude of the fluid remaining the same.

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It appears, from the preceding results, that the quantities of water discharged increase with the length of the tube, and that these quantities are very nearly as the square roots of the altitudes of the fluid above the interior orifice of the vertical tube.

We have already seen that the theoretical are to the real discharges as 1 to 0·62, or nearly as 16·1 to 10. But, by comparing the two last experiments in the preceding table, it appears that the quantity of fluid discharged by a cylindrical tube where the water follows its sides, is to the quantity discharged by the same tube when the *vena contracta* is formed, as 13 to 10; and since the same quantity must be discharged by the latter method as by a simple orifice, we may conclude that the quantity discharged according to theory, and that which is discharged by a cylindrical tube and by a simple orifice, are to one another very nearly as the numbers 16, 13, 10. Though the water, therefore, follows the sides of the cylindrical tube, the contraction of the fluid vein is not wholly destroyed; for the difference between the quantity discharged in this case, and that deduced from theory, is too great to be ascribed to the increase of friction which arises from the water following the circumference of the tube.

243. In order to determine the effects of tubes of different diameters, under different altitudes of water in the reservoir, M. Bossut instituted the experiments the results of which are exhibited in the following table:—

Quantities of Water discharged by Cylindrical Tubes two inches long, with different Diameters.

Constant altitude of the water above the orifice.		Diameter of the Tube.		Quantity of water discharged in a minute.
Feet.	Inches.		Lines.	Cubic inches.
3	10	The tube being filled with the issuing fluid.	6	1689
			10	4703
		The tube not filled with the issuing fluid.	6	1293
			10	3598
2	0	The tube being filled with the issuing fluid.	6	1222
			10	3402
		The tube not filled with the issuing fluid.	6	935
			10	2603

244. By comparing the different numbers in this table, we may conclude,—

1. That the quantities of water discharged by different cylindrical tubes of the same length, the altitude of the fluid remaining the same, are nearly as the areas of the orifices, or the squares of their diameters.

2. That the quantities discharged by cylindrical tubes of the same diameter and length are nearly as the square roots of the altitude of the fluid in the reservoir.

3. Hence the quantities discharged during the same time, by tubes of different diameters, under different altitudes of fluid in the reservoir, are nearly in the compound ratio of the squares of the diameters of the tube, and the square roots of the altitudes of the water in the reservoir.

4. By comparing these results with those which were deduced from the experiments with simple orifices, it will be seen that the discharges follow the same laws in cylindrical tubes as in simple orifices.

245. The following table is deduced from the foregoing experiments, and contains a comparative view of the quantities of water discharged by a simple orifice, according to theory, and those discharged by a cylindrical tube of the same diameter under different altitudes of water. The numbers might have been more accurate by attending to some of the preceding remarks; but they are sufficiently exact for any practical purpose. The fourth column, containing the ratio between the theoretical and actual discharges, was computed by M. Prony:—

Comparison of the Theoretical with the Real Discharges from a Cylindrical Tube one inch in Diameter, and two inches long.

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Constant altitude of the water in the reservoir above the centre of the orifice.	Theoretical discharges through a circular orifice one inch in diameter.	Real discharges in the same time by a cylindrical tube *one* inch in diameter and *two* inches long.	Ratio of the theoretical to the real discharges.
Paris feet.	Cubic inches	Cubic inches.	
1	4381	3539	1 to 0·81781
2	6196	5002	1 to 0·80729
4	8763	7070	1 to 0·80681
6	10732	8654	1 to 0·80638
8	12392	9975	1 to 0·80496
10	13855	11151	1 to 0·80483
12	15180	12205	1 to 0·80403
14	16393	13177	1 to 0·80382
1	2	3	4

By comparing the preceding table with that in art. 235, we shall find that cylindrical tubes discharge a much greater quantity of water than simple orifices of the same diameter, and that the quantities discharged are as 81 to 62 nearly. This is a curious phenomenon, and will be afterwards explained.

246. The application of this table to other additional tubes under different altitudes of the fluid not contained in the first column, is very simple. Let it be required, for example, to find the quantity of water discharged by a cylindrical tube 4 inches in diameter and 8 inches long, the altitude of the fluid in the reservoir being 25 feet. In order to resolve this question, find (by art. 237) the theoretical quantity discharged, which in the present instance will be 350490 cubic inches, and this number diminished in the ratio of 1 to 0·81 will give 284773 for the quantity required. The length of the tube in this example was made 8 inches, because, when the length of the tube is less than twice its diameter, the water does not easily follow its interior circumference. If the tube were longer than 8 inches, the quantity of fluid discharged would have been greater, because it uniformly increases with the length of the tube; the greatest length of the tube being always small, in comparison with the altitude of the fluid in the reservoir.

247. When the cylindrical tube is two inches long, and its diameter one, the water will fill the tube, and issue in threads parallel to the axis of the orifice; the vein also will cease to contract, and the diminution of the discharge can only take place from a diminution of the velocity; the ratio, then, of the actual to the theoretic discharge will be the same as that of the actual to the theoretic velocity. The following table lets us see this:—

Observer.	Jet.		Velocity.		Coefficient	
	Abscis.	Ordin.	Real.	Theoretic.	Of Velocity.	Of Waste.
	Met.	Met.	Met.	Met.		
Venturi.....	1·462	1·868	3·415	4·154	0·824	0·822
Castel.....	0·546	0·673	2·017	2·426	0·832	0·827
Castel.....	1·140	1·769	3·669	4·414	0·832	0·829

From the above table we see that the coefficients of discharge and velocity are sensibly equal. It appears, also, that the velocity of a jet issuing from a cylindrical adjutage is equal to 0·82 of that due to the charge or height of the reservoir; and that the height due to the velocity of exit is only $(\cdot82)^2 = \cdot6724$ of the last; since the heights of the charges are as the squares of the velocities.

248. The coefficient, it will be perceived, has risen from 0·62 to 0·82, the cause of which, together with the increased

waste, are probably due to the following circumstances. The fluid vein, after its contraction, on entering the additional adjutage, tends to assume and preserve a cylindrical form, the section of which will be that of the contracted vein, and consequently it tends to issue without touching the walls of the cylindrical tube. Some fillet threads, however, move towards these walls, owing either to some divergence in their direction, or to some attractive force, or to both combined. When a contact of fluid particles takes place at the walls, then they are strongly held by molecular attraction; and the same force causes particle to cling to particle, even over the whole vein, which issues from a full pipe, and passes quickly by the contracted section. The immediate cause, however, is contact, and every circumstance which favours that will tend to produce an augmentation in the value of the coefficient and volume discharged. The principal of these circumstances are:—1. The length of the tube; the longer it is the greater is the tendency to contact; the less it is the less is that tendency. 2. A feeble velocity; the fluid threads will then be drawn with greater facility towards the walls. 3. The affinity of the matter of the tube for the fluid, or rather its disposition to be more easily wetted.

249. Venturi made several ingenious experiments on cylindrical adjutages, piercing the thin plate of a reservoir, the orifice of which was in diameter 0·0406 met.; and under a charge of 0·88 met. he obtained a volume of 0·137 cub. met. of water in 41 seconds. To this simple orifice he next adapted a cylindrical pipe, not continued beyond the narrowest part of the vein, and having a form very nearly the same; the diameter of the contraction being 0·0327 met., and its distance from the orifice 0·025; and under the same charge he obtained the same volume, but now in 42 seconds. To this first pipe he added a continuation beyond the contracted part, of the same dimensions as the orifice, and to obtain the same volume under the same head, the time required was only 31 seconds. Lastly, to the orifice he fitted on a uniform pipe of the same length as in last experiment, and the volume escaped in 31 seconds was 0·137 cub. met.

It appears, then, that the introduction of a cylindrical adjutage does not diminish the contraction, but makes the fluid pass by the contracted section with a greater velocity in the ratio of 31 : 41 or 42; and hence the augmentation of the waste. Venturi attributed the cause of the above to an excess of the atmospheric pressure on the fluid surface contained in the reservoir, an excess arising from a void in that part of the adjutage where the greatest contraction takes place. He endeavoured to prove this by many very interesting experiments, but his results have been too much generalized.

Two of the most beautiful experiments of Venturi are explanatory of what he termed the *lateral communication of motion in fluids*.[1]

(γ.) *Flow through Converging Conical Adjutages.*

250. The investigations on pipes of this kind were up to 1838 very inexact and imperfect. Four experiments made on this subject by the Marquis Poleni, are recorded in his *De Castellis per quæ derivantur Fluviorum Aquæ* (1718), and cited by Bossut in his *Hydrodynamique*. Their accuracy, however, was doubted by Daubisson, and this circumstance, together with the paucity of results on converging conical adjutages, determined him, along with Castel, to project a series of experiments which we shall notice presently. With respect, however, to very large conical adjutages, or rather pyramidal *nozzles*, employed for the purpose of putting hydraulic wheels in motion (458), we have three very accurate experiments of the engineer Lespinasse on the mills of the canal of Languedoc.[2] The nozzles in these experiments were frusta of a rectangular pyramid, having a length of 2·923 met, the greater base 0·731 by 0·975 met., the smaller base 0·135 by 0·190 met. The opposite faces were respectively inclined at angles of 11° 38′ and 15° 18′, and the charge was 2·923 met. The two first experiments, of which the results are here given in a tabular form, were made on a mill with two millstones, furnished each with a separate wheel. In the first experiment the water was only given to a single wheel, but in the second it was given to both at once. Such adjutages were found to diminish the waste very little, the real differing from the theoretic waste by between 100th and 200ths of the latter.

Waste.	Coefficient.
Cub. met.	
0·1916	0·987
0·1895	0·976
0·1901	0·979

251. As in this adjutage there are two contractions (171), the formula given in Prop. II. (181), to calculate the waste for a single contraction is inapplicable in the present case. Let n be the exterior contraction, or the ratio of the contracted section of the fluid to that of the orifice, and n' the coefficient of the velocity, or the ratio of the real to the theoretic velocity, nn' will be the coefficient of the waste, or the ratio of the real to the theoretic waste. Let S represent the sectional area of the orifice, V the velocity due to the charge, the real waste will be expressed by the formula $n\mathrm{S} \cdot n'\mathrm{V} = nn'\mathrm{SV} = nn'\mathrm{S}\sqrt{2g\mathrm{H}}$ (Prop. II. 181). The quantities n and n' are found by experiment. The *coefficients* of *velocity* and *discharge* find a very important application in the case of jets of water, as in fire-engines (517) and fountains.

252. To determine these coefficients, and specially to determine the angle of convergence which would cause the greatest discharge, a variety of adjutages were submitted to experiment by M. Castel, in each of which the diameter of the orifice of issue and the length of adjutage remained constant; but the diameter of entrance, and consequently the angle of convergence, gradually increased. The flow was produced under different charges for each adjutage. At every experiment the real waste was determined by direct gauging, and the velocity of escape by the method of the parabola (Prop. I. 177). The waste divided by SV gave nn'; and the observed velocity divided by $\mathrm{V}(=\sqrt{2g\mathrm{H}})$ gave n'. The series of numbers for nn' showed the waste corresponding to each angle of convergence, and consequently the angle of maximum waste; and the series of numbers for n' indicated the progression by which the velocities increased.

253. So early as 1831, M. Castel had, with a very small apparatus, and under feeble charges, made a series of experiments on adjutages of this nature. The results were detailed in the *Annales des Mines* for 1833. In 1837 he renewed his experiments, and considerably extended his labours by means of the beautiful experimental apparatus at the Water-house of Toulouse.

254. This apparatus consisted of a rectangular metal chest, 0·41 met. long, 0·41 broad, and 0·82 deep, communicating by a pipe with a reservoir kept constantly full, and 9 met. above the chest; the different adjutages were fitted into one of the walls of the latter vessel. A rectangular opening was made, and pipes were so arranged round its sides, that charges of 0·20, 0·50, 1·0, 1·50, 2·00, and 3 met. above the experimental adjutage, could easily be procured. The adjutages were of two kinds; the diameter of one set was 0·0155 met., and about 0·040 met. in length; and the diameter of the other was 0·020 met. and 0·050 met. in length. For the purpose of determining very exactly the velocity of issue from the adjutage, M. Castel set up a horizontal plate or floor, in the centre of which was a groove 0·10 met. wide, into which

[1] See *Recherches Expérimentales sur la Communication Latérale du Mouvement dans les Fluides*, 1797.
[2] *Anciens Mémoires d l'Académie de Toulouse*, tom. ii., 1784.

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the jet passed; its range was measured by means of a graduated rule fixed to, and very near the plate. This power was the ordinate of the path described by the jet; 1·140 met. was the absciss; and from these two co-ordinates the velocity of projection was deduced by 177.

255. The same adjutage, under charges which varied from 0·21 to 3·03 met., gave wastes proportional to $\sqrt{H}$, and consequently coefficients which were sensibly the same. A slight increase will be observed under the charge of 3 met.:—

Adjutage of 0·0155 met.			Adjutage of 0·020 met.		
Charge.	Coefficient of		Charge.	Coefficient of	
Met.	Waste.	Velocity.	Met.	Waste.	Velocity.
0·215	0·946	0·963	0.211	0·956	0·966
0·483	0·946	0·966	0·483	0·957	0·968
0·992	0·946	0·963	0·995	0·955	0·965
1·492	0·947	0·966	1·498	0·956	0 962
2·006	0·946	0·956	2·008	0·956	0·959
3·030	0·947	...	3·030	0·957	...

The higher charges are given in the tables for each series of diameters which have furnished the maximum waste.

With respect to the coefficients of the velocity, they would have also been sensibly the same had it not been for the resistance of the air. As this resistance diminishes the throw or range of the jet, and increases as the charge increases, we should expect in the calculated coefficients a diminution varying with the charge, although in reality there was no actual diminution in the velocity with which the fluid issued or tended to issue. In the following table we compare the coefficients both of the waste and of the velocity, obtained by the same series of adjutages, which differed only in their angle of convergence. Five or six different coefficients obtained from five or six different charges, very nearly the same, have been taken so as to determine a mean coefficient:—

Adjutage, 0·0155 met. in diameter.				Adjutage, 0·0200 met. in diameter.			
Angle of Convergence.		Coefficient of		Angle of Convergence.		Coefficient of	
Deg.	min.	Waste.	Velocity.	Deg.	min.	Waste.	Velocity.
0	0	0·829	0·830	...		...	...
1	36	0·866	0·866	...		...	...
3	10	0·895	0·894	2	50	0·914	0·906
4	10	0·912	0·910	...		...	...
5	26	0·924	0·920	5	26	0·930	0·928
7	52	0·929	0·931	6	54	0·938	0·938
8	58	0·934	0·942	...		...	...
10	20	0·938	0·950	10	30	0·945	0·953
12	4	0·942	0·955	12	10	0·949	0·957
13	24	0·946	0·962	13	40	0·956	0·964
14	28	0·941	0·966	15	2	0·949	0·967
16	36	0·938	0·971	...		...	...
19	28	0·924	0·970	18	10	0·939	0·970
21	0	0·918	0·971	...		...	...
23	0	0·913	0·974	23	4	0·930	0·973
29	58	0·896	0·975	33	52	0·920	0·979
40	20	0·869	0·980	...		...	...
48	50	0·847	0·984	...		...	...

256. From the facts here tabulated it follows,—1. That for one and the same orifice of issue, and under the same charge, beginning with 0·83 of the theoretical waste, the actual waste gradually increases in proportion as the angle of convergence increases, but only up to 13½°, where the coefficient is 0·95. Beyond this angle it diminishes, slowly at first, like all variables about the maximum; at 20° the coefficient is about 0·92 or 0·93. But after this the diminution becomes more and more rapid, and terminates as low as 0·65, which is the coefficient for an orifice in a thin plate, this last being the limiting position of converging adjutages, that, namely, in which the angle of convergence has attained its maximum value of 180°. Hence, then, the maximum waste will be obtained with a converging adjutage of from 13° to 14°.

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257. The explanation of this is probably the following:—In conical adjutages the theoretical waste is altered by the attraction of the walls, which tends to augment, and the contraction which tends to diminish it, by diminishing the section of the vein a little below the issue. From the experiments of Venturi, it would appear that the fluid vein, at its entry into the adjutage, preserves its natural form of a conoid of 18° to 20°; so that the more the angle of adjutage approaches this value, and the nearer the walls are to the vein when, after experiencing its greatest contraction, it tends to dilate itself, and when it is wholly under the attractive action of the walls, the greater will be the waste, and the maximum of counter action will give the maximum of waste. But, again, at 10° of convergence, the exterior contraction begins to be sensible, and causes a diminution of the waste; it has already reduced it by five per cent. at 18°, and thus the angle of maximum waste should naturally be expected between these two values, or about 14°.

The adjutages of 0·020 met. diameter of issue, gave coefficients from $\frac{1}{100}$th to $\frac{3}{100}$ths greater than the adjutages of 0·0155 met. An error of $\frac{1}{10}$th of a millimetre at least in estimating the diameter of the first would, in a great measure, account for this difference; and the difference very likely arose from an error of this kind. The diameters of the second adjutages, however, were very correctly measured.

2. In regard to the coefficients for the velocity, we find them increasing from the angle of 0°, like those of the discharge, up to the convergence of 10°: beyond that point they increase more rapidly; and when beyond the angle of maximum waste, whilst the waste diminishes the coefficients of velocity go on increasing and approach their limit 1. They are already nearly equal to 1 at 50°, and not far from it at 40°. Conical adjutages may, by their diverse convergence, form a progression, the first term of which is the cylindrical adjutage, and the last the orifice in a thin plate; the velocity of projection, increasing with the convergence, varies then from that of the tube additional up to that of a simple orifice, that is, from $0{\cdot}82\sqrt{2gH}$ up to $\sqrt{2gH}$.

3. Comparing the coefficients of waste with those of velocity, or the successive values of $n\,n'$ and n', and dividing the first by the second, we obtain the values for n, or the coefficients of the exterior contraction. As the angle increases from 0° up to 10°, the values of n are sensibly = 1, and consequently there is no contraction; and notwithstanding the convergence of the walls, the fluid molecules issued parallel to the axis. But beyond 10° the contraction shows itself; it reduces more and more the section of the vein, and terminates by reducing it to an equality with that of the orifice in a thin plate, as is shown in the annexed table.

Angle.	n.
8°	1·00
15	0·98
20	0·95
30	0·92
40	0·89
50	0·85
180	0·65

Experiment having shown that cylindrical adjutages produce their full and entire effect as respects waste, when their length is equal to 2½ times at least their diameter, M. Castel fixed the length of the conical adjutage at about 2½ times the diameter of issue; thus it was 0·040 met. for those of 0·0155, and 0·050 met. for those of 0·020, in order, as far as possible, not to complicate the results with the friction of the water against the walls. In order, however, to determine the effect of elongation, he projected two other series for the adjutages of 0·0155 met.; in one the common length was 0·03 met., and reckoned the *minimum*; in

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the other it was 0·10 met., a very useful practical dimension. These he did not complete. He had already, however, made some approximations to them: thus, for adjutages of 0·0155 met., he took five of the length of 0·035 met., and the result was 0·938 as the coefficient of waste; whereas with a length of 0·04 met. the coefficient was 0·936: another adjutage, in length 0·03 met., gave 0·941 instead of 0·938; and one of 0·024 met. in length gave 0·931 in place of 0·926; thus a diminution of the length has a slight tendency to augment the waste. But, on the other hand, with adjutages of 0·020 met. the waste increases with the length; thus, in lengths varying from 0·50 met. to 0·10 met., and angles under 11° 52′, he had a coefficient of 0·965; under angles of 14° 12′, one of 0·958; and under 16° 34′, one of 0·950. It thus appears that the effect of the lengths of adjutages is far from being ascertained, and new experiments require to be undertaken to determine its full extent.

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(δ.) *Flow through Conical Diverging Adjutages.*

258. We have seen (in 172) that this adjutage was known to the ancient Romans, and that by it we obtain a larger flow in a given time than from any other pipe. Bernouilli studied the effects of these adjutages and subjected them to calculation, and in one of his experiments found that the real velocity at the entry of the adjutage was greater than the theoretical velocity in the ratio of 100 : 108; but it is to Venturi that we are principally indebted for the knowledge which we possess of the results which these adjutages give. The following is a table of results from Venturi's experiments:—

Quantities of Water discharged from Orifices of various forms, the constant Altitude of the Fluid being 32·5 *French, or* 34·642 *English inches.*

No.	Nature and Dimensions of the Tubes and Orifices.	Time in which 4 Paris cubic feet were discharged.	Paris cubic inches discharged in a minute.
		Seconds.	Inches.
1	A simple circular orifice in a thin plate, the diameter of the aperture being 1·6 inches	41	10115
2	A cylindrical tube 1·6 inches in diameter, and 4·8 inches long	31	13378
3	A tube similar to B (fig. 55), which differs from the preceding only in having the contraction in the shape of the natural contracted vein	31	13378
4	The short conical adjutage A (fig. 55), being the first conical part of the preceding tube	42	9874
5	The tube D (fig. 55) being a cylindrical tube adapted to the small conical end A, *mn* being 3·2 inches long	42·5	9758
6	The same adjutage, *mn* being 12·8 inches	45	9216
7	The same adjutage, *mn* being 25·6 inches	48	8640
8	The tube C consisting of the cylindrical tube of Exp. 2, placed over the conical part of A	32·5	12760
9	The double conical pipe E, $ab=ac=1·6$ inches, $cd=0·977$ inches, $ef=1·376$ inches, and the length *ce* of the outer cone $=4·351$ inches	27·5	15081
10	The tube F, consisting of a cylindrical tube 3·2 inches long, and 1·376 inches in diameter, interposed between the two conical parts of the preceding	28·5	14516

259. It appears from these experiments of Venturi that when water is conveyed through a straight cylindrical pipe of an unlimited length, the discharge of water can be increased only by altering the form of the terminations of the pipe; that is, by making the end of the pipe A (fig. 53), of

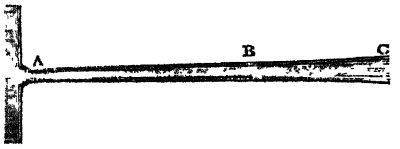


Fig. 53.

the same form as the *vena contracta*, and by forming the other extremity BC into a truncated cone, having its length BC about nine times the diameter of the cylindrical tube AB, and the aperture at C to that at B, as 18 to 10. By giving this form to the pipe, it will discharge more than twice as much water in a given time, the quantity discharged by the cylindrical pipe being to the quantity discharged by the pipe of the form ABC, as 10 to 24.

260. M. Venturi also found that the quantities of water discharged out of a straight tube, a curved tube forming a quadrantal arc, and an elbowed tube with an angle of 90°, each branch having a horizontal position, are to one another nearly as the numbers 70, 50, 45. Hence we see the disadvantages of sinuosities and bendings in conduit pipes. In the construction of hydraulic machines, any variation in the internal diameter of the pipe ought to be carefully avoided, excepting those alterations at the extremities which we have recommended in the preceding paragraph.

261. In one of his experiments Venturi employed a mouthpiece identical to that in fig. 53, and not unlike the form of the contracted vein; the diameter of the orifice in the plate was 0·0406 met., that of the contracted section 0·0338 met., and the body of the adjutage, beyond this last, varied in length and expansion, the latter element being measured by the angle comprised between the sides prolonged inwards. These adjutages were adapted to a reservoir kept constantly full; the flow took place under a constant charge of 0·88 met., and he observed the time required to fill a vessel the capacity of which was 0·137 cub. met.

The following table contains the results of his principal observations, the time corresponding to the theoretical velocity being $25''·49$:—

Adjutage.		Time of Escape.	Coefficient.
Expansion.	Length.		
Deg. min.	Met.	Sec.	
3 30	0·111	27·5	0·93
4 38	0·334	21·0	1·21
4 38	0·460	21·0	1·21
4 38	0·460	19·0	1·34
5 44	0·176	25·0	1·02
5 44	0·059	31·0	0·82
10 16	0·264	28·0	0·91
10 16	0·045	28·0	0·91
14 14	0·045	42·0	0·61

Venturi concludes, from his experiments, that the adjutage of maximum waste should have a length of nine times the diameter of the smaller base, and an angle of divergence or expansion of 5° 6′. Such an adapted adjutage would give a waste 2·4 times greater than an orifice in a thin plate, and 1·46 times greater than the theoretical waste. The dimensions also should vary with the charge.

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262. Venturi's *Lateral Communication of Motion in Fluids* (249) may be explained by one of his own experiments. Let a pipe AC (fig. 54), about half an inch in diameter and a foot long, proceeding from the reservoir AB, and having its extremity bent into the form CD, be inserted into the vessel CDG, whose side DG gradually rises till it passes over the rim of the vessel. Fill this vessel with water, and pour the same fluid into the reservoir AB, till, running down the pipe AC, it forms the stream EGH. In a short time the water in the vessel CDG will be carried off by the current EG, which communicates its motion to the adjacent fluid. In the same way, when a stream of water runs through air, it drags the air along with it, and produces wind. Hence we have the water-blowing machine, which conveys a blast to furnaces (art. 540), and which will be described in a future part of this article. The lateral communication of motion, whether the surrounding fluid be air or water, is well illustrated by the following beautiful experiments of Venturi's. In the side of the

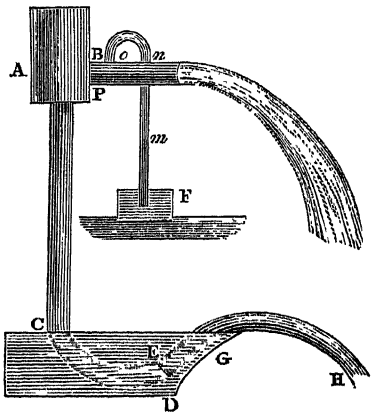


Fig. 54.

reservoir AB (fig. 54), insert the horizontal pipe P, about an inch and a half in diameter, and five inches long. At the point *o* of this pipe, about seven-tenths of an inch from the reservoir, fasten the bent glass tube *onm*, whose cavity communicates with that of the pipe, whilst its other extremity is immersed in coloured water contained in the small vessel F. When water is poured into the reservoir AB, having no connection with the pipe C, so that it may issue from the horizontal pipe, the red liquor will rise towards *m* in the incurvated tube *onm*. If the descending leg of this glass siphon be six inches and a half longer than the other, the red liquor will rise to the very top of the siphon, enter the pipe P, and running out with the other water, will in a short time leave the vessel F empty. Now, the cause of this phenomenon is evidently this: When the water begins to flow from the pipe P, it communicates with the air in the siphon *onm*, and drags a portion along with it. The air in the siphon is therefore rarefied, and this process of rarefaction is constantly going on as long as the water runs through the horizontal pipe. The equilibrium between the external air pressing upon the fluid in the vessel F, and that included in the siphon, being thus destroyed, the red liquor will rise in the siphon, till it communicates with the issuing fluid, and is dragged along with it through the orifice of the pipe P, till the vessel F is emptied (421).

263. Another beautiful experiment of Venturi, and similar to the above, was made in the following manner. He added three cylindrical tubes to the lower side of a conical diverging adjutage like that in fig. 53, and which would give 0·137 cub. met. in 25^s, the first pipe being at the contracted section, the second distant by one-third the length of the adjutage, and the third pipe at a distance of two-thirds the same length. These tubes were dipped into a vessel of mercury, and while the flow was taking place, the mercury rose in the respective tubes to heights of 0·120, 0·046, and 0·0158 met.; if water had been in the vessel these heights would have been 1·63, 0·63, and 0·125 mets. respectively. From the theory of Bernouilli, the pressure in this experiment at the point of greatest contraction is expressed by $-1·60$ met.; observation gave it as $-1·63$ met.

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264. Eytelwein also made several experiments on diverging adjutages; as these bear directly on the practical application of the subject, we shall briefly mention them. He took a series of cylindrical pipes of different lengths, and 0·026 met. in diameter, which were successively fitted on to a vase full of water; at first singly, then carrying at its anterior extremity a mouth-piece like A in fig. 53, which had nearly the form of the contracted vein; afterwards, carrying at its other extremity an adjutage B (in fig. 53), of the form recommended by Venturi; and lastly, furnished at once both with mouth-piece and adjutage. The flow took place under a mean charge of 0·730 met., and the following table gives the principal results:—

Length of pipe.	Coefficient of Waste of single pipe from		Waste of single pipe. Waste.	
Metres.	Experiment.	Formula of pipes.	With mouth-piece.	With adjutage.
0·001	0·62	0·99	...	...
0·026	0·62	0·97	1·56	...
0·078	0·82	0·95	1·15	1·35
0·314	0·77	0·86	1·13	1·27
0·628	0·73	0·77	1·10	1·24
0·942	0·68	0·70	1·09	1·23
1·255	0·63	0·65	1·09	1·21
1·569	0·60	0·61	1·08	1·17

The above table shows—1*st*, The ratio according to which the length of the pipes diminishes the waste; 2*d*, That the increase of the waste arising from the divergence which the mouth has at the entry of the pipes, diminishes in proportion as their lengths increase; 3*d*, The effect of divergence diminishes the waste, and that more rapidly as the pipes increase in length. Eytelwein took a pipe 6·28 met. long, and 0·26 in diameter, and found no difference in the waste, whether he employed or not a diverging adjutage. When this adjutage was fitted on to the reservoir, the waste was 1·18, the theoretical being 1. On adapting it to the mouth-piece, but without the intermediate tube, it rose to 1·55; the mouth-piece alone gave only 0·92. Thus, the effect of the adjutage B (fig. 53), fitted on to the mouth-piece A of the same figure, augments the waste in the ratio of 0·92 to 1·55, or 1 : 1·69.

265. M. Venturi was induced to institute a set of experiments, in which he employed tubes of the various forms exhibited in fig. 55. The results of his researches are contained in the table of 258, for which we have computed the column containing the number of cubic inches discharged in 1 minute. The constant altitude of the water in the reservoir was 32·5 French inches, or 34·642 English inches. The quantity of water which flowed out of the vessel in the times contained in the first column was 4 French cubic feet, or 4·845 English cubic feet. The measures in the table are all English.

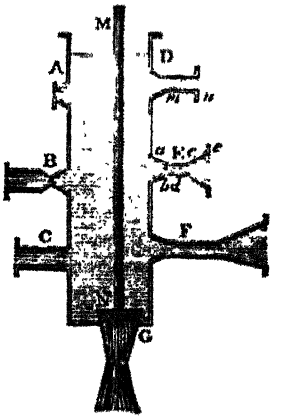


Fig. 55.

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266. When a cylindrical tube is applied to an orifice, the oblique motion of the particles which enter it is diminished; the vertical velocity of the particles, therefore, is increased, and consequently the quantity of water discharged. M. Venturi maintains that the pressure of the atmosphere increases the discharge of water through a simple cylindrical tube, and that in conical tubes the pressure of the atmosphere increases the expenditure in the ratio of the exterior section of the tube to the section of the contracted vein, whatever be the position of the tube.

SECTION III.—ON THE FLOW OF WATER OVER WEIRS, OVERFALLS, OR DEVERSOIRS.

267. If we make a rectangular opening with a horizontal base in the upper part of the side of a vessel, the top edge being removed, the water, when maintained at a constant level, will flow out of this opening in the form of a sheet, and constitute an *over-fall* or *weir*.

The flow of water over weirs is very important. To determine the nature of the results arising from the use of such an orifice, we have to look principally to foreign hydraulicians. Dubuat in 1779 made several experiments on overfalls 18¾ inches wide, and 6¾ inches deep; those of Poncelet and Lesbros (388), 36 in number, were very carefully performed at Metz; the *head*, or charge of water, varied from ¾ of an inch up to 8 inches; and the width was constantly about 7¾ inches. Messrs Smeaton and Brindley conducted a set of experiments, made over a waste-board 6 inches wide, and from 1 to 6 inches deep. Dr Robison made several experiments on the same subject. In 1834 MM. Daubisson and Castel made a series of very accurate experiments, at Toulouse water-works, on overfalls discharging water from a rectangular canal 29¾ inches wide, and of a variable depth. The widths of the apertures ranged upwards to the full width, and the head varied from about 1 to 8 inches. Mr Ballard made a set on weirs, on the River Severn, at Powick, near Worcester, in September 1836. But the most recent experiments on weirs are a first series by Mr Thomas Evans Blackwell, performed on the Kennet and Avon Canal in July 1850, and a second series by Messrs Blackwell and Simpson, made at Chew Magna, Somerset, during the summer of the same year.

268. If we look attentively at a waste-board B (fig. 56), we shall find that the water at a short distance C above it

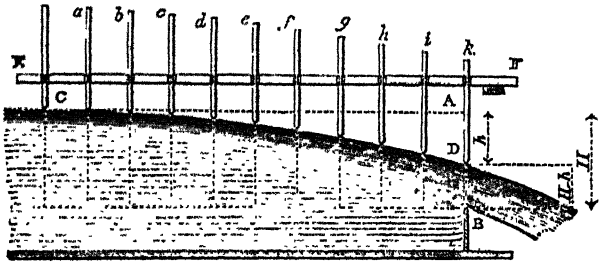


Fig. 56.

assumes a curved form CD, so that its height immediately over the weir is not equal to AB but only to DB. Now, in the common theory the fluid particles are supposed to have the same velocity on their arrival at D, as if they had fallen freely down AD; and so on, all the particles in the vertical section, DB, are assumed to flow out with velocities due to their heights below A: so that as respects the velocity of exit, and the number of the fluid threads, and also as respects the discharge, the case of a weir on such a supposition would be identical with a rectangular orifice closed at D, and in which the water level extended without any curvature up to A. Call, then, Q the volume discharged or waste escaped in one second, l the breadth of the weir, H and h the charge on the lower and upper edge respectively, m the coefficient of reduction of the theoretic to the real waste, then have we (by Prop. IV., 184), $Q = \frac{2}{3} l\sqrt{2g} \cdot m \times (H\sqrt{H} - h\sqrt{h})$.

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269. However natural such a supposition might be, MM. Daubisson and Castel deduce from their experiments facts which show that the wastes are more exactly given by supposing that the escape took place as if from the whole height AB, the fluid being supposed without curvature up to A. On such a supposition, we have $h = 0$, and

$\therefore Q = \frac{2}{3}\sqrt{2g} \cdot ml\, H\sqrt{H} = 5{\cdot}35 \cdot ml H\sqrt{H}$ (Prop. III. 183).

In the articles on Weirs, g is given in feet.

Hence the escape over weirs is only a particular case of the flow by orifices in general, that, viz., where the charge on the upper edge is nothing. Both Bidone (404) and Poncelet (388) had already shown that this was the case, and that the coefficients which serve ordinary orifices can be adapted to weirs also, when the flow is made under analogous circumstances.

270. In the formulæ given above, it has been supposed that the fluid above the sill was in repose, or rather above that point where the surface begins to be curved towards the sill. But this is not really the case, for before arriving at this point the water has received an initial velocity, which must be taken into account, as we have already done in Prop. XVI. 203. We must now add on to the head due to the velocity in the case where the water is in repose, and which is now only $\frac{2}{3}$ H (Prop. V. 185), the head which would generate that velocity with which it arrives. Let this velocity be u, and h the charge due to it; then, since $h = \frac{u^2}{2g} = 0{\cdot}01552 \times u^2$, we shall have the real velocity of issue

$$= \sqrt{2g\,(\tfrac{2}{3}H + 0{\cdot}01552 \times u^2)} = 5{\cdot}35\sqrt{H + 0{\cdot}03494 \times u^2};$$

$\therefore Q = 5{\cdot}35 \times ml \,.\, H \,.\, \sqrt{H + 0{\cdot}03494 \times u^2}$. u denotes the mean velocity of the section of the water which approaches the weir; its exact determination is well nigh impossible; but as its value differs little from that of the velocity at the surface, the equality may be admitted, and will modify the value of the coefficient which is to be determined experimentally. Call, then, this new coefficient m', and w the velocity of the surface of the water; then,

$$Q = 5{\cdot}35 \times m'l\, H\sqrt{H + 0{\cdot}03494 \times w^2}.$$

271. In the following experiments M. Castel[1] has put these formulæ to the test. We must remember, however, that the expression for the waste has two variables—the width of the weir, and a function of the velocity or charge. Now, in order that the formulæ should have claim to be well-founded, it is necessary that the waste should be exactly proportional to each, in which case, the coefficient m' would be constant: if this should happen with the coefficient, it will be a test of the accuracy of the formulæ.

272. M. Castel in 1835 and 1836 made numerous experiments on this subject, and with extraordinary care, at the Water-works of Toulouse. The principal apparatus which he employed was a wooden rectangular canal or trough, 6 met. long, 0·74 wide, and 0·55 deep: at one extremity he received a supply of water, and the other was so arranged that he could fit on thin copper plates in which the weirs were cut. The breadth of the overfalls varied from 0·01 to 0·74 met.; the sill or base was always 0·17 met. above the floor of the canal. The waste was received at pleasure and during a given time, into a zinc-plated cistern of 3·20 cub. met. capacity; this vessel was the *gauge basin*; it was therefore graduated vertically with the greatest care. The time that

[1] *Mémoires de l'Académie des Sciences de Toulouse*, tom. iv., 1837.

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the water took to rise a certain height was noted by a chronometer indicating quarter seconds.

273. The charges or heights of water above the sill of the weir were gradually increased from 0·03 to 0·10 and even to 0·24 met., for narrow overfalls. The most important, and, at the same time, the most difficult matter was to determine exactly the measure of the charges. In order to do this very correctly, M. Castel placed over the middle of the canal, and parallel to its length, a bar or rule EF (fig. 56), and which carried, at distances of 0·05 met., 10 vertical pointed brass rods *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, *k*, graduated into millimetres, and capable of sliding up and down; on the edge of the guides was a vernier graduated into 10ths of a millimetre. Whenever he wished to make an experiment, the requisite amount of water was admitted into the canal, and the regime or regulation for the proper supply being duly attended to, he let down the system of 10 rods, and put their points as accurately as possible in contact with the curved surface of the water. On subtracting, then, the reading of each rod from the vertical distance between the horizontal bar EF and the sill B, he obtained the values of the ordinates of the curve which the fluid particles described, as they advanced to the centre of the overfall B. These ordinates increased as they became more distant from B: at 0·2 or 0·3 or 0·4 met., the increase was sensible; the greatest ordinate was the true charge H, while the smallest was the charge immediately over the sill or $H-h=$ the thickness of the sheet of water over the base B. The mean results of these experiments are to be seen in the following table:—

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Charge upon the Sill, in metres.	Canal, 0·74 metres wide. Coefficients, the Length of the Overfall being, in metres, 0·74	0·68	0·60	0·50	0·40	0·30	0·20	0·10	0·05	0·03	0·02	0·01
0·24	...	...	...	...	...	...	....	0·595	0·615	...	0·639	...
0·22	...	...	...	...	...	...	...	0·594	0·614	...	0·639	...
0·20	...	...	...	...	...	...	0·596	0·594	0·614	0·629	0·640	0·670
0·18	...	...	...	...	...	...	0·595	0 594	0·613	0·628	0·641	0·672
0·16	...	...	...	...	...	...	0·595	0·592	0·613	0·628	0·642	0·674
0·14	...	...	...	...	...	0·603	0·593	0·592	0·612	0·628	0·643	0·675
0·12	...	...	...	...	0·621	0·604	0·592	0·591	0·612	0·628	0·645	0·678
0·10	...	0·657	0·644	0·631	0·621	0·604	0·593	0·591	0·612	0·627	0·648	0·687
0·08	0·662	0·656	0·644	0·632	0·620	0·606	0·595	0·592	0·612	0·627	0·652	0·698
0·06	0·662	0·656	0·645	0·632	0·622	0·610	0·604	0·595	0·612	0·628	0·658	0·713
0·05	0·662	0·656	0·644	0·633	0·626	0·616	0·611	0·597	0·613	0·629	0·663	...
0·04	0·662	0·656	0·645	0·636	0·632	0·623	0·619	0·604	0·614	...	0·669	...
0·03	0·663	0·660	0·651	0·642	0·636	0·631	0 624	0·618	...	...	...	...

274. After having in great measure exhausted the observations on the above canal, M. Castel experimented on one 0·361 met. wide, narrowing up the former by two partition boards 2·24 met. long. At the entrance of this small canal, which was placed in the centre of the larger, there was formed under large discharges a minute fall, which would have introduced some slight modifications into the results obtained had the partitions been extended up to the extremity of the larger canal. M. Castel, both on this and the former canal, performed in all 494 experiments, each being repeated twice. In each case the values of Q, *l*, and H, being given immediately by experiment, the coefficient *m* was deduced from the formula $Q=5{\cdot}35\ mlH\sqrt{H}$ (269). The mean values of the experiments on the second canal are set down in the following table. In this and the former table where blanks occur no observations were made:—

Charge upon the Sill, in metres.	Canal, 0·361 metres wide. Coefficients, the Length of the Overfall being, in metres, 0·36	0·30	0·20	0·10	0·092	0·079	0·05	0·03	0·02	0·01
0·24	...	...	...	0·619	...	...	0·624	0·629	0·647	0·666
0·22	...	...	...	0·615	0·613	0·617	0·620	0·627	0·646	...
0·20	...	...	...	0·611	0·608	0·614	0·618	0·626	0·645	0·667
0·18	...	...	0·633	0·608	0 606	0·610	0·616	0·626	0·644	...
0·16	...	...	0·628	0·605	0·603	0·608	0·615	0·625	0·644	0·668
0·14	...	0·678	0·624	0·603	0·601	0·605	0·614	0·624	0·644	...
0·12	0·700	0·666	0·620	0·600	0·599	0·603	0·614	0·623	0·646	0·674
0·10	0·684	0·656	0·617	0·598	0·598	0·600	0·614	0·624	0·648	...
0·08	0·672	0·652	0·616	0·599	0·597	0·599	0·613	0·624	0·654	...
0·06	0·669	0·652	0·617	0·600	0·597	0·600	0·613	6·626	...	...
0·05	0·667	0·653	0·620	0·605	0·604	...	0·614	...	...	...
0·04	0·668	0·653	0·624	0·613	0·611	...	0·613	....	...	...
0·03	0·670	0·665	0·632	0·628	0·625	...	...	...	...	...

275. After having tabulated these results, M. Castel applies the simple and common formula $Q=5{\cdot}35\times lH\sqrt{H} \propto H\sqrt{H}$, and first shows that the wastes Q are proportional to the function of the charge $H\sqrt{H}$. For this purpose he takes the twenty-two series of wastes obtained, each with the same width of weir, but under different charges; he reduces the discharges of each series to that which they would have been, if one of them, *e.g.*, that under 0·08 met., had been taken for unity or 1; he reduces also the series of

values of $H\sqrt{H}$, and places them side by side, as in columns 1, 2, 3 of the following table :—

Charges.	Series of Wastes.			Series of	
H	1	2	3	$H\sqrt{H}$	$\frac{H\sqrt{H}}{-h\sqrt{h}}$
Met.					
0·20	...	3·96	3 98	3·95	4·01
0·18	...	3·38	3·39	3·38	3 42
0·16	...	2·83	2·84	2·83	2·87
0·14	...	2·31	2·32	2·31	2·34
0·12	...	1·83	1·84	1·84	1·86
0 10	1·40	1·39	1·40	1·40	1·41
0·08	1 00	1·00	1·00	1·00	1 00
0·06	1·650	0·652	0·650	0·650	0·643
0·05	0·494	0·498	0·495	0·494	0·486
0·04	0·354	0·381	0·354	0·354	0·345

The first two are given by the canal 0·74 met., with the overfalls 0·60 and 0·10 met. in length; the third is from a canal 0·36 wide, with an overfall 0·05 met. long. The conclusions, then, derived from a comparison of the twenty-two series of wastes with each other, and with those derived from the function $H\sqrt{H}$ are—

1*st*, That, on exceeding the charge 0·06 or even 0·05 met., some higher charges being excepted, the difference between the numbers of the same horizontal line are very small; they rise only by a 100th or so; and thus, in a practical point of view, the difference may be taken as nothing; so that the relation between the wastes may be regarded as the same as that between the corresponding values of $H\sqrt{H}$.

2*d*, That for charges of 0·05 met. and below it, the wastes decrease in a ratio less than $H\sqrt{H}$, and much less as the charge becomes more feeble, but only with the mean lengths; for when they are very small, or when they approach the width of the canal, the equality is again produced.

3*d*, In some higher charges, especially with wide overfalls, the wastes increase in a less ratio than $H\sqrt{H}$. This result, which was scarcely perceptible in a canal of 0·74 met., became very prominent in one of 0·36 met., where the water with these charges and with these widths, arrived at the overfall with considerable velocity. Now, in these cases, and they always present themselves when the fluid section l. H at the passage of the weir exceeds the fifth part of the section of the current in the canal, the wastes ought not to increase as $H\sqrt{H}$, but as $H\sqrt{H+0{\cdot}03494\times w^2}$, so that the formula as given in 270 must now be used. Hence, in limiting the subject to overfalls, properly so called, that is, those in which the water has an initial velocity of arrival, Q will be very nearly proportional to $H\sqrt{H}$.

276. The formula, however, is no longer so coincident with experiment when the widths of the overfall vary. Beginning with the width of the basin the wastes diminish with the width of the overfall, but more rapidly up to a certain point, beyond which they diminish, less rapidly. The following table will show this. The canal of 0·74 met. has 12 widths, which are as the numbers in the first column; the second column shows the progress in which the corresponding wastes diminish, which were obtained under charges varying from 0·06 to 0·10 met. In the case of the canal of 0·36 met., where ten widths were employed, those only are set down which were nearly analogous to those of the other canal. This series of relations indicates that in both canals the wastes follow one and the same law with respect to the widths of the overfalls; to the relative widths, however, of the respective canals, and not to the absolute widths.

Canal of			
0·74 Metres.		0·36 Metres.	
Width.	Waste.	Width.	Waste.
1000	1000	1000	1000
919	911	...	...
811	788	831	807
676	645	...	...
540	507	554	507
405	371	...	...
270	243	277	246
135	121	138	125
68	62	...	...
40	40	...	...
27	27	...	...
13	14	...	...

277. Since for one and the same width of overfall, and on neglecting extreme cases, the wastes are proportional to $H\sqrt{H}$, the coefficients should be nearly equal, and tables of 273 and 274 show us that they are so. Strictly speaking, however, the coefficients of any vertical column, beginning with the higher charges, decrease, generally very slowly, down to a certain charge, beyond which they rapidy increase; this charge, which is about 0·10 met., will be a minimum. Further, the charges remaining the same, the wastes at first decrease more and afterwards less rapidly than the widths of the overfalls; it follows that under the same charge, beginning with the width of the channel, the coefficients go on diminishing up to a certain point, and then beyond this increase. At this point, then, there will also be a minimum, which takes place when the width of the overfall is nearly one-fourth that of the channel of supply. Thus, in the horizontal as well as in the vertical columns of 273 and 274, there is a minimum, and hence there is a common minimum. In its immediate neighbourhood the coefficients on each side of it are very little different from one another; the variation is small, and so may be regarded as constant. But beyond this distance, the differences become considerable; they exceed an 8th in the values; and hence the waste by overfalls cannot be properly given with a constant numerical coefficient in the expression $l\,H\sqrt{H}$, for, mathematically speaking, the expression would not be admissible. In practice, then, we would require the assistance of a very extended table of coefficients deduced from hundreds of experiments. But the nature of the *motion* which the coefficients follow, when properly looked at, will enable us to avoid this labour, and to deduce a few simple rules suitable to the different cases which present themselves.

278. From what has been said in 275, the formula $l\,H\sqrt{H}$ is not applicable, on the one hand, when the charges are under 0·06 met.; nor, on the other, when the product of the transverse area and the width of the overfall exceeds the fifth part of the section of water in the supplying canal. Between these limiting values the above expression may be very well employed when combined with a coefficient depending on the width of the overfall.

Reckoning from the width of the canal itself, the coefficients diminish with the width of the overfall, until it has reached the fourth part of that of the channel; they still increase although the widths continually diminish; and what is rather remarkable, the coefficients, when diminishing, follow the relative widths of the overfall with respect to that of the canal, whereas, when they are increasing, which occurs afterwards, they depend on the absolute widths.

Such being the case, there will be four cases to distinguish relative to the coefficient to be employed in actual practice.

1*st*, In the neighbourhood of the common minimum already mentioned, the coefficients vary very little from each other. From the experiments of M. Castel at Toulouse, from a width of overfall nearly equal to one-third of that of the canal, supposed to exceed 0·30 met., down to an absolute width of 0·05 met., the coefficients only varied from 0·59 to 0·61, the mean of which is 0·60. Therefore the variable coefficient in this case to multiply $l\,H\sqrt{H}$ will be $5{\cdot}35\times 0{\cdot}60 = 3{\cdot}21$. Hence, between the limits, we have $Q = 3{\cdot}21 \times l\,H\sqrt{H}$, a formula which is well adapted for gauging small streams of water.

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2*d*, When the width of the overfall is a maximum, that is, equal to the whole breadth of the canal, in which case it will be a weir or waste-board proper, the coefficients have a remarkable constancy. M. Castel, in his experiments with a barrier 0·17 met. high, found no difference between the coefficients obtained from charges varying from 0·03 to 0·08 met. With an overfall 0·225 met. high the coefficients varied only from 0·664 to 0·666, the charges varying from 0·031 to 0·074 met.; when he took the mean it was 0·665. Hence, since $5{\cdot}35 \times 0{\cdot}665 = 3{\cdot}55775$, and calling L the width of the canal or length of the barrier, we have $Q = 3{\cdot}558 \times LH\sqrt{H}$, a formula which may be used advantageously in gauging large courses of water, and with charges varying from 0·04 to 0·03 met.; but for accuracy it is necessary that the charge be less than one-third the height of the barrier.

3*d*, For widths of overfalls comprised between that of the channel and the fourth part of the same, the coefficient of the expression $5{\cdot}35 \times lH\sqrt{H}$ will vary with the relative width, or the ratio of the width of the overfall to that of the canal. The annexed table of coefficients is the result. These coefficients have been found, not by direct experiment, but by taking proportional parts between the coefficients deduced from experiment, and those from the tables given in 273 and that of 274. The coefficients for both canals were separately determined by observation, in order to show that the same relative width has corresponding coefficients sensibly the same, although the real value of the width was in one canal nearly double that of the other, which was a clear proof, that above 0·25 met., or a fourth part of the width of the channel, the coefficients depend for their value on the relative, not on the absolute widths of the overfall.

Relative width.	Coefficient for Canal of	
	0·74 Met.	0·36 Met.
1·00	0·662	0·667
0·90	0·656	0·659
0·80	0·644	0·648
0·70	0·635	0·635
0·60	0·626	0·623
0·50	0·617	0·613
0·40	0·607	0·609
0·30	0·598	0·600
0·25	0·595	0·598

4*th*, It is otherwise, however, when this width falls below a fourth that of the canal. Then, and when at the same time it is less than 0·08, or 0·06 met., the width of the canal has no further effect, and each absolute width of the overfall has its proper coefficient. Thus, on the canal of 0·36 met., as on that of 0·74, the widths of 0·05, 0·03, 0·02, 0·01 met., gave in both coefficients of 0·61, 0·63, 0·65, and 0·67 respectively.

279. With respect to the formula given in 268, or $Q = 5{\cdot}35 \times ml(H\sqrt{H} - h\sqrt{h})$, where $h = AD$ (fig. 56), the last column of the table in art. 275 lets us see that although the series of values tabulated for $(H\sqrt{H} - h\sqrt{h})$ differs little from those of the corresponding wastes, yet it follows them less closely than does the series of values for $H\sqrt{H}$. Hence, on this account, the second formula is less trustworthy than the first. Its application, besides, is made more difficult, for it has a term $h\sqrt{h}$, the exact determination of which is very difficult.

280. In the formula, however, involving a term which is a function of the velocity with which the water flowing in the canal arrives at the overfall, this is scarcely the case. This formula is for the case of a high velocity, where the water makes its escape in virtue both of the charge H, and that due to a previously acquired velocity; it is expressed by $Q = 5{\cdot}35 \times m'lH\sqrt{H + 0{\cdot}03494 \times w^2}$, which leads to 270.

M. Castel has deduced from his experiments values for the coefficient m'. In these experiments he did not measure the velocity w of the surface current in the canal, but it may be determined from the mean velocity, which in this case is $Q = v\,L\,(H + a)$, where L is in this case the width of the channel of supply, a the height of the sill above the bottom of the channel, and H the charge.

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The velocity of surface water will be shown in 331 to be a 4th part higher than the mean velocity; hence we have, $w = 1{\cdot}25 \times \frac{Q}{L\,(H + a)}$. With this value of w, which is the highest that can be assumed, the coefficient m' differs only from m of the common formula when the velocity in the canal has a value sufficiently great that $0{\cdot}03494 \times w^2$, which causes the difference between the two formulæ, is comparable with H. Since $0{\cdot}03494 \times w^2$ is very small, and under the square root, it will influence the quantity m' by little more than half its amount relative to H; if it be, for example, 2, 4, or 6 hundredths of H, the coefficients, everything else being the same, will only differ from each other by 1, 2, or 3 hundredths. In these three cases the section lH of the fluid sheet at the overfall is found to be respectively 0·1724, 0·244, and 0·3 times the section of the supplying canal, or $L\,(H + a)$; wherefore, when the first of these two sections is less than the 5th part of the second, m and m' will be within $\frac{1}{100}$th of each other. This was the case with two overfalls experimented on by M. Castel, where the width was less by one-half than that of the channel of supply. When it was greater, the term $0{\cdot}03494 \times w^2$ had more influence, and the difference between the coefficients became greater. But although this term has been employed, it has not reduced to equality the coefficients m and m' for different widths of overfall; it has not reduced by one-half the differences which the values of m present, so that neither of the expressions $Q = 5{\cdot}35 \times mlH\sqrt{H}$, $Q = 5{\cdot}35 \times m'lH\sqrt{H + 0{\cdot}03494 \times w^2}$ can be employed with a constant coefficient, except where the width of the overfall is the same as that of the canal of supply.

In order then to determine this constant coefficient, M. Castel dammed up a canal of 0·74 met. by copper barriers, the height of which gradually decreased from 0·225 to 0·032 met.; and he found coefficients as noted in the following table:—

Height of barrier.	Coefficients m', the charge being			
	Met. 0·08	Met. 0·06	Met. 0·05	Met. 0·04
Met.				
0·225	0·651	0·655	0·657	0·660
0·170	0·640	0·647	0·650	0·654
0·130	0·650	0·649	0·652	0·656
0·093	0·635	0·642	0·646	0·650
0·075	0·647	0·652	0·655	0·660
0·041	0·667	0·664	0·665	0·668
0·032	0·676	0·676	0·676	0·680

Those of the first five barriers are nearly the same, although otherwise they do not present the same regularity as ordinary overfalls: the mean term may be taken as 0·650. With respect to the last two barriers of 0·041 and 0·032 met., they are in a distinct class; they were very low, and the charges much exceeded their height; so that the case was as much one of a course of water flowing in an ordinary channel as when it passed over a waste-board. Since there was a near equality between the coefficients for one and the same barrier, the formula which was employed for their determination is in a manner confirmed. The experiments again on the canal of 0·36 with a barrier of 0·17 met. high, gave coefficients the mean of which was 0·654. Let the mean between those two means be taken, or 0·652, then since $5{\cdot}35 \times 0{\cdot}652 = 3{\cdot}488$,

$$\therefore\ Q = 3{\cdot}488 \times LH\sqrt{H + 0{\cdot}0349 \times w^2},$$

where w is to be determined by direct observation.

Experiments on the Motion of Fluids.

We have been very particular with these experiments of M. Castel, and Daubisson's remarks upon them, owing to the importance of the subject; for further information, see volume already mentioned. Sometimes channels are adapted to overfalls, in which case the water discharged will be confined, and be resisted by the friction of the bottom and sides; this retardation must react on the water and diminish the discharge. Into this case, however, we need not enter.

281. There is still a particular case of an overfall to be considered; it is that which Dubuat has termed a *demi-deversoir* or *deversoir incomplet*; we call such overfalls *drowned weirs*. A drowned weir, then, is when the *tail* of the water rises above the level of the waste board sill. Dubuat divided the height AC (fig. 57), the level of the canal

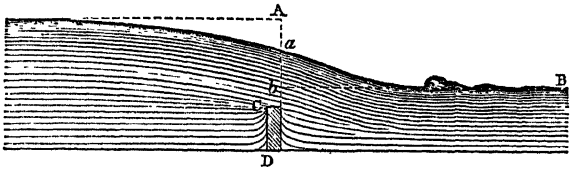


Fig. 57.

above that of the sill C, into two parts, Ab and bC; the flow from the first he considered as from an ordinary overfall where Ab (=H) would be the charge, and the volume of escape by it would be $Q = 3{\cdot}488 \times l\,H\sqrt{H} + 0{\cdot}0349 \times w^2$. In the second part he regarded the flow as taking place out of a rectangular orifice, the height of which was bC, and the charge equal to the difference of level Ab, between the surface of the upper and that of the lower course. The height of this lower surface above the sill is bC; and this height bC will be equal to $n-y$, representing n and y respectively by bD and CD. To the charge Ab or H must be added, as in the case of closed orifices, the height due to the velocity u of the water in the canal, and then the velocity of issue will be $\sqrt{2g(H + 0{\cdot}01553 \times u^2)}$, or $= \sqrt{2g(H + 0{\cdot}01 \times w^2)}$, where $w = 1{\cdot}25 \times u$ (280). Hence for the volume discharged by this part we have

$$Q = 4{\cdot}96 \times l\,(n-y)\sqrt{H + 0{\cdot}01 \times w^2}.$$

Let the two partial discharges be added together so as to obtain the total waste Q';

$$\therefore Q' = 3{\cdot}488 \times l\,H\sqrt{H + 0{\cdot}0349 \times w^2} + 4{\cdot}96 \times l\,(n-y)\sqrt{H + 0{\cdot}01 \times w^2}.$$

282. Mr Smeaton made several experiments on weirs. He conducted his observations by noting the time in which a vessel of 20 cubic feet would be filled with water flowing over a *notch* 6 inches wide, of various depths, and with different charges, as given in the table.

Depth of notch in inches.	Time of discharging 20 cubic feet.
	Sec.
1	436
1⅛	295
2 5/16	139
3⅛	93
6½	30
5	46
1¼	326
1⅜	230
5⅝	47

The annexed table will show his results. We have thus a method of determining the coefficients. Thus, let the head, as in table 287, be 0·1042 feet, then from formula $Q = \frac{2}{3} l H \sqrt{2g\,H} = \frac{2}{3} \times 0{\cdot}05 \times 0{\cdot}1042 \times 8{\cdot}024 \times \sqrt{0{\cdot}1042} = 0{\cdot}08995$ cubic feet per second: but the experiment gave 20 cubic feet in 326 seconds; hence, we have in one second 0·06135 cubic feet;

$$\therefore 0{\cdot}08995 : 0{\cdot}06135 = 1 : 0{\cdot}682 = \text{coefficient}.$$

283. In September 1836, Mr S. Ballard made a series of experiments on the flow of water over weirs on the Severn at Powick, near Worcester. The experiments were made on a weir 2 feet long, which stood perpendicularly across a trough, and the results are exhibited in the following table:—

Experiments on the Motion of Fluids.

Depth of water flowing over weir, in inches.	Cubic feet per minute, over 1 foot of weir.	Depth of water flowing over weir, in inches.	Cubic feet per minute, over 1 foot of weir.
1	5·88	4	46·87
1¼	7·14	4¼	49·45
1½	9·55	4½	54·87
1¾	12·37	4¾	59·60
2	14·93	5	63·38
2¼	18·29	5¼	66·17
2½	23·07	5½	73·17
2¾	27·69	5¾	77·58
3	32·14	6	82·56
3¼	34·61	7	102·27
3½	37·81	8	126·76
3¾	41·47	...	...

At the commencement of these experiments the results could not be rendered satisfactory owing to the difficulty of observing the exact depth of water on the weir, the gauge on the side being rendered inaccurate by the action of capillarity. The method then adopted was to attach two needles, one a very little larger than the other, to the lower end of a nicely graduated gauge, so that on the water being admitted by a sluice, regulated by a screw, its level was adjusted until it just touched the longer needle, and occasionally by its uneven motions the shorter one, which thus gave the exact height of the water above the weir. The gauge tank was graduated vertically and capable of containing 300 cubic feet. It was thought that the perpendicular position of the board forming the weir might lessen the volume passing over it, and, to avoid this, a sloping board was substituted, inclining on the upper side from the top of the weir downwards. Under this new arrangement the volume discharged was increased, with 1 inch depth of water, from 5·88 cubic feet per minute to 6·76 cubic feet in the same time, or about 15 per cent. Experiments were afterwards made on a weir 1 foot long, and the volume discharged was found to be less than with the 2-feet weirs. This was attributed to the contracted stream caused by the direction of the course of water at the sides of the weir. Experiments were also tried with oblique and circular weirs, and the volume of discharge was found uniformly to increase with the length of the weir. See *Civil Engineer and Architects' Journal*, vol. xiv., p. 647.

284. The experiments on overfalls by Mr T. E. Blackwell, being conducted on a much larger scale, may, for practical purposes, be regarded as furnishing results even more trustworthy and valuable than those of Dubuat, MM. Daubisson, and Castel. The first set of experiments was made in July 1850, in a side pond of the Kennet and Avon Canal, the area of which measured 106,200 square feet. It was guarded by a lock at each end, so that no current disturbed the surface. The supply reservoir, which was distinct from the experimental one, did not furnish a supply equal to the volume that escaped. The deficiency was made up three or four times a-day from the upper lock. This, however, would make no appreciable difference in the result when the reservoir was so large and the time required so small. The subsidence of the water due to even the largest volume of 444 cubic feet discharged, would only be about 0·00418 feet over the whole surface, so that the mean fall would be no more than 0·00209 feet. At some small distance above the overfall, the depth of water was somewhat reduced by a submerged course of masonry which rose to within 18 or 20 inches of the surface; and the overfall was placed on the outer line of the dam, and not exactly in the line of one of the sides of the reservoir. From the measurements given of the head, taken at still water, and the corresponding depth of the sheet of water flow-

Experiments on the Motion of Fluids.

ing off, it appeared that some degree of resistance opposed the motion of the water up to the overfall. Every care was taken to determine the correct head of water, or the total depth from the surface of the water to the crest of the bar or overfall. The bar itself was about 12 feet long and 2 feet deep, and was arranged to rise or fall at pleasure, and the crest of the bar was made as level as possible. The gauging tank had a capacity of 444·39 cubic feet; whatever leakage took place during an experiment was carefully measured in a separate vessel. The plate forming the overfall bar was of iron, $\frac{1}{16}$th inch thick.

285. The second set of experiments, in which he was assisted by Mr Simpson, were performed during the summer of 1850, at Chew Magna, Somersetshire; the reservoir employed was a very small one, and kept constantly supplied by a pipe 2 feet in diameter, discharging from an upper tank under a head of 19 feet. As the distance between the experimental and supply reservoir was only 100 feet, it was presumed that the water arrived at the overfall with some part of the velocity due to so great a head; this was perceptible to the eye in heads above 5 or 6 inches, but the peculiar form of the reservoir prevented the amount from being accurately determined,—a circumstance which so far casts uncertainty on the results. The overfall reservoir had wings placed at an angle of 45°, and the overfall bar was a cast-iron plate $\frac{1}{16}$th inch thick, with a square top. The *heads* were measured on a bar 4 feet long, and placed diagonally that its zero point was just level with the overfall top, and its upper end raised one foot above; it was divided and subdivided so that $\frac{1}{16}$th of an inch could be easily read. The gauging tank had a capacity of 400 cubic feet, but for the purposes of experiment it only contained 389·79 cubic feet.

Experiments on Overfalls, Kennet and Avon Canal.

Overfall.	Total depth of water above crest in inches.	Time in seconds.	Waste. Total quantity.	Waste. Per second.	Waste. Average per second.	Waste. Per sec. for 1 ft. in width.	Coefficients. m.	Coefficients. k.	Mean of Coefficients. m.	Mean of Coefficients. k.
Thin plate 3 ft. long.	1	176½	45·97	·260	·260	·087	·451	·087	·421	·080
	6	131¼	441·77	3·366	3·366	1·122	·395	·076		
Thin plate 10 ft. long.	1	177½	189·90	1·088	1·088	·104	·539	·104	·445	·086
	5	47¼	442·03	9·355	9·355	·935	·433	·083		
	9	24	441·99	18·416	18·416	1·842	·353	·069		
Plank 2 in. wide, 3 ft. long.	1	757	137·91	·181	·180	·060	·311	·060	·380	·073
	3	159	183·90	1·157	1·138	·376	·375	·072		
	6	131½	443·07	3·370	3·363	1·121	·395	·076		
	10	59½	442·99	7·445	7·492	2·497	·409	·079		
Plank 2 in. thick, 6 ft. long.	1 to 1 5/16	487½	171·23	·354	·354	·059	·306	·059	·377	·072
	3	184	430·61	2 389	2·396	·399	·398	·077		
	6	64½	442·72	6·890	6·890	1·150	·405	·074		
	10	34¼	443·03	12·950	13·156	2·193	·359	·069		
	14	19¾	443·60	22·477	22·183	3·697	·366	·071		
Plank 2 in. thick, 10 ft. long.	1	230	152·62	·665	·563	·056	·290	·056	·371	·072
	4	67¼	436·53	6·491	6·192	·619	·401	·077		
	7	32¾	410·01	13·780	13·720	1·372	·384	·074		
	9	23¾	441·16	18·575	19·417	1·942	·372	·072		
	12	15½	442·29	28·529	28·526	2·853	·356	·069		
Plank 2 in. wide, 10 ft. long.	5	4¾	442·11	9·664	...	0·966	·447	·086	·459	·090
	1	190	183·90	0·968	...	0·97	·503	·097		
Crest 3 ft. wide, 3 ft. long, slope 1 in 12.	1	254½	45·97	·181	·181	·060	·311	·300	·338	·065
	9	85¼	442·26	5·188	5·188	1·729	·332	·064		
Crest 3 ft. wide, 3 ft. long, slope 1 in 18.	1	218¾	45·97	·210	·210	·070	·363	·070	·339	·065
	9	86	442·24	5·143	5·127	1·709	·328	·063		
Crest 10 ft. long, 3 ft. wide, slope 1 in 18.	1 to 7/8	282	169·80	·603	·703	·060	·311	·060	·337	·065
	8	30	442·89	14·761	14·761	1·476	·338	·066		
Crest 3 ft. wide, 3 ft. long, level.	1	265¼	45·97	·173	·173	·058	·301	·058	·311	·060
	9	89¾	442·15	4·926	4·926	1·642	·317	·061		
Crest 3 ft. wide, level, 6 ft. long.	3	222¼	438·52	1·973	1·971	·329	·328	·063	·322	·061
	2	29½	443·21	15·030	14·965	2·495	·311	·060		
Crest 3 ft. wide, 10 ft. long, level.	1	399½	166·93	·092	·492	·049	·254	·049	·314	·061
	80	24	443·19	18·467	18·467	1·847	·303	·059		

286. The tabulated results give observations on the flow of water—over a plank 2 inches thick, with square edges; over a thin plate; over a crest, resembling the top of a weir, of which the breadth was 3 feet, the position of the surfaces horizontal; and also at inclinations downwards, of 1 in 18, and 1 in 12 respectively. These main divisions were observed throughout, and the lengths of the weirs were severally 3 feet, 6 feet, and 10 feet. The formula which has been compared with experiments, so as to determine the coefficient m, is $Q = m\,l\,H\,\sqrt{2\,g\,H}$, and the formula in use among English engineers for the discharge, or $D = k\,.\,l\,.\,H\,\sqrt{H} = 5{\cdot}1 \times H^{\frac{3}{2}}$, where D is the volume of waste per minute for every foot in width of the overfall, H the head in inches, and 5·1 a *constant* coefficient of reduction. Mr Blackwell has set down in the tables the value of the variable coefficient k.

The preceding table is taken from twelve different tables, containing the result of 243 experiments on overfalls where the reservoir was large in proportion to the overfall, and the water was still. The mean coefficient of each table is set down.

The following table is the result of seventy experiments on an overfall 10 feet long and 2 inches wide, with a reservoir of 5717 square feet, kept constantly full:—

Experiments on Overfalls.

(Overfall bar, 10 feet long, 2 inches wide.)

Total depth of water above crest in inches.	Time in seconds.	Waste. Total quantity.	Waste. Per second.	Waste. Average per second.	Waste. Per second for 1 foot in width.	Coefficients. m.	Coefficients. k.
1 to ⅞	560½	384·71	·690	·690	·069	·394	...
2¼	133¾	385·79	2·900	2·900	·290	·455	...
2⅞	93¼	383·71	4·115	4·115	·412	·437	...
3 bare	82	385·71	4·700	4·700	·470	·469	...
4	50⅞	384·71	7·620	7·680	·768	·497	...
4 1/16	43½	386·71	8·900	8·770	·877	·507	...
4 1/16	43½	385·71	8·870	9·017	·902	·500	...
5 bare	34	383·71	11·290	11·290	1·129	·520	...
6	27¼	385·71	14·150	14·150	1·415	·499	...
6 3/16	27½	398·79	14·500	14·030	1·443	·499	...
7 3/16	20¼	398·79	19·450	19·610	1·961	·478	...
8	16½	385·71	23·380	23·380	2·338	·535	...
9	14	385·71	27·550	27·550	2·755	·521	...
					Mean...	·480	

The results in the table of the first set of experiments represent the case of the discharge of water by an overfall from a large still reservoir. In the second set the discharges are analogous to the case of a weir in a river or in a running stream.

287. Mr Blackwell deduces from his experiments several important facts. In thin plates the coefficient is highest at the smallest head observed; it reaches the mean at a head of about 3 inches, but beyond this point it decreases as the head increases. With a plank 2 inches thick, and a head of 1 inch, the coefficient is less than the mean; the mean is earlier reached as the length of the weir becomes greater; the mean head is about 3 inches, the coefficient continues to rise higher than the mean till the head reaches about 9 inches, but after this it is depressed below it. He found that a head of about 4 inches gave a smaller outflow than could be obtained by interpolating the results with heads of 3 and 5 inches. It is difficult to explain the reason of the depression.

Mr Blackwell also made several experiments to determine the effect of converging wing walls, noting the results on a weir 10 feet long, with and without wings, the wings

making an angle of 54°. The mean coefficient for that without wings was ·371, while that with wings was ·459. The coefficients in the second table, up to a head of 3 inches, are below the mean, above that head they fluctuate considerably; but generally they keep above the main line. These anomalies are difficult to be accounted for, since every care was taken in the experiments. They remain to be elucidated by further investigations.

The following table, compiled from various sources, gives at one view the results of different experimenters:—

Experiments on Overfalls.

Overfall 0·5 *feet long.* Smeaton and Brindley.												
Heads	...	...	·083	·1042	·1146	·1354	·1927	·2604	·4166	·4687	·5417	...
Coefficients	...	...	·713	·681	·654	·638	·636	·602	·609	·571	·633	...
Overfall 1·533 *feet long.* Dubuat.												
Heads	...	...	...	...	...	·1482	...	·2666	·3887	...	·5627	...
Coefficients	...	...	...	...	...	·648	...	·624	·627	...	·630	...
Overfall 0·656 *feet long.* Daubisson and Castel.												
Heads	...	...	·098	·131	·164	·196	·262	·328	·393	·459	·524	·590
Coefficients	...	...	·632	·624	·620	·617	·616	·617	·620	·624	·628	·633
Overfall 0·6548 *feet long.* Poncelet and Lesbros.												
Heads	·033	·066	·099	·1332	·1998	·2664	·333	·50	·666	·75	...	...
Coefficients	·626	·625	·618	·611	·601	·595	·592	·590	·585	·577	...	...
Overfall 3 *feet long and* 10 *feet long.* Blackwell.												
Heads	...	...	·083	·166	·25	·33	·416	·50	·583	·666	·75	...
Coefficients	...	...	·742	·738	·636	·635	·625	·592	...	·580	·529	...
Overfall 10 *feet long.* Simpson and Blackwell.												
Heads	...	...	·083	·166	·25	·33	·416	·50	·583	·666	·75	...
Coefficients	...	...	·608	·682	·725	·745	·780	·749	·772	·802	·781	...

288. According to Mr Beardmore, in his *Hydraulic* and *Tide Tables*, the best mode of gauging weirs is by means of a post with a smooth head, level with the edge of the waste-board or sill, and driven firmly in some part of the pond above the weir, which has still water. A common rule can then be used for ascertaining the depth, or a gauge, showing at sight the depth of water passing over, may be nailed on, with its zero at the level of the sill of the weir. Among practical engineers, gauging by a weir has been always justly held to afford the most certain and efficient result, especially for ascertaining the comparative discharges of streams. For correct gauging, the effects of wind and current must be destroyed, a thin-edged waste-board must be used, and a weir not so long in proportion to the width above it as to wire-draw the stream, else the water will arrive at the weir with an initial velocity due to a fall which is not estimated in the gauging, and the result will be most probably too small. A weir, for correct gauging, should always have a free fall over; but there are sometimes cases where measurements are required with drowned weirs—so called when the tail has risen above the level of the sill. In this case we have two conditions which have been already stated in 281. Mr Beardmore's *Hydraulic Tables* for overfalls proper, gives the discharge for one foot of length.

SECTION IV.—EXPERIMENTS ON THE EXHAUSTION OF VESSELS.

289 It is almost impossible to determine the exact time in which any vessel of water is completely emptied. When the surface of the fluid has descended within a few inches of the orifice, a kind of conoidal funnel, of which the air occupies the middle part, is formed immediately above the orifice. The pressure of the superincumbent column being therefore removed, the time of exhaustion is prolonged. The water falls in drops; and it is next to impossible to determine the moment when the vessel is empty. Instead, therefore, of endeavouring to ascertain the time in which vessels are completely exhausted, the Abbé Bossut has determined the times in which the upper surface of the fluid descends through a certain height:—

Experiments on the Motion of Fluids.

Times in which Vessels are partly exhausted.

Original altitude of the water in the vessel.	Constant area of a horizonal section of the vessel.	Diameter of the circular orifice.	Depression of the upper surface of the fluid.	Time in which this depression takes place.
H	A	...	$H-h=a$	T
Paris feet.	Square feet.	Inches.	Feet.	Min. sec.
11·6666	9	1	4	7 25½
		2	4	1 52
		1	9	20 24½
		2	9	5 6

Comparison of the Results of Theory with those of Experiment.

Diameter of the circular orifice.	Depression of the upper surface of the fluid.	Time of the depression of the surface by experiment.	Time of the depression of the surface by the formula.	Difference between the theory and the experiments.
Inches.	Feet.	Min. sec.	Min. sec.	Seconds.
1	4	7 25½	7 22·36	3·14
2	4	1 52	1 50·59	1·41
1	9	20 24½	20 16	8·50
2	9	5 6	5 4	2·00

It appears from this table also that the times of discharge, by experiment, differ very little from those deduced from the corrected formula; and that the latter always err in defect. When the orifices are in the sides of the reservoir, the altitudes H, h of the surface may be reckoned from the centre of gravity of the orifice, unless when it is very large.

290. In order to compare these experimental results with those deduced from theory, we must employ the formula of Prop. X. 196, where the expression for the surface descending through any space a in a given time is

$$T=\frac{2A}{mS\sqrt{2g}}(\sqrt{H}-\sqrt{h}).$$

Let there be, for example, a prismatic vessel, the horizontal section of which is a square of 0·975 met. to the side, the orifice in the bottom being 0·0271 met. in diameter; the depth of water in it over the centre of the orifice is 3·79 met.; in what time will the surface fall through a depth of 1·30 met., reckoning from the orifice?

Here $A=(0{\cdot}975\text{ met.})^2=0{\cdot}9506$ sq. met., $S=\pi(0{\cdot}0135)^2=0{\cdot}000577$ sq. met., $H=3{\cdot}79$, $h=3{\cdot}79-1{\cdot}30=2{\cdot}49$ met., and m say 0·61;

$$\therefore T=\frac{2\times0{\cdot}9506}{0{\cdot}61\times0{\cdot}000577\times\sqrt{2g}}(\sqrt{3{\cdot}79}-\sqrt{2{\cdot}49})=450^s=7^m\,30^s.$$

Bossut, however, when operating with these data, found the time actually required to be $7^m\,25^s{\cdot}5$, g being given in metres.

291. He also made three experiments with the same apparatus, the results of which, theoretical and practical, are noted in the following table:—

Diameter of orifice.	Diminution of surface.	Time of diminution from Experiment.	Time of diminution from Formula.
Metres.	Metres.	Min. sec.	Min. sec.
0·0271	2·92	20 25	20 41
0·0541	2·92	5 6	5 10
0·0541	1·30	1 52	1 52

The calculated time is slightly in excess of the observed result, but this being small may be neglected; the difference probably arose from some error of observation. To exemplify the expression in 198 for the fluid surface falling down a certain depth, let the upper surface of a basin which is sensibly prismatic, have an area of 1000 sq. met.; the water issues by a sluice opening 0·65 met. broad by 0·085 met. deep. The vessel, when the sluice rises, is filled to a height of 2·70 met. above this opening; find the depth through which the surface will pass in one hour?

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Since a of 198 is also $=\frac{tmS\sqrt{2g}}{A}\left(\sqrt{H}-\frac{tmS\sqrt{2g}}{4A}\right)$

$$\therefore \text{Depth required}=\frac{3600\times0{\cdot}70\times0{\cdot}05525\times4{\cdot}43}{1000}\times\left(\sqrt{2{\cdot}70}-\frac{3600\times0{\cdot}70\times0{\cdot}05525\times4{\cdot}43}{4\times1000}\right)=0{\cdot}9182\text{ met.}$$

where the value of g is taken in metres, and $m=0{\cdot}70$.

Hence, volume escaped in the course of the hour $=1000\times0{\cdot}9182=918{\cdot}2$ cub. met.

SECTION IV.—EXPERIMENTS ON THE ESCAPE OF WATER PASSING FROM ONE RESERVOIR INTO ANOTHER.

292. When a reservoir contains water, an escape may take place by an orifice in the bottom or side, not only in the open air, but also into another vessel partly full of water. If the escape be considered under this latter point of view, the three cases which will occur have already been mentioned under Prop. XV. (204).

As an application of the second case of Prop. XV., we may take the canal of Languedoc. General Andreossy, in his history of this canal, gives in mean terms—

The length of the lock from one gate to the other...	35 08	met.
... Breadth of the lock (bulging in the middle) from 6·50 met. to.....	11·04	...
... Fall from the upper to the lower course.....	2·274	...
... Horizontal section of the lock	325·6	sq. met.
... Section of one opening	0·6286	...
... Height of the upper course above the centre of one opening.....	1·949	met.
... Depth of the same centre to the level of the lower course	0·325	...
... Coefficient of contraction when two openings of the gate are open at the same time may be taken as (229).....	0·548	

We may consider at first, the part of the lock which is below the centre of the orifice. The time of its filling, as determined by the rule of escapes in the open air (181), will, taking two openings, equal to

$$\frac{325{\cdot}6\times0{\cdot}325}{0{\cdot}548\times2\times0{\cdot}6286\times\sqrt{2g}\sqrt{1{\cdot}949}}=24^s{\cdot}85.$$

For the part now which is above the centre of the orifice, we shall have, by the formula 204, g being in metres,

$$\frac{2\times325{\cdot}6\times\sqrt{1{\cdot}949}}{0{\cdot}548\times2\times0{\cdot}6286\times\sqrt{2g}}=298^s=4^m\,58^s.$$

Thus the time required to fill the entire lock will be the sum of these two times, or $323^s=5^m\,23^s$. But General Andreossy says that the time required to fill it was between 5^m and 6^m; the mean of which is $5^m\,30^s$, which differs very little from the theory.

293. Experiments have also been made on a sluice-gate of the canal of Bromberg in Germany; Eytelwein cites them in his *Manuel de Mecanique et d'Hydraulique*. The lock was 49·59 met. long, its breadth was from 6·59 met. to 9·10 met., and its section was 422 sq. met.; the height of one of the openings was 0·4185 met., and that of the other 0·5623 met., the breadth of each was 0·6277 met. The escape took place first by the one then by the other, so that there were two sets of experiments. In each the water was previously left to rise in the lock to 0·06 met. above the upper edge of the opening; then the edge of the first opening was below the level of the upper course by 2·223 met., and that of the second by 2·197 met. The time that the water took to raise itself a certain space, or till the vessel was full, was reckoned in seconds. The results are given in the following table:—

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Number of opening.	Volume of water elevated.	Time of elevation from Calculation.	Time of elevation from Experiment.
	Metres.	Sec.	Sec.
1	0 6277	260	263
	0·6277	319	327
	0·6277	458	491
	0·3399	667	682
	2·2230	1704	1763
2	0·31385	93	90
	0·31385	102	102
	0·31385	112	114
	0·31385	128	128
	0·31385	151	149
	0·31385	197	197
	0·31385	476	454
	2·197	1259	1234

The time of the partial elevations has been found by the formula $t = \frac{2A}{mS\sqrt{2g}}(\sqrt{H} - \sqrt{h})$ (196), where m may be taken as 0·625. The value of H in each of these partial experiments is the sum of the elevations noted in the second column, and reckoned from the bottom of the column, comprising an elevation corresponding to the time indicated against it; h is the same sum, but without comprehending this elevation: thus, for the second of the experiments noted in the table, $H = 0{\cdot}3399 + 0{\cdot}6277 + 0{\cdot}6277 = 1{\cdot}5953$, and $h = 0{\cdot}3399 + 0{\cdot}6277 = 0{\cdot}9676$. By comparing then the two last columns, the results of experiments are found to agree very closely with those of calculation. If the difference were large, it would only indicate the great difficulty in determining the exact time when the water ceased to rise in the lock, the elevation about the end of the time taking place by infinitely small degrees.

294. As an example of the third case of Prop. XV., we may consider the two contiguous locks in the double sluice-gate of a canal. When a boat which ascends a canal has entered into the lower lock by its lower gate, it is shut in; the flood-gates, however, separating it from the upper lock rise; the water therefore falls in the latter, but rises in the former, and continues to do so until a common level has been attained; the gate of separation is now opened, and the boat is introduced into the upper lock. Take for instance the double sluice-gate of Bayard, near Toulouse.[1] Let the time be reckoned from the moment at which the water, on reaching the lower lock, has attained the centre of the opening of the flood-gate. H being = 4·14 met., $h = 0{\cdot}24$ met., A = 205 sq. met., B = 215 sq. met., $s = 1{\cdot}249$ sq. met. (for the two openings), and $m = 0{\cdot}548$; then the time elapsing from the moment of the rising of the flood-gate till the water has attained the same level in both locks, will, g being taken in metres, be expressed by

$$t = \frac{2 \times 205 \times 215 \times \sqrt{4{\cdot}14 - 0{\cdot}24}}{0{\cdot}548 \times 1{\cdot}249 \times \sqrt{2g} \times 420} = 137^{s} = 2^{m}\,17^{s}.$$

But observation shows us that this time is $2^{m}\,29^{s}$. The difference of 12^{s} indicates that the flood-gates were not fully raised when the water reached the centre of their openings, and the formula supposes that this was the case.

295. The consideration of vessels divided into different compartments by partitions, or diaphrams pierced by orifices, present, during the escape of the fluid which they contain, divers phenomena which have given rise to interesting mathematical results; for an account of which we refer the reader to Daniel Bernouilli's *Hydrodynamique*, sect. viii., and to Bossut's work on the same.

SECTION V.—EXPERIMENTS ON VERTICAL AND OBLIQUE JETS.

Experiments on the Motion of Fluids.

296. We have already seen that, according to theory, vertical jets should rise to the same altitude as that of the reservoirs from which they are supplied. It will appear, however, from the following experiments of Bossut, that jets do not rise exactly to this height. This arises from the friction at the orifice, the resistance of the air, and other causes which shall afterwards be explained.

*Altitudes to which Jets rise through Adjutages of different forms, the Altitude of the Reservoir being Eleven Feet, reckoning from the upper surface of the horizontal Tubes, mn*P, *op*R.

Diameter of the horizontal tubes *m*P, *o*R, each being six feet long.	Form of the orifices.	References to Fig. 74.	Diameter of the orifice.	Altitude of the jet when rising vertically, reckoning from *m*.	Altitude of the jet when inclined a little to the vertical.
Inch. lines.			Lines.	Ft. in. lin.	Ft. in. lin.
3 8	Simple orifice	H	2	10 0 10	10 4 6
3 8	...	G	4	10 5 10	10 7 6
3 8	...	F	8	10 6 6	10 8 0
3 8	Conical tube	E	94 by 70	9 6 4	9 8 6
3 8	Cylindrical tube	D	4 by 70	9 1 6	7 3 6
0 9½	Simple orifice	M	2	9 11 0	...
0 9½	...	L	4	9 7 10	...
0 9½	...	K	8	7 10 0	...

297. It appears, from the first three experiments of the preceding table, that *great jets rise higher than small ones;*

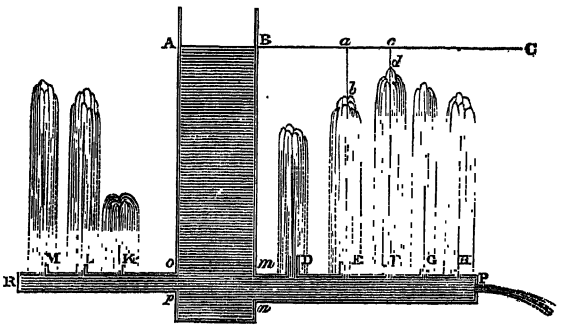


Fig. 58.

and from the last three experiments, that *small jets rise higher than great ones when the horizontal tube is very narrow.* There is, therefore, a certain proportion between the diameter of the horizontal tube and that of the adjutage or orifice, which will give a maximum height to the jet. This proportion may be found in the following manner. Let D (fig. 58) be the diameter of the tube, d that of the adjutage, a the altitude B m of the reservoir, b the velocity along the tube; and as the velocity at the adjutage is constant, it may be expressed by $\sqrt{a}$. Now the velocity in the tube is to the velocity at the adjutage as the area of their respective sections, that is, as the square of the diameter of the one is to the square of the diameter of the other. Therefore, $\sqrt{a} : b = D^2 : d^2$, and, consequently, $b = \frac{d^2\sqrt{a}}{D^2}$. If there is another tube and another adjutage, the corresponding quantities may be taken as Δ, δ, α, β, and we shall have the equation $\beta = \frac{\delta^2\sqrt{\alpha}}{\Delta^2}$. If we wish, therefore, that the two jets be furnished in the same man-

[1] *Histoire du Canal du Midi*, par le Gen. Andreossy.

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ner, then if the velocity in the first tube leaves to the first jet all the height possible, the velocity in the second tube leaves also to the second jet all the height possible, and we shall have $b=\beta$, or $\frac{d^2\sqrt{a}}{D^2}=\frac{\delta^2\sqrt{a}}{\Delta^2}$. Hence $D^2:\Delta^2=dd\sqrt{a}:\delta\delta\sqrt{a}$; that is, *the squares of the diameters of the horizontal tubes ought to be to one another in the compound ratio of the squares of the diameters of the adjutages, and the square roots of the altitudes of the reservoir.* Now, it appears from the experiments of Mariotte (*Traité du Mouvement des Eaux*), that when the altitude of the reservoir is 16 feet, and the diameter of the adjutage 6 lines, the diameter of the horizontal tube ought to be 28½ lines. By taking this as a standard, therefore, the diameters of the horizontal tube may be easily found by the preceding rule, whatever be the altitude of the reservoir and the diameter of the adjutage.

It results from the last three experiments, that the jets rise to the smaller height when the adjutage is a cylindrical tube (see D, fig. 58), that a conical adjutage throws the fluid very much higher, and that when the adjutage is a simple orifice the jet rises highest of all.

298. From a comparison of the fifth and sixth columns of the table, it appears that a small inclination of the jet to a vertical line makes it rise higher than when it ascends exactly vertical. Bossut, for example, gave a very slight inclination to a jet which rose vertically to a height of 3·42 met., and found the height increased to 3·47 met.;[1] but even then it still falls short of the height of the reservoir. When the water first escapes from the adjutage, it generally springs higher than the reservoir; but this effect is merely momentary, as the jet instantly subsides, and continues at the altitudes exhibited in the foregoing tables. The great size of the jet at its first formation, and its subsequent diminution, have been ascribed to the elasticity of the air which follows the water in its passage through the orifice; but it is obvious that this air, which moves along with the fluid, can never give it an impulsive force. In order to explain this phenomenon, let us suppose the adjutage to be stopped, the air which the water drags along with it will lodge itself at the extremity of the adjutage, so that there will be no water contiguous to the body which covers the orifice. As soon as the cover is removed from the adjutage, the imprisoned air escapes; the water immediately behind it rushes into the space which it leaves, and thus acquires in the tube a certain velocity which increases at the orifice in the ratio of the area of the section of the tube to the area of the section of the orifice. When the orifice is small in comparison with the tube, the velocity of the issuing fluid must be considerable, and will raise it higher than the reservoir. But as the jet is resisted by the air, and retarded by the descending fluid, its altitude diminishes, and the simple pressure of the fluid becomes the only permanent source of its velocity. The preceding phenomenon was first noticed by Toricellius.[2]

299. The following table exhibits all that is necessary in the formation of jets. The first two columns are taken from Mariotte,[3] and show the altitude of the reservoir requisite to producing a jet of a certain height. The third column contains, in Paris pints, 36 of which are equal to a cubic foot, the quantity of water discharged in a minute by an orifice 6 lines in diameter. The fourth column, computed from the hypothesis in art. 296, contains the diameters of the horizontal tubes for an adjutage 6 lines in diameter, relative to the altitudes in the second column. The thickness of the horizontal tubes will be determined in a subsequent section:—

Altitudes of Reservoirs, the Diameters of the Horizontal Tubes, &c., for Jets of different Heights.

Altitude of the jet.	Altitude of the reservoir.		Quantity of water discharged in a minute from an adjutage six lines in diameter.	Diameters of the horizontal tubes suited to the two preceding columns.
Paris feet.	Feet.	inches.	Paris pints.	Lines.
5	5	1	32	21
10	10	4	45	26
20	21	4	65	31
30	33	0	81	34
40	45	4	95	37
50	58	4	108	39
60	72	0	120	41
70	86	4	131	43
80	101	4	142	45
90	117	0	152	47
100	133	4	163	49

300. We have already seen that jets do not rise to the heights of their reservoirs, and have remarked that the difference between theory and experiment arises from the friction at the orifice, and the resistance of the air. The diminution of velocity produced by friction is very small, and the resistance of the air is a very inconsiderable source of retardation, unless when the jet rises to a great altitude. We must seek, therefore, for another cause of obstruction to the rising jet, which, when combined with these, may be adequate to the effect produced. Wolfius has very properly ascribed the diminution in the altitude of the jet to the gravity of the falling water. When the velocity of the foremost particles is completely spent, those immediately behind, by impinging against them, lose their velocity, and, in consequence of this constant struggle between the ascending and descending fluid, the jet continues at an altitude less than that of the reservoir. Hence we may discover the reason why an inclination of the jet increases its altitude; for the descending fluid falling a little to one side does not encounter the rising particles, and therefore permits them to reach a greater altitude than when their ascension is in a vertical line. Wolfius observes, in proof of his remark, that the diminution is occasioned also by the weight of the *ascending* fluid, that mercury rises to a less height than water; but this cannot be owing to the greater specific gravity of mercury; for though the weight of the mercurial particles is greater than that of water, yet the momentum with which they ascend is proportionally greater, and therefore the resistance which opposes their tendency downwards, has the same relation to their gravity, as the resistance in the case of water has to the weight of the aqueous particles.

301. The two following experiments on oblique jets are given by Bossut. When the height NS of the reservoir AB (fig. 59) was 9 feet, and the diameter of the adjutage

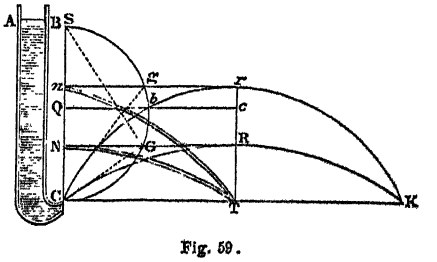


Fig. 59.

at N, 6 lines, a vertical abscissa CN of 4 feet 3 inches and 7 lines, answered to a horizontal ordinate CT of 11 feet 3 inches and 3 lines. When the altitude NS of the reservoir

[1] This was also observed by Wolfius (*Opera Mathematica*, tom. i., p. 802, schol. iv).

[2] *De Motu Projectorum: Oper. Geometr.*, p. 192.

[3] *Traité du Mouvement des Eaux*, part iv., disc. 1., p. 303.

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was 4 feet, the adjutage remaining the same, a vertical abscissa CN of 4 feet 3 inches and 7 lines, corresponded with a horizontal ordinate CT of 8 feet 2 inches and 8 lines. The real amplitudes, therefore, are less than those deduced from theory; and both are very nearly as the square roots of the altitudes of the reservoirs. Hence, to find the amplitude of a jet when the height of the reservoir is 10 feet, and the vertical abscissa the same, we have $\sqrt{9}$ feet: $\sqrt{16}$ feet = 11 feet 3 inches 3 lines: 15 feet 4 lines, the amplitude of the jet required. This, rule, however, will apply only to small reservoirs; for when the jets enlarge, the curve which they describe cannot be determined by theory, and therefore the relation between the amplitudes and the heights of the reservoirs must be uncertain.

302. The following experiments on oblique jets were performed by MM. Michelotti and Venturi. When the height of the adjutage above a horizontal plane was 19·33 inches, the amplitude of projection, according to Michelotti, was 23·2 inches, with a simple orifice, and 20 inches with an additional tube. Venturi found that when the height of the water in the reservoir was 32½ inches, and that of the adjutage above a horizontal plane 54 inches, the amplitude of projection was 81½ inches with a simple orifice, and 69 inches with an additional tube.

303. The most recent experiments on the height and discharge of jets are those lately made by the Southwark Water Company in January 1844, and those by the Preston Water Company in March of the same year. One set of experiments of the first company was made in Union Street through stand pipes, hose, and jets—there being six stand pipes, each 360 feet apart, and connected—

With	a 7-inch main,	2,400	feet long.
The head was carried on through a	9-inch ...	1,500	...
... ...	12-inch ...	600	...
... ...	15-inch ...	1,650	...
... ...	20-inch ...	10,350	...

The total distance, then, from the head at Battersea, where the pressure was 120 feet, was 16,500 feet, or a distance of nearly 3⅓ miles.

The second set of experiments of the same company was made in Tooley Street, where the stand pipes were connected—

With	a 9-inch main,	4,200	feet long.
The head was carried on through a	15-inch ...	3,000	...
... ...	a 20-inch ...	12,750	...

So that the total distance from the head at Battersea under the above pressure, was 19,950 feet, or nearly 4 miles.

Experiments on the Height and Discharge of Jets, made by the Southwark Water Company in January 1844.

	Stand pipes used.	Length of hose.	Diameter of jet.	Height of jet.	Volume per minute.
	No.	Feet.	Inches.	Feet.	Cubic feet.
First experiment.	1	40	7/8	50	15·7
	2	40	7/8	45	...
	3	40	7/8	40	...
	4	40	7/8	35	...
	5	40	7/8	30	...
	6	40	7/8	27	...
	1	80	7/8	...	16·6
	1	160	7/8	40	16·0
	1	40	2½	...	42·1
Second experiment.	a 1	40	7/8	40	13·17
	a 2	40	7/8	31	10·90
	b 1	40	7/8	34	11·98
	b 2	40	7/8	23	9·30
	1	40	7/8	60	17·15
	2	40	7/8	60	...
	4	40	7/8	45	14·90
	6	40	7/8	40	13·80

In both experiments every service pipe, or other outlet, was kept shut. The stand pipes employed were 2½ inches diameter, and the length of the hose varied.

The pipes marked *a* are through 600 feet of 5-inch main, but a 4-inch main was fitted on close to the 5-inch main; those marked *b* are through 600 feet of 5-inch main, and 600 feet of 4-inch main, both in addition to the 19,950 feet of main already mentioned.

304. The experiments by the Preston Company were made, first, on a 6-inch main, under a pressure of 110 feet; and, second, on a 6-inch main, under a pressure of 46 feet.

The results for the first are,—

	Height.	Discharge in cubic feet.	
With 1 jet ¾-inches,	57 feet,	12·5 per minute	by day.
... 1	64 ...	14·4 ...	by night.
... 2 jets ...	56 ...	12·5 ...	by day.
... 2	62 ...	14·0 ...	by night.

The results of the second are :—

	Height.	Discharge in cubic feet.	
With 1 jet ¾-inch,	24 feet,	4·8 per minute	by day.
... 1	28 ...	5·6 ...	by night.
... 2 jets ...	20 ...	4·5 ...	by day.
... 2	25 ...	4·8 ...	by night.

305. At Leeds jets may be thrown from 60 to 70 feet high, and in the lower part of the town from 40 to 50 feet high, the pressure being 180 feet, and services in full draught. At New York the height of the water is 115 feet above high water, 105 feet above the lowest, and 60 feet above the highest streets: the distributing reservoir is distant 4 miles, and communicates with the city by a 36-inch main; yet the city fountains throw from 60 to 70 feet high. At Harlaem, River Valley, a $\frac{1}{12}$th-inch pipe and a $\frac{1}{24}$th-inch jet, throw the water to a height of 110 feet. At Philadelphia the surface of water in the reservoirs is 98 feet above high water, 55 feet above the highest, and 93 feet above the lowest points of the city. The distance from the reservoir to the extreme point of mains and pipes is 6 miles, by a main from 20 to 22 inches in diameter. Yet the water will rise by night to a height of from 40 to 50 feet, while by day to a height of 25 feet.

SECTION VI.—EXPERIMENTS ON THE MOTION OF WATER IN CONDUIT PIPES.

306. It must be evident to every reader, that, when water is conducted from a reservoir by means of a long horizontal pipe, the velocity with which the water enters the pipe will be much greater than the velocity with which it issues from its farther extremity; and that, if the pipe has various flexures or bendings, the velocity with which the water leaves the pipe will be still farther diminished. The difference, therefore, between the initial velocity of the water, and the velocity with which it issues, will increase with the length of the pipe and the number of its flexures. By means of the theory, corrected by the preceding experiments, it is easy to determine with great accuracy the initial velocity of the water, or that with which it enters the pipe; but on the obstructions which the fluid experiences in its progress through the pipe, and on the causes of these obstructions, theory throws but a feeble light. The experiments of Bossut afford much instruction on this subject; and it is from them that we have arranged the following table, containing the quantities of water discharged by pipes of different lengths and diameters, compared with the quantities discharged from additional tubes:—

Experiments on the Motion of Fluids.

Quantities of Water discharged by Conduit Pipes of different Lengths and Diameters compared with the Quantities discharged from additional Tubes inserted in the same Reservoir.

Experiments on the Motion of Fluids.

Constant altitude of the water in the reservoir above the axis of the tube.	Length of the conduit pipes.	Quantity of water discharged in a minute by an additional tube.	Quantity of water discharged by the conduit pipe in a minute.	Ratio between the quantities of water furnished by the tube and the pipe of 16 lines diameter.	Quantity of water discharged by an additional tube in a minute.	Quantity of water discharged by the conduit pipe in a minute.	Ratio between the quantities of water furnished by the tube and the pipe of 24 lines diameter.
		Tube and pipe 16 lines diam.			Tube and pipe 24 lines diam.		
Feet.	Feet.	Cubic inches.	Cubic inches.	...	Cubic inches.	Cubic inches.	...
1	30	6330	2778	1 to ·4389	14243	7680	1 to ·5392
1	90	6330	1587	1 to ·2507	14243	4534	1 to ·3183
1	180	6330	1052	to ·1662	14243	3119	1 to ·2190
2	30	8939	4066	1 to ·4548	20112	11219	1 to ·5578
2	90	8939	2352	1 to ·2631	20112	6812	1 to ·3387
2	180	8939	1583	to ·1770	20112	4710	1 to ·2341

307. The third column of the preceding table contains the quantity of water discharged through an additional cylindrical tube 16 lines in diameter, or the quantity discharged from the reservoir into a conduit pipe of the same diameter; and the fourth column contains the quantity discharged by the conduit pipe. The fifth column, therefore, which contains the ratio between these quantities, will also contain the ratio between the velocity of the water at its entrance into the conduit pipe, which we shall afterwards call its initial velocity, and its velocity when it issues from the pipe, which shall be denominated its final velocity; for the velocities are as the quantities discharged, when the orifices are the same. The same may be said of the 6th, 7th, and 8th columns, with this difference only, that they apply to a cylindrical tube and a conduit pipe 24 lines in diameter.

308. By examining some of the experiments in the foregoing table, it will appear that the water sometimes loses $\frac{8}{10}$ths of its initial velocity. The velocity thus lost is consumed by the friction of the water on the sides of the pipe, as the quantities discharged, and consequently the velocities, diminish when the length of the pipe is increased. In simple orifices, the friction is in the inverse ratio of their diameter; and it appears from the table, that the velocity of the water is more retarded in the pipe 16 lines in diameter, than in the other which has a diameter of 24 lines. But though the velocity decreases when the length of the tube is increased, it by no means decreases in a regular arithmetical progression, as some authors have maintained. This is obvious from the table, from which it appears, that the differences between the quantities discharged, which represent also the differences between the velocities, always *decrease*, whereas the differences would have been *equal*, had the velocities decreased in an arithmetical progression. The same truth is capable of a physical explanation. If every filament of the fluid rubbed against the sides of the conduit pipe, then, since in equal times they all experience the same degree of friction, the velocities must diminish in the direct ratio of the lengths of the tubes, and will form a regular arithmetical progression, of which the first term will be the final, and the last the initial velocity of the water. But it is only the lateral filaments that are exposed to friction. This retards their motion; and the adjacent filaments which do not touch the pipe, by the adhesion to those which do touch it, experience also a retardation, but in a less degree, and go on with the rest, each filament sustaining a diminution of velocity inversely proportional to its distance from the sides of the pipe. The lateral filaments alone, therefore, provided they always remain in contact with the sides of the pipe, will have their velocities diminished in arithmetical progression, while the velocities of the central filaments will not decrease in a much slower progression; consequently, the mean velocity of the fluid, or that to which the quantities discharged are proportional, will decrease *less* rapidly than the terms of an arithmetical progression.

309. Bossut made the following experiment to show, that, in open channels and pipes, even where there is a considerable slope, the flow very soon becomes uniform. He constructed a wooden canal 650 feet long, with a slope of 1 in 10, and having divided it into equal spaces of 108 feet each, found that the water traversed all the other spaces except the first in equal times.

310. But besides the resistance which the water experiences from the walls of the pipe, and which is the most considerable, there is also the resistance arising from contraction, as Eytelwein first showed. If the bores be large this resistance is insensible, but if small it is too appreciable to be neglected. Further, if the pipe have one or more bends in its length, a third kind of resistance will arise; the loss by this resistance will evidently be greater in the case of an angular than in that of a uniformly curved tube. Bossut, for example, took a straight pipe 0·027 met. in diameter, and 16·24 in length, and under a charge of 0·325 met. obtained 0·02084 cub. met. of a volume in one minute. He now coiled the same pipe six times round, and obtained a volume of 0·02040 cub. met. (Bossut, *Hyd.* § 659). Rennie (410) also, after the same manner, took a straight pipe half-an-inch in diameter, and 15 feet long, and having adapted it to a reservoir under a charge of one foot, obtained a volume of 1·9 cub. feet in 1 min. But having bent the same pipe so as to produce a series of concavities and convexities in a semicircle of a radius 3·25 in., and having fixed it to the same reservoir, he found a volume of 1·7 cub. feet in the same time. Thus the 14 bends diminished the waste in the ratio of 100 : 89; when the charge was quadrupled, the ratio was 100 : 88. Venturi long ago showed the bad effect of bends by a series of experiments on three tubes 0·38 met. in length and 0·033 in diameter; one was straight, the second was rounded at an angle of 90°, and the third was right-angled. The charge employed was one of 0·88 met., and a vessel of capacity 0·137 cub. met. was filled by them respectively, in 45°, 50°, and 70°. In illustration of the same fact, Rennie took a pipe 15 feet in length and one inch in diameter, and under a charge of 4 feet, found the following volumes discharged per minute:—

[1] *Phil. Trans. of Royal Society of London*, 1831.

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With a straight pipe of the above dimensions...	0·4175	cubic feet.
... 15 semicircular bends.....	0·3676	...
... 1 right angle.....	0·3318	...
... 24	0·1511	...

311. These retarding or resisting forces in the case of fluids, go by the name of friction, the word being taken from the consideration of solid bodies rubbing or sliding upon each other. As there are laws of friction for the latter, so there are also laws of friction or resistance for the former. In the case of fluids, then, passing through straight pipes, as deduced from experiments, the resistance is—1. Independent of the pressure: thus water moving in a pipe under a head of 100 feet, experiences as great a resistance as if the head were 50 feet. Dubuat showed this law from experiments on the oscillation of water in siphons. In connection with this, see, under RIVER, the experiment in which two vessels are connected by a siphon. 2. The resistance is, at any one velocity, proportional to the surface exposed to the action of the flowing water. 3. The resistance varies directly as the square of the velocity nearly, the border being constant. The third law is more nearly expressed by adding the simple power of the velocity.

312. When a pipe is inclined to the horizon, as CDE (fig. 60), the water will move with a greater velocity than in the horizontal tube CD*hf*. In the former case, the relative gravity of the water, which is to its absolute gravity as F*f* to C*f*, or as the height of the inclined plane to its length, accelerates its motion along the tube. But this acceleration takes place only when the inclination is considerable; for if the angle which the direction of the pipe forms with the horizon were no more than one degree, the retardation

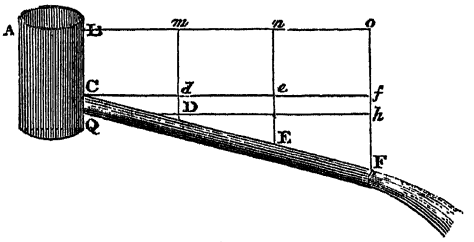


Fig. 60.

of friction would completely counterbalance the acceleration of gravity. Thus when the pipe CF, 16 lines in diameter, was 177 feet, and was divided into three equal parts in the points D and E, so that CD was 59 feet, CE 118 feet; and when CF was to F*f* as 2124 to 241, the quantity of water discharged at F was 5795 cubic inches in a minute, the quantity discharged at E was 5801 cubic inches in a minute, and the quantity at D 5808 cubic inches. The quantities discharged therefore, and consequently the velocities, decreased from C to F; whereas if there had been no friction, and no adhesion between the aqueous particles, the velocities would have increased along the line CF in the subduplicate ratio of the altitudes CB, D*m*, E*n*, and F*o*; AB being the surface of the water in the reservoir. The preceding numbers, representing the quantities discharged at F, E, and D decrease very slowly; consequently, by increasing the relative gravity of the water, that is, by inclining the tube more to the horizon, the effects of friction may be exactly counterbalanced. This happens when the angle *f*CF is about 6° 31′, or when F*f* is the eighth or ninth part of CF. The quantities discharged at C, D, E, and F will then be equal, and friction will have consumed the velocity arising from the relative gravity of the included water.

313. In order to determine the effects produced by flexures or sinuosities in conduit pipes, M. Bossut made the following experiments:—

Quantities of Water discharged by Rectilineal and Curvilineal Leaden Pipes, 50 feet long, and 1 inch in diameter.

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Altitude of the water in the reservoir.		Form of the Conduit Pipes.—See Figures 61 and 62.	Quantities of water discharged in a minute.
Feet.	inches.		Cubic inches.
0	4	The rectilineal tube MN placed horizontally.....	576
1	0	The same tube similarly placed.....	1050
0	4	The same tube bent into the curvilineal form ABC, fig. 61, each flexure lying flat on a horizontal plane, ABC being a horizontal section.....	540
1	0	The same tube similarly placed.....	1030
0	4	The same tube placed as in fig. 62, where ABCD is a vertical section, the parts A, B, C, D rising above a horizontal plane, and the parts *a*, *b*, *c* lying upon it.....	520
1	0	The same tube similarly placed.....	1028

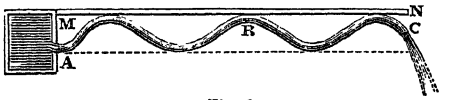


Fig. 61.

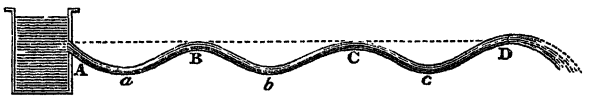


Fig. 62.

314. 1. The two first experiments of the preceding table show that the quantities of water discharged diminish as the altitude of the reservoir. This arises from an increase of velocity, which produces an increase of friction.

2. The four first experiments show, that a curvilineal pipe, in which the flexures lie horizontally, discharges less water than a rectilineal pipe of the same length. The friction being the same in both cases, this difference must arise from the impulse of the fluid against the angles of the tube; for if the tube formed an accurate curve, the curvature would not diminish the velocity of the water.

3. By comparing the 1st and 5th, and the 2d and 6th experiments, it appears that, when the flexures are vertical, the quantity discharged is diminished. This also arises from the imperfection of curvature.

4. It appears, from a comparison of the 3d and 5th with the 4th and 6th experiments, that when the flexures are vertical, the quantity discharged is less than when they are horizontal. In the former case, the motion of the fluid arises from the central impulsion of the water, retarded by its gravity in the ascending parts of the pipe, and accelerated in the descending parts; whereas the motion in the latter case arises wholly from the central impulsion of the fluid. To these points of difference the diminution of velocity may somehow or other be owing.

When a large pipe has a number of contrary flexures, the air sometimes mixes with the water, and occupies the highest parts of each flexure, as at B and C, fig. 62. By this means the velocity of the fluid is greatly retarded, and the quantities discharged much diminished. This ought to be prevented by placing small tubes at B and C, having a small valve at their top.

315. A set of valuable experiments were made by M. Couplet, and a detailed account of them given in the Memoirs of the Academy for 1732, in his paper entitled *Des Recherches sur le Mouvement des Eaux dans les Tuyaux de conduite.* These experiments are combined with those of the Abbé Bossut in the following table:—

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Results of the Experiments of Couplet and Bossut on Conduit Pipes, differing in Form, Length, Diameter, and in the Materials of which they are composed,—under different Altitudes of Water in the Reservoir.

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Altitude of the water in the reservoir.			Length of the conduit pipe.	Diameter of the conduit pipes.	NATURE, POSITION, AND FORM OF THE CONDUIT PIPES.	Ratio between the quantities which would be discharged if the fluid experienced no resistance in the pipes, and the quantities actually discharged; or the ratio between the initial and the final velocities of the fluid.
Ft.	in.	lin.	Feet.	Lines.		
0	4	0	50	12	Rectilineal and horizontal pipe of lead	1 to 0·2810
1	0	0	50	12	The same pipe similarly placed	1 to 0·3050
0	4	0	50	12	The same pipe with several horizontal flexures	1 to 0·2640
1	0	0	50	12	Same pipe	1 to 0·2910
0	4	0	50	12	The same pipe with several vertical flexures	1 to 0·2540
1	0	0	50	12	Same pipe	1 to 0·2900
1	0	0	180	16	Rectilineal and horizontal pipe of white iron	1 to 0·1660
2	0	0	180	16	Same pipe	1 to 0·1770
1	0	0	180	24	Rectilineal and horizontal pipe of white iron	1 to 0·2180
2	0	0	180	24	Same pipe	1 to 0·2340
20	11	0	177	16	Rectilineal pipe of white iron, and inclined so that CF (fig. 60) is to Ff as 2124 is to 241	1 to 0·2000
13	4	8	118	16	Rectilineal pipe of white iron, and inclined like the last	1 to 0·2500
6	8	4	159	16	Rectilineal pipe of white iron, and inclined like the last	1 to 0·3540
0	9	0	1,782	48	Conduit pipe almost entirely of iron, with several flexures both horizontal and vertical	1 to 0·3500
1	9	0	1,782	48	Same pipe	1 to 0·0376
2	7	0	1,782	48	Same pipe	1 to 0·0387
0	3	0	1,710	72	Conduit pipe almost entirely of iron, with several flexures both horizontal and vertical	1 to 0·0809
0	5	3	1,710	72	Same pipe	1 to 0·0878
0	5	7	7,020	60	Conduit pipe, partly stone and partly lead, with several flexures both horizontal and vertical	1 to 0·0432
0	11	4	7,020	60	Same pipe	1 to 0·0476
1	4	9	7,020	60	Same pipe	1 to 0·0513
1	9	1	7,020	60	Same pipe	1 to 0·0532
2	1	0	7,020	60	Same pipe	1 to 0·0541
12	1	3	3,600	144	Conduit pipe of iron, with flexures both horizontal and vertical	1 to 0·0992
12	1	3	3,600	216	Conduit pipe of iron, with several flexures both horizontal and vertical	1 to 0·1653
4	7	6	4,740	216	Conduit pipe of iron, with several flexures both horizontal and vertical	1 to 0·0989
20	3	0	14,040	144	Conduit pipe of iron, with several flexures both horizontal and vertical	1 to 0·0517

316. In order to show the application of the preceding results, let us suppose that a spring, or a number of springs combined, furnishes 40,000 cubic inches of water in one minute; and that it is required to conduct it to a given place 4 feet below the level of the spring, and so situated that the length of the pipe must be 2400 feet. It appears from the table in art. 245, that the quantity of water furnished in a minute by a short cylindrical tube, when the altitude of the fluid in the reservoir is 4 feet, is 7070 cubic inches; and since the quantities furnished by two cylindrical pipes under the same altitude of water are as the squares of their diameters, we shall have by the following analogy the diameter of the tube necessary for discharging 40,000 cubic inches in a minute; $\sqrt{7070} : \sqrt{40000} = 12$ lines or 1 inch : $28\frac{1}{2}$ lines, the diameter required. But by comparing some of the experiments in the preceding table, it appears that, when the length of the pipe is nearly 2400 feet, it will admit only about one-eighth of the water, that is, about 5000 cubic inches. That the pipe, however, may transmit the whole 40,000 cubic inches, its diameter must be increased. The following analogy, therefore, will furnish us with this new diameter; $\sqrt{5000} : \sqrt{40000} = 28{\cdot}54$ lines : 80·73 lines, or 6 inches $8\frac{7}{10}$ lines, the diameter of the pipe which will discharge 40,000 cubic inches of water when its length is 2400 feet.

317. The following experiments on the quantities of water discharged by different pipes of various lengths, and with different adjutages, were made by M. Bossut at the public and private fountains of Mezières in October 1779:—

Head of water.		Length of pipe.	Diameter of pipe.	Size of orifice.	Ratio of the real to the theoretical discharges.	Ratio of the height due to the velocity to the head of water.	Cubic inches of water discharged in a minute.
Ft.	in.	Feet.	Lines.	Lines.			
24	7	161	12	$7\frac{1}{2}$	0·045	0·002	242
23	9	192	12	$5\frac{1}{2}$	0·075	0·006	230
19	3	193	12	$6\frac{1}{2}$	0·068	0·005	222
19	9	188	12	$6\frac{1}{2}$	0·061	0·004	237
19	10	146	12	$2\frac{1}{2}$ by 7	0·089	0·008	168
29	1	187	15	$7\frac{1}{2}$ by $5\frac{1}{2}$	0·105	0·011	588
8	0	1069	18	Two adjutages, each 6 lines	0·435	0·189	1686
24	7	278	15	$3\frac{1}{2}$	0·396	0·157	458
32	7	314	15	Two adjutages, having each 5 lines	0·227	0·052	1232
30	5	446	18	2 by $6\frac{1}{2}$	0·037	0·001	636
26	3	506	18	4	0·447	0·200	696
27	0	668	18	$5\frac{1}{2}$	0·301	0·091	900
30	0	812	18	11	0·048	0·002	600
10	5	194	12	5	0·377	0·139	576
10	11	462	12	$5\frac{1}{2}$	0·332	0·109	576
10	0	420	15	7	0·163	0·028	483

318. Dubuat undertook a series of experiments to determine the laws of resistance of bends, and their intensity. In order to this he employed different pipes, first straight, and measured the charge necessary to obtain a certain ve-

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lume in a certain time; then bent into different forms, such that the central fillet would make a certain number of angles, and of a certain size; and anew verified the charge under which the same volume would be obtained from the bent pipes in the same time. The difference between the two charges for the same pipe, now straight, then bent, was evidently the charge due to the bends, and, consequently, the measure of their resistance. The experiments were 25 in number, the most important of which are set down in the following table:—

Pipe.				Velocity of water.	Resistance due to bends.	Coefficient.
Diameter.	Length.	Angles. Number.	Angles. Value.			
Metres.	Metres.		Deg.	Metres.	Metres.	
0 0271	3·167	1	36	2·300	0·0203	0·0111
0·0271	3·167	2	36	2·300	0·0406	0·0111
0·0271	3·167	3	36	2·300	0·0674	0·0123
0·0271	3·167	4	24·57	2·300	0 0406	0·0111
0·0271	3·167	10	36	1·939	0·1598	0·0123
0 0271	3·749	4	36	1·572	0·0444	0·0130
0·0271	3·749	4	36	0·794	0·0111	0·0127
0·0271	19·95	4	36	0·776	0·0106	0·0127
0·0541	6·910	4	36	2·336	0·0785	0·0099
0·0541	6·910	4	36	1·590	0·0360	0·0103
0·0541	6·910	6	24·57	2·336	0·2339	0·0124
		5	36·00			
		1	56·23			

Dubuat concludes from these experiments that the resistance of bends is proportional to the square of the velocity of the fluid, to the number of bends, and to the square of the sine of the angle which the bends make with the straight line of direction. Mr Beardmore, in his *Hydraulic and Tide Tables*, has added, inversely as the hydraulic mean depth. Experimenters, however, are not agreed on this point (414).

SECTION VII.—EXPERIMENTS ON THE PRESSURE EXERTED UPON PIPES BY THE WATER WHICH FLOWS THROUGH THEM.

319. The pressure exerted upon the sides of conduit pipes by the included water has been already investigated theoretically in Prop. XX., Part II. The only way of ascertaining by experiment the magnitude of this lateral pressure, is to make an orifice in the side of the pipe, and find the quantity of water which it discharges in a given time. The lateral pressure is the force which impels the water through the orifice; and therefore the quantity discharged, or the effect produced, must be always proportional to that pressure as its producing cause, and may be employed to represent it. The following table is founded on the experiments of Bossut:—

Quantities discharged by a Lateral Orifice, or the Pressures on the Sides of Pipes, according to Theory and Experiment.

Altitude of the water in the reservoir.	Length of the conduit pipe.	Quantities of water discharged in 1 minute according to theory.	Quantities of water discharged in 1 minute according to experiment.
Feet.	Feet.	Cubic inches.	Cubic inches.
1	30	176	171
1	90	190	190
1	180	193	194
2	30	244	240
2	90	264	261
2	180	269	266

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It appears from the preceding table, that the real lateral pressure in conduit pipes differs very little from that which is computed from the formula; but in order that this accordance may take place, the orifice must be so perforated, that its circumference is exactly perpendicular to the direction of the water, otherwise a portion of the water discharged would be owing to the direct motion of the included fluid.

320. It is found by experiment that, for pipes under pressure, a velocity of 200 feet per minute is very good for working with, giving perhaps a better proportional discharge than if the pipe had a greater inclination, and consequently the water a greater speed. A velocity of 150 feet per minute will prevent depositions of mud, &c., in pipes and sewers.

321. At the West Middlesex Water-works, it is found that the friction of the pipes reduces the head of water between one-fourth and one-fifth. The Grand Junction Water Company's new engine, at Kew, works against a head of 205 feet, while the gauge on the other side of the stand, which indicates the back pressure from London, gives only 170 feet; showing a loss of head equal to 35 feet, by the draught on the great 45-inch main. At Philadelphia the friction of the pipes causes a diminution of 25 feet of head when the city is drawing water. We see from the above that in towns supplied with water there is a considerable loss of head.

322. In towns there cannot but occur a great number of bends in the supply pipes. These bends taking place, as they actually do in many cases, in a vertical plane, are subject to two disturbances in the discharge. The first is an accumulation of air at the top of the bends, and which can only be liberated by valves self-acting, or worked by hand at stated times, since much air enters the pipes with the particles of water. The second is, that the diameter of the pipe over its whole length should be duly proportioned, so that it may discharge the volume due to its diameter. Thus, at a distance x, from the fountain head or reservoir y, the nature of the locality may be such, that the pipe at x will be a very little above the situation y, in which case the requisite volume of water will not pass out by the pipe z, lower situated than x, or that volume due to a fall from y to z Neither can the pipe be fully effective at x, since it is not completely filled. It is clear then, that for the requisite volume to be discharged at z, the pipe from y to x must be of larger dimensions than that from x to z. The neglect of providing against these impediments has led to much inconvenience and serious disappointment. It is said that when Edinburgh was supplied with water from *Comiston* about 1740, Maclaurin, from calculation, promised eleven times, and Desaguliers six times, more than the inhabitants received; the latter gentleman, however, erected air vessels or chests at different distances along the main, and the city was well supplied. When the Edinburgh City Water-works were extended, about 30 years ago, and the main pipe made of iron, every precaution was taken by Mr Jardine, the engineer, to secure the proper supply. The first 18,300 feet of the main had a fall of 1 in 282, the diameter of the main being at the reservoir 20 inches, and at the end of the above distance 18 inches; the remaining distance of 27,900 feet had a fall of 1 in 97, and the diameter of the discharging main at the Castlehill is 15 inches. On the whole, the actual discharge is not greater than that which would be given by a pipe of a diameter equal to 15 inches, and of a *uniform slope over the entire distance.* Mr Jardine erected, at 14 different points, cast-iron vessels to receive the compressed air as it collected; by opening a cock at each point, every three or four days the air is liberated. This was one of the earliest works in iron on a great scale, and it is reckoned a model of its kind; the cost of the works at the present price of iron would only be

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about ⅓d that which was paid. We may judge, however, of the efficient nature of the iron main, when it is stated that it has cost nothing for repairs since the time of its erection, and it has not ceased to deliver a daily supply.

323. Mr W. A. Provis, M. Inst. C. E., undertook several experiments in the year 1838, *on the flow of water through small pipes*. The pipes employed were leaden, 1½ inches in diameter, drawn to a length of 15 feet, and soldered together with great care. The united pipe was stretched on a wooden beam, resting on upright posts, in such a manner that it could be depressed or kept horizontal over its whole length towards the discharging end. A stop-cock was inserted into the upper end of the pipe; the lower end fitted into a cistern 2 feet square in the bottom, and 3 feet high, graduated upwards from the centre of the bore of the cock. There was a second cistern above this last, which, by means of a pipe and cock, supplied the lower with water. To the lower end of the pipe was attached, by a universal joint, an open trunk or spout by means of which the water from the pipe could be turned at pleasure into or outside a receiver, the capacity of which was 4 cubic feet. By means of a valve at the bottom of the receiver the water could be discharged. When an experiment was to be made, the highest cistern at the upper end of the pipe was filled with water, and the graduated one below it was also filled to the proper height. An assistant kept the latter vessel at the constant required level, by a continued supply from the upper one; a second assistant turned the cock which discharged into the pipe at the given signal. The lower end of the spout was held by a third assistant, who turned the stream into the receiver when ordered. Before taking the result of an experiment, the water was allowed to run for some time, but after a uniform and steady motion had been acquired in the water, and the signal given, the discharge for the time was determined. It was found that considerable difference prevailed in the time required for the run of the water through the pipe, owing to the dryness or moisture of the inner surface, and also by the accumulation of air inside when the pipe was level or slightly inclined. When the pipe was level and its interior nearly dry, as was the case on commencing in the morning, the time required for the water to pass through the pipe was nearly 50 per cent. more than after the tube had been thoroughly wetted. In all the experiments where the pipe was level, or nearly so, and more especially in the longer lengths, there were frequent regurgitations of the water, owing to the accumulation of air within the pipe; the experiments, however, on the time in filling the receiver, were not begun till the stream had become regular and equable. In order to guard against error, duplicate results were taken, and if any discrepancy took place in the first two results, a third was added.

The mean results of these experiments are given in the following table, which shows us—1. That when the pipes were level, the volumes discharged were nearly inversely as the square roots of their lengths. 2. In comparing the discharge with that passed through the 100-feet pipe, the departure from this rule appears greatest in the case of the short pipes of 20 feet length, when under the pressure of the greatest head of water. With a head of 6 inches, the rule would give about 100th more than the observed discharge; with a head of 35 inches, the rule would give about a 9th more than the actual discharge. The intermediate heads show intermediate differences. 3. By giving the pipes a regular and uniform descent, the discharge is increased through the long pipes in a greater ratio than through the short ones. 4. By increasing the head of water pressing at the upper ends of the pipes, the increase of volume is nearly in the same ratio through the long and short lengths :—

Fall of Pipe.	Lengths of Pipe.				
	100 feet.	80 feet.	60 feet.	40 feet.	20 feet.
Head of Water=35 *inches.* (*Volume discharged in one minute.*)					
Level.	2·275	2·5	2·874	3·504	4·528
1 in 112	...	2·774	3·127	3·721	4·776
2 in 112	...	3·077	3·38	3·967	4·949
3 in 112	...	3·356	3·636	4·286	5·217
Head of Water=30 *inches.*					
Level.	1·991	2·264	2·594	3·178	4·138
1 in 112	...	2·594	2·891	3·404	4·363
2 in 112	...	2·909	3·221	3·735	4·486
3 in 112	...	3·179	3·428	3·951	4·802
Head of Water=24 *inches.*					
Level.	1·745	2·008	2·302	2·823	3·664
1 in 112	...	2·353	2·637	3 096	3·95
2 in 112	...	2·673	2·927	3·428	4·138
3 in 112	...	2·926	3·2	3·582	4·326
Head of Water=18 *inches.*					
Level.	1·476	1·684	1·959	2·394	3·116
1 in 112	...	2·106	2·324	2·711	3·428
2 in 112	...	2·461	2·637	3·019	3·636
3 in 112	...	2·774	2·944	3·276	3·809
Head of Water=12 *inches.*					
Level.	1·151	1·352	1·558	1·882	2·487
1 in 112	...	1·811	1·975	2·296	2·782
2 in 112	...	2·212	2·341	2·594	2·981
3 in 112	...	2·513	2·681	2·945	3·243
Head of Water=6 *inches.*					
Level.	·753	0·901	1·052	1·26	1·666
1 in 112	...	1·476	1·6	1·752	2·06
2 in 112	...	1·951	2·008	2·172	2·313
3 in 112	...	2·308	2·382	2·48	2·622

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324. As pipes are exposed to forces besides those arising from the included water, they must be made much stronger than the preceding experiments would seem to require. The thicknesses of iron and leaden pipes used in France in the time of Bossut, are given in the following table :—

Iron Pipes.		Leaden Pipes.	
Diameter.	Thickness.	Diameter.	Thickness.
Inches.	Lines.	Inches.	Lines.
1	1	1	2½
2	3	1½	3
4	4	2	4
6	5	3	5
8	6	4½	6
10	7	6	7
12	8	7	8

SECTION. VIII.—EXPERIMENTS ON THE MOTION OF WATER IN CANALS.

325. By a canal is meant a regularly constructed water-course or channel, having a uniform bed with the same inclination at every part, and containing the same volume of water over its whole length. Let a horizontal plane or right

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line ab, be drawn through any point a, of the bed of a canal, and a vertical cb, corresponding to any other point c, of the bed, then the inclination for the length ac of the canal will be represented by cb = length ac × sine of inclination bac. Call, then, L the length of a portion of a regular canal, D the difference of levels between the two extremities of L, then the sine of inclination of canal will always be expressed by $\frac{D}{L}$.

Call, again, S the section of the canal perpendicular to the axis of the current; then if the canal be rectangular, l its breadth, and h its height, or depth of water, $S = lh$; if the canal be trapezoidal, l the breadth of the bottom, and also n the slope of the lateral sides, $S = (l + nh)h = (l + h \cdot \cos \alpha)h$, where α is the inclination of the walls to the horizon.

Let also c be the perimeter of the section, then for a rectangular canal $c = l + 2h$; if it be trapezoidal,

$$c = l + 2h\sqrt{n^2 + 1} = l + \frac{2h}{\sin \alpha}.$$

The ratio of S : c, Dubuat calls the *mean radius* (341).

326. When water flows in a canal, gravity is a force continually acting upon its particles. If the water be in repose, the tendency of gravity to put the water in motion is destroyed, and the surface is horizontal. But when the surface is inclined, then motion takes place among the particles, and hence the hydraulic axiom that motion will take place among the fluid molecules of a course of water whenever the surface is inclined. The inclination will apparently be the immediate cause of movement, but it is the gravity of the particles which produces it.

327. This action of gravity on the particles will be illustrated in the following cases. Let both the bed and surface of the canal be parallel, then we shall have, as it were, the case of a body sliding down an inclined plane, the particles being not only that layer in immediate contact with the bed, but those also of all the upper layers. Hence, since in this case gravity cannot act with its full intensity, so much of its effect will be lost, and the particle will slide down the bed with an intensity expressed by $g \sin f$, where g is the accelerating force of gravity, and f the inclination of the surface to the horizontal plane. This is the condition of all the molecules on such a canal. Let now the surface be no longer parallel to the bed, but let the former be more inclined than the latter, any fluid molecule whatsoever traversing a length parallel to the bed will be subject to the action of gravity, together with that due to the inequality of pressure at the two extremities of the length. But these two forces are together equal to $g \sin f$. Let, again, the bed be horizontal, and the surface inclined, then the particles in contact with the bottom will have their action destroyed by the resistance of the bed, but every other particle not in contact with the bottom will have a moving force represented by $g \sin f$, where f is the inclination of the surface to the horizon. Let, lastly, the bed slope upwards, then the particles covering the bed will be impelled upwards along the bottom, while all others will be urged downwards with a force equal to the difference between the pressures of two columns, one of which is the depth of the particle under the surface, and the other the distance from the surface of any point on the horizontal plane passing through the former particle. This difference will again be expressed by $g \sin f$, which will be the moving force on the particle.

328. We see, then, that in all the above cases, each particle, on traversing a line of any layer, is urged by a force equal to $g \sin f$, or this is the final velocity of a particle, or the accelerating force at the end of a unit of time as a second. It evidently varies as the inclination, for g is constant. Let A be $\sin f$, then the accelerating force will be g A. Now, were this accelerating force the only one acting on a fluid moving in a canal, it is evident that the motion or velocity would never become uniform; for, if so, then equal volumes would pass through each section in equal times. But experiment and observation show us, that after a certain time, the accelerating force is imperceptible, and the water flows on with a uniform motion. Bossut, (*Hydrod.* § § 797, &c.), in order to prove this, took a wooden canal 200 met. long, with an inclination of 1 in 10, and divided the length into spaces of 33 met.; he found that, with the exception of the first space, the water passed over all the others in the same time. It is evident, then, that some retarding force exists whereby the accelerating force is destroyed at every instant. Whenever, therefore, this accelerating force has been destroyed, the water will move onwards with the velocity which it had at the first moment of escape. The retarding force mentioned above may be regarded as arising from the resistance of the bed,

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But besides this retarding force, there is another of considerable intensity; it is that arising from the resistance or friction of the sides, which is not to be neglected. Eytelwein, to show this, took a pipe 0·63 met. long., and at the end of 100 sec. it discharged 0·148 cub. met.; having now doubled its length, 1·26 met., the same volume was obtained in 117 sec. Hence, we have another hydraulic axiom,—when the mean velocity is uniform, the accelerating force is equal to the retarding forces.

329. We shall have an idea of the nature of these resistances by observing the motion of a stream of water; as soon as it enters its course the water spreads over, wets and clings to the surface of the bed, and the same is the case with the walls; it is over this watery coating that the whole fluid mass passes, each of its particles being affected by the first coating, and by each rubbing on another. Hence the mass takes a mean velocity. Dubuat, from a considerable number of experiments, showed that this resistance between the bed of a canal and the water passing through it, is altogether different from the friction of a solid body on another, for his results show that, in the case of fluids, the resistance of friction is independent of the pressure (311). His experiments seem to have been performed with great care and ingenuity; he tried the flow of water over glass, lead, pewter, iron, wood, and different kinds of earths, and found no variation in the friction. (*Principes d'Hydraul.* § § 34 *et* 36.) This inference of Dubuat is generally set down, in books on hydraulics, as the first law of friction in fluids. Daubisson, however, questions the truth of the law, stating that the adherence of the water is equivalent to a single force, and which may be measured, like all other forces, by a weight. He cites also one of Dubuat's own experiments, where a piece of white iron put in contact with a tranquil surface of water, required a force of between 4·70 and 5·07 kil. on the square metre, to withdraw it from the water. He also mentions as an objection to it, the fundamental experiment which served Venturi to establish his *principle of the lateral communication of fluids* mentioned in 262.

330. The movement of water in canals is similar to that of water in pipes, the only difference being, that the one has an exposed surface, while the other has not. The fact of canals having an exposed surface offers a third cause of retardation, for the surface layer of fluid particles rubs against the lower layer of atmospheric particles. Hence, the liquid threads are not all animated with the same velocity; those which are most distant from the walls will move quickest, and thus we should expect the particles on the surface in the middle of the canal to have the greatest velocity. This is not, however, the case; the particles moving with the greatest velocity are actually found to be a little under the surface, as we shall see, in 359, in the experiments to determine the velocity of rivers. The loss of this velocity

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arises from the friction of the fluid particles with those of the atmosphere. Hence, also, the particles in a perpendicular section of a canal have not the same velocity, but if a mean of all these different velocities be taken, we shall have the *mean velocity* of this section. Call v the mean velocity, and s the perpendicular section, then the volume discharged, or waste, in a unit of time, is $Q = sv$.

331. It is a matter of great importance in a practical point of view to determine the ratio of the mean velocity to the velocity of the surface. A knowledge of this relation has always been considered of great value by hydraulicians, and many experiments have been undertaken for the purpose. Dubuat is to be trusted on this head. He made thirty-eight experiments on two wooden canals, 43 metres long; the form of one was rectangular, and 0·487 metres broad, the section of the other was a trapezium, the least base of which was 0·156 met., and the sides inclined at an angle of 36° 20′ to the horizon: the depth of the water varied only from 0·054 metres to 0·273 metres, and the velocity was from 0·16 to 1·30 metres. The deductions of Dubuat from these experiments are, that the relation of the velocity of the surface to that of the bottom is greatest when the mean velocity is least; that the ratio is wholly independent of the depth; the same velocity of surface always corresponds to the same velocity of the bed. He observed, also, that the mean velocity is a mean proportional between the velocity of the surface and that of the bottom. Call v the mean velocity, u the velocity of the bottom, and V that of the surface, then Dubuat's results may be represented by the equations, $u = (\sqrt{V} - 0{\cdot}165)^2$, and $v = \frac{1}{2}(V + u) = (\sqrt{V} - 0{\cdot}082)^2 + 0{\cdot}00677$. M. Prony has discussed Dubuat's observations, and has adopted the formula $v = V.\frac{V + 2{\cdot}372}{V + 3{\cdot}153}$. The corresponding values of V and v are set down in the annexed table. M. Prony takes a mean term, and for practice makes $v = 0{\cdot}8 \times V$, so that, for the mean velocity of a current, it will suffice to diminish the surface velocity by one-fifth. Hence, the mean velocity of water flowing in a current is equal to four-fifths the superficial velocity.[1]

V.	v.
0·25	0·77×V
0·50	0·79×V
1·00	0·81×V
1·50	0·83×V
2·00	0·85×V

332. When the surface of a current flowing into a long and regular canal takes at last a constant inclination, which is the same as that of the bed, in which case they will both be parallel, then all the transverse sections will be equal, and the mean velocity will be the same in each. The water moving in a canal under such circumstances is said to have a *uniform motion*. But when the inclination of the surface varies from one point to another, the surface is no longer parallel to the bottom, and so at divers points of the canal the transverse sections, and, consequently, the velocities also will vary. Nevertheless, since the volume of water entering the canal, and taken at any point, remains the same, the section of the fluid mass will be constant, and the velocity will have at all times the same value. Everything, indeed, will be unchanged, and although we shall not have a uniform, there will at least be a *permanent motion*.

333. A canal, with the exception of *canals employed in inland navigation*, may receive supply at its head from a reservoir, basin, or portion of a river, the level of which is raised for this purpose by dikes or banks. When the head of the canal, at the point where it receives the supply, is open, it is called a *canal with a free entrance*; when it is furnished with a sluice, it is termed a *sluiced canal*.

334. In the case of a canal with a free entrance, the water on entering forms a fall; its level lowers, then gradually rises by gentle undulations; beyond the influence of which it assumes a form nearly plane and parallel to the bed, the inclinations being regarded as constant. The velocity accelerates during the lowering of the fall, retards while it is rising from the surface, and at last becomes sensibly uniform. Dubuat found that when the motion became uniformly regular, the velocity of the surface was nearly that due to the entire height of the fall, and that the height due to the mean velocity is equal to the difference between the height of the reservoir and that of the uniform section. (*Principes d'Hydraul.*, §§ 177 *et* 178.) The fall which is formed at the entrance of a canal diminishes the depth of the uniform section, and lessens the volume of discharge. Hence, if a canal receive all the water that it is destined to convey, the fall must disappear.

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Dubuat also infers from his experiments on this subject, that the velocity and the uniform section establish themselves at a certain distance from the reservoir, in the same manner as if uniformity commenced at the beginning of the canal. (*Principes*, § 177.)

335. The force of a current necessary to move a machine depends not only on the volume of water which it conveys, but also on the height from which it may fall. This force will be measured by the product of the volume and the height of the fall. The greater inclination that is given to a canal, and the more we augment the volume, a factor of the above product, the other factor, the fall, will be diminished for the same time; so that the product, increasing at first with the inclination, will diminish when the inclination is increased. There will thus be a *maximum* force, which it is very important to determine, and to put in practice. Thus, a volume of water equal to 11·86 cub. met. issues from a canal having a fall of 4·50 met., the effective fall being 4·06 met.; the product of these two quantities is 48·15, the corresponding inclination being 0·001045. But when the inclinations 0·0015, 0·002, 0·0025, and 0·003 met. are tried, the corresponding products will be 52·65, 54·68, 54·93, and 54·01. The fall of 0·003 met. has already given a diminution; and if the fall of 0·0026 met. be tried, the corresponding product is 54·88 met. Wherefore, the *maximum* effect in this case will lie between the inclinations of 0·0025 and 0·0026 met.

336. When a canal (333), furnished with a sluice, receives water by the opening which is established at its head, it happens either that the upper edge of the opening is not completely and permanently covered by the water passing into the canal, or that it is so. If the charge over the centre of the orifice be greater than twice or thrice the height of the orifice, the upper edge will not be covered by the water, and the waste will be the same as if the canal did not exist. Bossut, for example, fitted on to a reservoir, having an orifice near the bottom, of dimensions 0·027 met. high, and 0·135 met. broad, a horizontal canal of the same sectional area, but 34 met. in length; the charges under which the escape took place were 3·80 met., 2·50 met., and 1·20 met., and he received at the extremity of the canal the same volume of water which it had taken in as when the canal was away altogether. (*Hydrod.*, § 750.) The reason of this equality is, that when the water is forced along by means of a strong charge, and consequently with great velocity, the tendency of the vein to contract beyond the plane of the orifice renders the section smaller, and thus, on issuing from the orifice, it touches neither the sides nor the bottom of the canal; it is thus, as it were, projected into air, and the discharge remains the same as if this really took place. But beyond the contracted section, the fluid vein expands, and the resistance which it receives when coming in contact with the walls causes a diminution of flow. Where the contact of the walls takes place, however, the distance is too great from the orifice to react against the passing vein, and no reduction will arise in the waste. The dis-

[1] See Prony's *Jaugeage des Eaux Courantes*, 1802.

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charge will always be expressed by the formula already given in 183, $ml'h'\sqrt{2gH}$, where l' and h' are the breadth and height respectively of the opening; m having the same values as for orifices in a thin plate.

337. When, again, the charge is feeble, the opening is covered, and the water issuing from the sluice comes in contact with the walls of the canal, and suffers a retardation which it communicates to the fluid as it passes the opening. The waste, and therefore also its coefficient, are less in this than in the previous case. It sometimes happens, that when the charge is small, the sluice has no sensible effect, and the same volume may be given either when the sluice is wholly raised, or when it is plunged a little into the water. If, however, the depth at which it is plunged be considerable, and if the fluid vein on issuing be entirely covered by still water (as in fig. 49), the height due to the velocity will be the difference between the elevation of the two fluid surfaces. The depth at the sluice-gate is found by taking the height of the water in the canal when the movement has become very regular, the depth close to the sluice-gate being very small. If then h be the depth of water in the canal, H' the height at least of the sluice-gate above the sill of the entrance, the waste of the opening of the sluice-gate, and, consequently, that of the canal, will be expressed by $Q = mlh'\sqrt{2g\,(H'-h)}$; but the expression for the discharge when the velocity has become sensibly uniform is

$$S\left(\sqrt{2736\frac{pS}{c}-0{\cdot}033}\right),$$

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where S and c area s above, and p the sine of inclination;

$$\therefore mlh'\sqrt{2g\,(H'-h')} = S\left(2736\,\frac{pS}{c}-0{\cdot}033\right),$$

which is the general equation relative to canals furnished with a sluice-gate at their head.

338. The experiments of the Abbé Bossut were made on a rectangular canal 105 feet long, 5 inches broad at the bottom, and from 8 to 9 inches deep. The orifice which transmitted the water from the reservoir into the canal was rectangular, having its horizontal base constantly five inches, and its vertical height sometimes half an inch, and at other times an inch. The sides of this orifice were made of copper, and rising perpendicularly from the side of the reservoir, they formed two vertical planes parallel to each other. This projecting orifice was fitted into the canal, which was divided into 5 equal parts of 21 feet each, and also into 3 equal parts of 35, and the time was noted which the water took to reach these points of division. The arrival of the water at these points was indicated by the motion of a very small water-wheel placed at each, and impelled by the stream. When the canal was horizontal, the following results were obtained:—

Velocity of Water in a Rectangular Horizontal Canal 105 *feet long, under different Altitudes of Fluid in the Reservoir.*

Altitude of the water in the reservoir	Ft. in. 11 8	Ft. in. 7 8	Ft. in. 3 8	Ft. in. 11 8	Ft. in. 7 8	Ft. in. 3 8	Space run through by the water.
Vertical breadth of the orifice	½ inch.	½ inch.	½ inch.	1 inch.	1 inch.	1 inch.	Feet.
Time in which the number of feet in column seventh are run through by the water	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	
	2	3−	3+	2	2+	3−	21
	5−	7	9	4	5	6+	42
	10−	13−	17+	7	9	11+	63
	16−	20−	27+	11	14	18+	84
	23+	28+	38+	16¼	20	26	105

339. It appears from column 1st, that the times successively employed to run through spaces of 21 feet each, are as the numbers 2, 3−, 5, 6, 7+, which form nearly an arithmetical progression, whose terms differ nearly by 1, so that by continuing the progression we may determine very nearly the time in which the fluid would run through any number of feet not contained in the 7th column. The same may be done with the other columns of the table.

If we compute theoretically the time which the water should employ in running through the whole length of the canal, or 105 feet, we shall find, that under the circumstances for each column of the preceding table the times, reckoning from the first column, are 6·350, 7·834, 11·330, 6·350, 7·834, 11·330 sec. It appears, therefore, by comparing these times with those found by experiment, that the velocity of the stream is very much retarded by friction, and that this retardation is less as the breadth of the orifice is increased; for since a greater quantity of water issues in this case from the reservoir, it has more power to overcome the obstacles which obstruct its progress. The signs + and − affixed to the numbers in the preceding table, indicate that these numbers are a little too great or too small.

340. It is of the utmost importance to determine the form of canal which will convey the greatest possible volume of water under a given area of transverse section. In order to this it must be remembered, that the volume conveyed along the canal is greatest when the transverse section of the fluid mass is greatest, and the wetted perimeter least. A figure, therefore, must be selected, which, under the same perimeter, presents the greatest surface. By geometry, we know the regular polygons fall under this class of figures; and as a circle is nothing else than a polygon with an infinite number of sides, circular and semi-circular channels are also included in it. But when a semi-polygonal figure is chosen for the channel, the utility diminishes as the sides of the polygon diminish. The most easily executed are the regular semi-hexagon, the semi-pentagon, and the semi-square.

341. The question of figure then for canals which will convey the greatest volume of water, is reduced to taking, among all the trapeziums with sides of a determinate slope, that one which has the greatest section for a given wetted perimeter; or (which is the same thing), that which has the greatest hydraulic mean depth. We shall find that this section is a semi-hexagon. The transverse area, therefore, or $S=(l+nh)h$ (see 325). This expression is to be a *maximum*, and, consequently, its differential will be zero;

$$\therefore \frac{dS}{dh} = l + h\frac{dl}{dh} + 2nh = 0;$$

$$\text{or, } h\,.\,dl + l\,.\,dh + 2nh\,.\,dh = 0.$$

But (325) $c = l + 2h\sqrt{n^2+1}$ is to be differentiated, and c is a constant;

$$\therefore \frac{dc}{dh} = 0 = \frac{dl}{dh} + 2\sqrt{n^2+1}\,;\ \text{or, } 0 = dl + 2\,.\,dh\,.\,\sqrt{n^2+1}\,;$$

and on substituting the value of dl from the former in the

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latter equation, we have $l=2h(\sqrt{n^2+1}-n)$; giving l also its value in the expression for the transverse section, we have $S = h^2(2\sqrt{n^2+1}-n)$; so also $c=4h\sqrt{n^2+1}-2nh$.

$$\therefore \frac{S}{c}=\frac{h^2(2\sqrt{n^2+1}-n)}{2h(2\sqrt{n^2+1}-n)}=\frac{h}{2}=$$

hydraulic mean depth (325); wherefore, in all trapezoidal channels of the best form with certain given slopes and area, the hydraulic mean depth is one-half the depth of the water.

The transverse section of the maximum discharging channel may be thus obtained. Suppose that ABCD (fig. 63) is the regular channel required, draw EB, EC, dividing the section into triangles, of which AEB, EDC are equal in every respect; and let EP, ER, EQ be perpendiculars upon AB, DC, and BC from E. Then we have

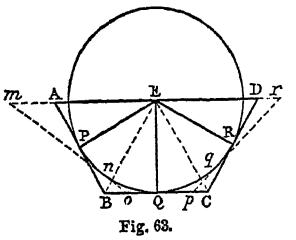


Fig. 63.

$$\frac{S}{c}=\frac{h}{2}, \text{ or } S = c\,.\,\frac{h}{2}, \text{ that is,}$$

$$= AB\,.\,\frac{EP}{2}+DC\,.\,\frac{ER}{2}+BC\,.\,\frac{EQ}{2}=(AB+BC+CD)\frac{h}{2};$$

$$\text{or } (AB+BC+DC)\frac{EP}{2}=(AB+BC+CD)\frac{h}{2};$$

$\therefore \frac{EP}{2}=\frac{h}{2}$; or, $h=EP$. A circle, then, with E as centre, and radii equal to EP, EQ, or ER, will pass through P, Q, and R. Generally, therefore, to find the maximum discharging section, describe a circle with any radius, draw a tangent to serve as the base of the section parallel to the horizontal diameter, and from the extreme points of the base draw two tangents of the requisite inclination till they meet the horizontal line; the figure comprised by the three tangents will be the transverse section required. The dotted tangents *mo*, *rp*, and the base *po*, mark another section for the same thing, but with the sides sloping at a different angle. Mr Neville gives this construction in his *Hydraulic Tables*, p. 129.

342. Canals for *inland navigation*, *aqueducts*, and wooden canals or *courses* for conveying water to manufactories, are invariably made of a rectangular form, owing to the simplicity, facility, and economy of their construction; but the semi-hexagonal section is that which conveys the greatest volume of water.

343. M. Genieys, in his *Essais sur les Moyens de Conduire, d'Elever, et de Distribuer les Eaux*, pays particular attention to the inclination of canals and aqueducts. He endeavours to find that velocity which best suits the nature of the soil, but specially one that would maintain the salubrity of the water. He gives 35 centimetres, or 13·75 inches per second, for the minimum velocity. M. Girard, in his *Rapport sur le projet général du Canal de l'Ourcq*, adopts a less velocity; he proposed at first to regulate the inclination of the Canal de l'Ourcq according to the law represented by the co-ordinates of the funicular polygon (see MECHANICS); but the inclinations per metre for the upper (0·0000625 met.) and lower (0·0001236 met.) part of the canal were found insufficient. Dubuat thought that the smallest inclination capable of maintaining the mobility of water is 1 in 1,000,000; the motion is scarcely perceptible at 1 in 500,000. While experimenting on an artificial canal set to 1 in 9288, he found the mean velocity to be nearly 6 inches per second, and 7 inches per second in a drain near Condé inclined at 1 in 27,000.

The most recent observations on the ancient aqueducts show that the inclination varied from 1 in 432 to 1 in 648. The fall of the new river or canal which conveys water to London is only 0·25 feet per mile, or 1 in 21,120; its motion, about one-half mile per hour, is too small, since during summer the temperature of the water is raised.

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344. The practical application of a fluid such as water flowing through orifices in the sides or bottoms of vessels, in pipes, and open canals, or over weirs, is of the utmost importance. Besides those instances which have already been mentioned for the purpose of illustration, we may state the following. An example, on a large scale, of water issuing through an orifice is to be found in the sluices constructed in tidal harbours for sweeping away at low water the deposit that generally accumulates there. Were it not for some effectual remedy of this kind, many of the most important tidal harbours on the English coast would have been long ere now completely silted up. Smeaton introduced these sluices into Britain from the low countries. He threw an embankment across some part which was wholly covered at high water, so that at the ebbing of the tide a considerable volume of water might be caught in a reservoir. At low water the sluices in the bank were drawn up, and the water allowed to escape among the mud. But this method soon fell into disrepute, as the area of the back-water itself soon became silted up. Smeaton, however, improved upon his original plan, by erecting a second bank altogether or nearly perpendicular to the first, by which the back-water was divided into two areas, each of which was made to cleanse the other, while both kept the harbour clear. The harbours of Ramsgate, Dover, and Hartlepool, are familiar illustrations of this method. (See Smeaton's *Reports*, vol. ii., pp. 202–209; and Sir John Rennie *On Harbours*.)

Other examples are seen in the filling of canal locks, and in the supplying of manufactories and other works from city pipes. In the latter case, a very small orifice is generally perforated in a disc, which is closed up so as to secure it from any unfair interference.

But perhaps one of the best instances of water flowing through orifices is to be found in districts watered by means of canals. Many examples of this kind are to be found in Captain Baird Smith's work on *Italian Irrigation*. In the irrigated districts of Italy it was long a matter of importance to determine the unit of volume of water, and some means of regulating the due supply to each proprietor; so that, on the one hand, neither the government nor landlords might be defrauded, nor, on the other, occupants of lands suffer any injustice. The earlier units were at first only orifices of a fixed area in the side of the canal, without any reference to the head or charge under which the issue took place; but the variations of the water-level in the canal, afterwards made it necessary that a constant pressure be maintained. The unit on the canal of Caluso was called *ruote* or wheel, and was defined as a square, the side of which is equivalent to 1·6702 feet: the upper edge of the outlet is locally said to be *a fior di acqua*, or level with the surface of the canal or reservoir, the discharge hence taking place under no pressure. The *modulo*, or volume per second discharged by the *ruota*, was 11·83 cubic feet. The volume measured by this *ruote*, which was introduced by F. D. Michelotti, was afterwards reduced to 10·84 cubic feet by his son Ignazio. Another of these units is the *oncia magistrale* of Milan; it is 0·655 feet high, 0·3426 feet broad, and has a constant pressure of 0·32944 feet over the upper edge of the outlet. The orifice is cut in a single stone slab, and that it may not be unfairly made use of, is girded by an iron ring. The *modulo* or volume of the *oncia magistrale*, as applied upon the Naviglio Grande, distributes 1851 cubic feet per second over a course of 31 miles. The honour of its discovery is due to Soldati of Milan, about the year 1571. It appears that for summer irrigation each cubic foot of water distributed per second suffices to water 61·8 acres, and that the annual rent for this volume is equivalent to L.13·25.

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345. Great improvements have taken place in these outlets since they were first applied. One of the simplest and most beautiful is that founded on the effect of the double cistern. It is identical with fig. 49 of Prop. XV., the only difference being that in the vertical side of FE, an orfice in that side discharges in the open air.

346. Captain B. Smith gives us, in the case of the Grand Ganges Canal, an example on a very magnificent scale, of water flowing through an orifice. This canal, which was lately opened, has a course of 898 miles, is navigable throughout, and waters a district of country equal in area to 5,400,000 acres. The inclination of this canal is 1 in 3520, its depth is 10 feet, the breadth of its bed over the whole length is 140 feet, and it is intended to convey 6750 cubic feet per second. The slopes are not mentioned, but at from 1·5 to 1, calculation would give a volume of 7316 cubic feet. The inclination of this canal may, from its vast dimensions, be regarded as considerable, and such that the resisting velocity would wear down its sides, but it is supposed that this is prevented, and consequently the velocity diminished, by the rapid growth of aquatic plants on its bed, which is a serious impediment on all canal works.

347. M. Girard feared that the growth of plants would be an element in retarding the velocity of the water flowin the Canal de l'Ourcq, and adopted the inclination of 0·0000305 met., or 1 in 947.

348. As an example of water flowing in pipes, we need only mention the supplying of cities by mains and *culverts* or tunnels. The Croton Water-works supply the city of New York by a culvert, the section of which is not unlike the dotted fig. of 341; it is covered over its entire length, which is a means of preserving the water pure, and of a low temperature; its fall is 13½ inches, or 1·125 feet per mile; the waste is 60,000,000 gallons every 24 hours, or 111·1 cubic feet per second.

349. The projected supply from Loch Katrine for the city of Glasgow is to be conveyed by means of a culvert 8 feet in diameter, and inclined at 1 in 6336. The valleys which intervene are to be passed by a 48-inch cast-iron main; the fall over the whole length will be 1 in 1000, or 5·28 feet per mile.

350. It is a very important matter also to have, both for cities, manufactories, and for irrigating purposes, a constant invariable discharge. The late Mr Thom, hydraulic engineer to the Gorbals Water-works, near Glasgow, devised an apparatus by which a constant discharge might be maintained through an orifice with a constantly varying charge over its centre.

351. The application of the subject to the case of weirs may be seen in the waste-boards thrown across rivers and streams. When weirs are seen in rivers, salmon-gaps are always made in the board, so that the fish may get up the stream. A very ingenious application of weirs is to be seen on the Manchester Water-works. The reservoirs are there supplied in part by the mountain streams, which, in rainy weather, carry down mud and filth, rendering the water unfit for domestic use. Hence the necessity of constructing weirs across several of these streams, to carry away the turbid water. In fine weather these supplying streams convey clear water, and discharge it by a weir at the top of a stone wall, which is a side of a reservoir open at the top. The opposite side of this reservoir is built at such a distance from the former that, in rainy weather, when the stream comes down with violence, its velocity urges it across the reservoir altogether, and all the dirty water is then conveyed to a compensation-pond, which supplies the mills of manufactories. Before and after its greatest velocity much muddy water would enter the reservoir, did not a man attend and put on a cover over the top.

SECTION IX.—FLOW OF WATER IN RIVERS.

352. It is only recently that the motions of rivers have been made the subject of scientific study; it may be said to date only from the year 1665, when the celebrated congress of philosophers met by appointment of the Roman and Florentine governments, to put an end to the quarrels which had taken place among the inhabitants bordering the Val de Chiana (the ancient *Chesina Palus*). The Chiana, lying between the Tiber and Arno had been alternately pushed backwards and forwards, till at last the district had become a noxious marsh. It was this same river which gave rise to the famous controversy in the Roman senate, when it was proposed to prevent the inundations of the Tiber, by throwing the Chiana into the Arno. What was once a marsh, however, is now one of the most fertile districts in Italy (10).

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353. On the resistance of irregular forms and slopes of river beds, Dubuat made several experiments which are worthy of notice. He took different kinds of earths, sands, and stones, and placed them successively on the bottom of a wooden canal; on inclining the canal at different angles he varied the velocity of the water, and, therefore, also obtained a measure of the material set in motion.

	Metres.
For white clay the measure was	0·08
... fine sand	0·16
... gravel of the Seine, size of a pea	0·19
... gravel of the Seine, size of a bean	0·32
... sea pebbles, an inch in diameter	0·65
... flint stones, size of a hen's egg	1·00

He afterwards covered the bottom of the canal with a layer of sand, and the sand moved with the water under a velocity of 0·3 met. After some time, the sand presented a series of beautiful undulations or ridges 0·12 met. broad. The grains of sand, forced on by the current, rose to the tops of the ridges, and after falling down by their own weight to the base of the next ridge, were again lifted to its summit. He found that half an hour was required for a particle to traverse a complete ridge, so that the rate of motion would be about 6 met. in twenty-four hours. It is in this way that the grains of sand move over the *Dunes* by the impulsion of the winds.

354. The effect of the velocity of the water in carrying away particles from the bed of a river will depend on their tenacity and size. With respect to the size, the volumes or weights of similar bodies decrease faster than their areas; and the pressure or force urging a body down a stream being proportional to the transverse section, is relatively greater the less is the volume; hence, the smaller the particles the less is the velocity required to move them. Mr Beardmore gives in his *Hydraulic Tables* the limit of *bottom* velocities in different materials.

30 feet in 1 minute will not disturb clay with sand and stones.
40 feet in 1 minute will move along coarse sand.
60 feet in 1 minute will move along fine gravel.
120 feet in 1 minute will move along rounded pebbles.
180 feet in 1 minute will move along angular stones.

When the beds of rivers, however, are protected by aquatic plants, they will bear higher velocities than those just now mentioned.

355. When the bed of a river is broad and deep, and the water moves slowly, the surface of the fluid will be nearly horizontal; but under a rapid current, in places where the river contracts, the surface assumes a very decided inclination. In a very decided slope of the surface to the horizon, the fluid surface becomes convex; it is concave when the inclination towards the horizon has diminished very much. Were the bed horizontal, and its outline constant, there would be an accelerated motion corresponding to the whole convexity of the surface; and a retarded one for the concavity. Were the bed uniformly inclined, there would only be an accelerated motion so long as the successive values of the inclination of the surface to the horizon were greater than that of the bed; otherwise,

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notwithstanding the convexity, the motion would be retarded.

356. The inequalities of the bottom have some influence on the form of the surface of the current. In general, the inequality at the surface will be smaller compared with that at the bottom, as the water is deeper and the velocity greater. Sometimes, also, in times of great inundations, when dikes about 8 feet high are covered, the surface is equal and the water passes over without any sensible depression.

357. The transverse section, then, of the surface of a river, presents the appearance generally of a convex curve, the summit thread being that which may be considered as having the greatest velocity. On each side of this fluid filament, the level lowers as the sides are approached by a quantity sometimes equal, sometimes unequal. The velocity also of the different parts of the current is large, and their respective elevation is considerable.

According to Dubuat, the principle which is exemplified in such a form of fluid surface, is as follows:—If, from any cause whatsoever, a fluid column comprised in an indefinite fluid, or contained between solid walls, should move with a given velocity, the pressure which it exercises laterally by its own motion against the surrounding fluid, or against the solid wall, will diminish that pressure which is due to the velocity with which it moves. (*Principes*, § 453.) Consequently, the molecules of the fluid threads, as also the surrounding ones, moving more quickly than those near the borders, exercise against them a feebler pressure, and a very large number or a higher column of them would be required to make an equilibrium. On this principle, however, philosophers are not generally agreed.

358. Various methods have been devised by different experimenters for measuring the velocity of running water, either at or under the surface. The velocity of the surface may be simply and directly found by means of a *float*, made of any substance the specific gravity of which is the same or a little heavier than that of water. No part of the body must, if accuracy is required, be exposed to the atmosphere. If the current flows regularly for a considerable distance, the float will be carried uniformly with the stream; and if we count the number of seconds elapsing between the float passing the extreme points of the interval, we know at once the rate of velocity per second, from the expression for uniform motion.

359. If to this float, which is supposed to be under the surface, we attach by a silken string a body specifically lighter than water, as a ball of pith of elder, part of the surface of which will be exposed to the atmosphere, and place both bodies in the middle of a current, it will be found that the pith-of-elder ball will be a little behind the one under the surface; which shows that the threads of fluid that flow fastest are not on the surface, but at a small distance, or rather immediately under it. This velocity, however, may be called that of the surface.

360. Bossut's *wheel* (*Traité d'Hydrodynamique*, § 665), similar to that in fig. 64, will also enable us to determine the surface velocity of running water. It is not, however, so correct an instrument as the float already described (358), for the friction of the screw, the resistance of the atmosphere, and the weight of the wheel, enter as elements of resistance. The small wheel WW should be formed of the lightest materials. It should be about 10 or 12 inches in diameter, and furnished with 14 or 16 float-boards. This wheel moves upon a delicate screw aB, passing through its axle Bb; and when impelled by the stream it will gradually approach towards D, each revolution of the wheel corresponding with a thread of the screw. The number of revolutions performed in a given time are determined upon the scale ma, by means of the index Oh fixed at O, and moveable with the wheel, each division of the scale being equal to the breadth of a thread of the screw, and the extremity h of the index Oh coinciding with the beginning

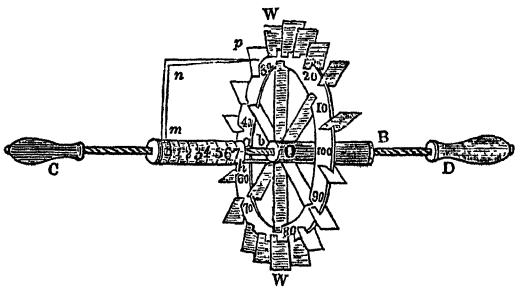


Fig. 64.

of the scale, when the shoulder b of the wheel is screwed close to a. The parts of a revolution are indicated by the bent index mn, pointing to the periphery of the wheel, which is divided into 100 parts. When this instrument is to be used, take it by the handles C, D, or when great accuracy is required, make the handles, regarded now as pivots, rest in grooves properly supported; and screw the shoulder b of the wheel close to a, so that the indices may both point to 0, the commencement of the scales. Then, by means of a stop-watch or pendulum, find how many revolutions of the wheel are performed in a given time. Multiply the mean circumference of the wheel (or the circumference deduced from the mean radius, which is equal to the distance of the centre of impulsion or impression from the axis bB), by the number of revolutions, and the product will be the number of feet through which the water moves in the given time. (Ferguson's *Lectures*.) Dubuat used a fir wheel of this kind very successfully. (See his *Hydraul.*, § 441.)

361. Another instrument by which we can determine the surface velocity of water is the *pendulum*, which consists of an ivory or hollow metal ball fixed to a thread, the other end of the thread being tied to a graduated quadrant. The quadrant is placed above the surface, but the ball is under the water; the force of the current drags the ball with it, and the string receives a certain inclination, the fixity of the machine itself balancing the force of the current. The surface velocity, as deduced by this instrument, is equal to the product of the square root of the tangent of inclination, and a constant, or $v = n\sqrt{\tan i}$, where v is the velocity required, n the constant, and i the inclination of the thread to the vertical. Venturoli mentions this and other pendulums. Zendrini[1] showed with this *pendulum* that the velocities in different parts of the section of the River Po were as the square roots of the heights, when the velocities are not very great. This has been confirmed by many succeeding experimenters.

362. To measure the velocity of running water below the surface, the *tube of Pitot* is the simplest instrument.[2] Pitot's tube is one of glass, bent nearly at right angles, and expanding in a funnel-shape at the lower end, which is to be plunged into the water to the required depth. If the water be in a state of rest when the instrument is plunged into the water, the orifice being right against the current, then the level within and without the tube will be the same; but if there be a current in the water, a column of fluid will ascend the vertical part of the tube, and be a counterpoise to the force of the stream, which impels the column upward. It is natural to suppose that if the depth of the layer the velocity of which is required, be h the fluid column, the velocity will be expressed by $v = \sqrt{2gh}$. But this is not the case, for the pressure exercised on a body plunged in water is dependent on its form, and further, the pressures of the divers

[1] *Leggi, Fenomeni, Regolazioni ed Usi delli Acque Correnti.*

[2] *Aquarum Fluentium Mensura*, lib. iv.

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fluid fillets around the central one diminish from the centre to the circumference of the vein. Hence the necessity of isolating, if possible, the central fillet at any depth, so as to determine its velocity. Dubuat, from these considerations, gave the tube a funnel-shape at its lower end, and closed up this orifice by means of a plate, piercing only its centre by a small hole. When the tube thus arranged was plunged to any depth in water, it was found that two-thirds only of the elevated column in the tube was the height due to the velocity, and not as above the whole height; or $v = \sqrt{2g \cdot \frac{2}{3}h} = 6{\cdot}55\sqrt{h}$ feet. (Bossut's *Hydraul.*, § 572.)

363. Brünnings devised a kind of balance which he named a *Tachometer*, or a measurer of velocity. The water at the required depth impinges on a vertical plate fixed to a horizontal rod, the extremity of which has attached to it a string passing upwards, and tied to a rod above the surface. This latter rod is kept in the horizontal position by means of a moveable weight, which, from its position on its arm, measures the velocity.

364. But of all instruments for measuring the velocity of a current at any depth, the most accurate is regarded as the *Mill of Woltmann*, which was described and made use of by him in 1790. The instrument, represented in fig. 65, consists of a small wheel with 2, 3, or 5 plane fins of considerable breadth, fixed by their radii to the main axis M, of the instrument. The beam M, carrying the wheel, is placed parallel to, or right against the direction of the stream; and the fins of the wheel are obliquely set with respect to the water; so that, as soon as the water impinges against the

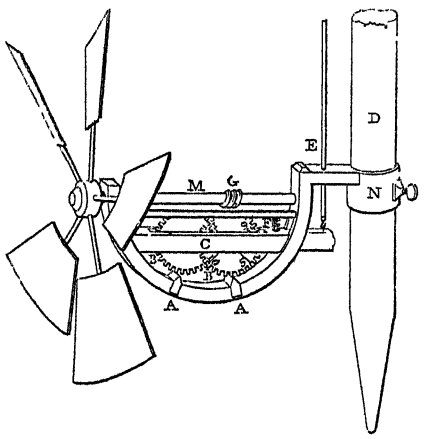


Fig. 65.

fins, the wheel will begin to rotate, and that more rapidly as the velocity of the stream increases. The number of turns that the wheel makes in a given time will enable us to determine the force of the current at any depth. In order, however, to obtain such a result, the beam M has an endless screw G, under which is a toothed wheel, which works into the screw. To the left of the toothed wheel is another, put in motion by a pinion fixed to the first, but moving much more slowly than it. The axes of both wheels B, B, have their extremities fitted into a piece C, moveable round its left end, but a rod E is employed to elevate or depress the right extremity of this sort of lever, in order to put the toothed wheel in communication with the endless screw G, or remove it. When the rod E is not pulled upwards, the lever-beam C lowers itself under the action of a spring F, whereof the upper part is attached to the frame of the apparatus; the toothed wheels B, B, also, and at the same time, lower themselves, and are caught by two projecting pieces A, A, which insert themselves into their teeth, and so prevent the wheels from turning round.

The whole apparatus, by means of the ring N, slides down a long pole to the required depth, and is there fixed by the screw S; the pole D being made fast in the river. The long rod D being then in the river, and the mill fixed at the proper part of its length, and the beam in the direction of the stream, the water will in the course of a few seconds produce a uniform motion of the fins, and no sooner has this taken place than the rod E is drawn up, which necessarily lifts the toothed wheels, and places one of them in connection with the endless screw of the beam, *i.e.*, with the fins. The apparatus is now allowed to be at work for a certain definite time, as one second, when the rod E is then let down, and the toothed wheels necessarily fall, and are caught by the projecting pieces A, A, which prevent them from turning after the communication has been stopped. The instrument is then drawn up, and the positions noted that the points A, A hold on the wheels, which will denote the number of teeth that the wheel to the right has turned round during the time of the experiment; and this number will indicate the turns that the wheel has made; for, as the beam turns round once, so does the screw, and one turn of the screw is equivalent to one tooth of the wheel passed over.

If we neglect the small amount of friction in this apparatus, the velocity of the stream is proportional to the velocity of the fins, and this last to the number n of turns which the wheel makes in a unit of time; or to N, the revolutions it makes in T seconds of time,

$$\therefore v = a \cdot n = a\frac{N}{T};$$

where a is a constant coefficient for the same mill, and to be determined by experiment. We can determine a, by counting the number of turns which the wheel makes in a given time when it is placed in a current of a known or uniform velocity, or by moving the instrument with a given velocity through a mass of still water; then, on dividing the number of turns by the time, we obtain the number of turns in a unit of time, and this being the divisor of the known or uniform velocity, will give a. Since a is thus known, and is a constant quantity for the same mill, it will suffice to count the number of turns the mill makes to divide it by the time taken in revolving, and let this quotient be multiplied by a, the product of which will give the velocity required.

The rapidity with which the mill turns under the action of a current, the velocity of which is 1 metre per second, depends on the dimensions and disposition of the fin. The palettes are generally thin, square copper plates, 0·025 met. in the side, and their radii 0·05 met. in length; the angle which their plane makes with the axis M is 45°.

365. These *stream-measurers* show us the curious fact, that the velocities vary at different points in the same transverse section; that the velocity diminishes, as we have already said (330), on approaching the bed, and its sides. The law of this diminution must be stated. The doctrine, however, was only taken up by philosophers after the year 1730; for, previous to that time, the common belief was that advanced by Guglielmini (in his work entitled *La Misura dell' Acque Correnti*, published about 1695), who supposed that the velocity at any depth of a river was as the square root of that depth. He regarded every point in a fluid mass as tending to move with the same velocity as it would do on issuing from an orifice; and, therefore, he inferred that the layer which has the greatest velocity must be that at the bed or bottom, and the layer of least velocity that at the surface, besides a continual acceleration from the river as it moves. But Pitot, in 1730, from a series of experiments on the River Seine, which he had made with his *tube* (362), showed that the velocities followed a law the very opposite of that advanced by Guglielmini; that they diminished from the surface on nearing the bed.[1]

[1] *Mémoires de l'Académie des Sciences de Paris*, 1732

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Brünnings, in 1789 and 1790, Ximenes, and other hydraulicians, undertook series of experiments to determine the law of diminution of the velocity. Brünnings' were confined to branches of the Rhine traversing Holland; at each station he took, by the *Tachometer* which he had constructed for this purpose, the velocity at the depth of every foot. From these results—which may be seen in the following table—

Names of Rivers.	Depth.	Velocity of		Ratio of mean to surface velocity.
		Surface.	Mean.	
	Met.	Met.	Met.	
Waal	1·57	0·670	0·627	0·934
Waal	1·57	0·708	0·664	0·938
Lower Rhine	1·88	0·874	0·779	0·892
Lower Rhine	2·51	1·001	0·926	0·925
Higher Rhine	2·51	1·097	1·058	0·965
Issel	2·82	1·283	1·218	0·965
Issel	2·82	1·289	1·243	0·965
Lower Rhine	2·82	1·307	1·259	0·963
Waal	3·45	1·025	0·938	0·915
Lower Rhine	3·45	1·379	1·320	0·957
Higher Rhine	3·76	1·307	1·220	0·936
Lower Rhine	3·76	1·397	1·286	0 921
Lower Rhine	3·76	1·416	1·361	0·962
Lower Rhine	3·76	1·433	1·369	0·954
Lower Rhine	4·08	1·484	1·341	0·934
Waal	4·39	1·184	1·068	0·902
Waal	4·39	1·226	1·131	0·923
Higher Rhine	4·39	1·467	1·332	0·908

Woltmann inferred that on reckoning from the surface the velocities diminished as the ordinates of a reversed parabola. Funk, considering the same table, supposed that the velocities followed the logarithmic curve, that is to say, that as the depths increase in arithmetical progression, the velocities diminish in geometrical progression. But M. Raucourt, from a series of experiments on the Neva, at St Petersburgh, has represented the velocities on the same vertical by the ordinates of an ellipse, the smaller axis being vertical, the lower extremity being under the bottom, and the upper a little under the surface.[1] M. Defontaine, however, from experiments on the Rhine with Woltmann's mill, gives the law of the diminution of velocities in the following terms:—In general, and in proportion to the depth under the surface, in a river, the velocity of the water gradually diminishes, at first insensibly, then more and more perceptibly, and increases very rapidly on nearing the bottom, where the velocity is almost always more than half the velocity at the surface. The curve may be easily represented by laying off on a vertical, lengths proportional to the depths, and horizontal lines proportional to the corresponding velocities of the table. The curve approaches nearly to an arc of the parabola, the ordinates of which are the velocities, diminishing by a constant quantity.[2]

Depth.	Velocity.
Met.	
0·00	1·226
0·20	1·218
0·40	1·198
0·60	1·167
0·80	1·125
1·00	1·057
1·20	0·950
1·40	0·880

366. These experiments of M. Raucourt on the Neva, and those of M. Defontaine on the Rhine and its affluents, are among the most important made on rivers in modern times.

The object of M. Raucourt was to ascertain how far the law of velocities of water in pipes coincided with that in open channels, when a river, for example, was frozen, and when free from ice. During the winter, therefore, of 1824, when the Neva was frozen, a part of it was chosen, which was 900 feet wide, and 63 feet deep, with a section very regular, so that this part of the river was, as it were, an immense pipe. Several holes were now made in the ice till the water was reached, and an instrument like the common ship's log sent down; the maximum velocity was found to be a little below the centre of each vertical, and diminished as either bank was neared. After repeated trials, the relative velocities were found to differ only by $\frac{1}{8}$th from each other.

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The greatest velocity was found to be a little below the centre of the deepest vertical, and = 2 ft. 7 in. per second;

Velocity near the top, = 1 ... 11 ...

Velocity near the bottom, = 1 ... 8 ...

During the summer of 1826 Raucourt commenced anew his experiments on the same river, both in calm and windy weather: when calm, the maximum velocity was the same as the surface velocity; when windy, the acceleration was greater or less. Detrem and Henry give, in the *Journal des Voies de Communication* for 1826, an account of the experiments which they undertook for the purpose of verifying the results of Raucourt. They found that the ratio of the mean to the superficial velocity was as 0·715 : 0·903; that the maximum velocity diminished from the upper to the lower part of the river from 1·79 to 1·015 met.; and that the volume of the Neva per second was 3284·54 cub. met. The inclination also was found to be 1 in 37078.

367. The object of M. Defontaine's experiments was the execution of certain works which were intended to restrain and regulate the course of that part of the Rhine adjoining the French territory. That part of the Rhine to which Defontaine mainly directed his attention, is comprised between Basle and Neubourg. The river here is very irregular in its motion, owing to the islands and sand-banks; its inclination also is very variable. The greatest slope is near Basle, at low water, owing to the rocks: during times of floods, the inclination decreases by four-fifths its value.

In the mean state of the Upper Rhine the inclination is 1 in 1037; while at the frontier below the confluence of the Lauter, after a course of 224·460 met. along the French shore, it is 1 in 2534, or nearly a third part of the former. The total fall being taken at 143·935 met., the mean inclination is 1 in 1545, which is nearly that of the river at Brisack and Sponeck. Besides the valuable information respecting this river which is to be found in Defontaine's work, *Travaux du Rhin*, we have the velocities of the river at different parts of it course.

The following table shows that the decrease of velocities is irregular, and that they do not follow the law of the square roots of the inclinations:—

Names of Places.	Velocities per second.		
	Low Water.	Mean Water.	High Water.
	Metres.	Metres.	Metres.
Basle	1·65	2·25	4·16
Huningen	1·70	2·75	...
In the angle of Krembs	1·88	2·62	...
... ... Schalampe	2·67	2·79	...
Opposite Vieux Brisach	1·81	2·15	3·60
At Sponeck	1·52	2·87	...
At Artolsheim	1·97	...	...
At Rhinau	2·51	...	...
At Guerstheim	2·19	...	...
At the Bridge of Kehl	1·50	2·13	2·85
At Offendorff	1·40	2·25	...
At Drusenheim	1·49	1·97	...
At Beinheim	1·24	1·73	...
Limit of Bavarian frontier	0·97	1·56	...
At Mannheim	0·70	1·20	2·30

368. M. Defontaine made also a series of experiments with Woltmann's mill on the velocities of the Rhine in different sections; in the determination of which an extent of 60 met. was traversed, and a float was used, so suspended that its specific gravity did not exceed that of the water. The results are seen in the following table:—

[1] *Annales des Ponts et Chaussées*, tom. iv., p. i., 1832.

[2] *Ib.*, tom. vi., 1833.

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Experiments on the Velocities of the Rhine in different Sections.

Velocities at different parts of the section.	No. of turns of instrument in 30 seconds.	Space passed through in 30 seconds.	Velocity per second.	Mean velocity per second.	Surface of the section of motion of the different strata.	Mean velocity per second.	Mean velocity deduced after formulæ of that of surface.
		Met.	Met.	Met.	Met.	Min.	Min.
At the surface.....	...	...	1·0000	0·9959			
Metres.							
At 0·10 below surface....	68	29·308	0·9769	0·9769			
... 0·20	67½	29·020	0·9673	0·9578			
... 0·30	65⅔	28·111	0·9370	0·9388			
... 0·40	63⅘	27·345	0·9115	0·9198			
... 0·50	62	27·024	0·9008	0·9008			
... 0·60	61 1/10	26·291	0·8764	0·8817	1·0131117	0·84426	0·81189
... 0·70	59	25·429	0·8476	0·8627			
... 0·80	58	24·998	0·8333	0·8437			
... 0·8347 intersection of the two divisions	...	...	...	0·8371			
... 0·90 below surface....	52⅘	22·682	0·7563	0·7867			
... 1·00	49⅔	21·281	0·7094	0·7094			
... 1·10 ... ... or from bottom.....	44	18·964	0·6321	0·6321			
At bottom.....	...	...	...	0·5548			

Defontaine deduces from these results,—1*st*, That the greatest velocity is at the surface; 2*d*, That the velocity, diminishing at first insensibly, decreases rapidly towards the bottom, in a ratio dependent on the nature of the bed; 3*d*, That supposing two right lines to pass through the extremities of four ordinates, determined by experiment, and conveniently chosen in the curve, which should pass through all the points obtained, the ordinates of these right lines, corresponding to the velocities observed in the other points, will differ little in the numerical expression of these velocities; 4*th*, That the point of intersection of two right lines, which each partial surface of partial motion circumscribes, has for its ordinate a numerical value, which differs very little from the mean velocity expressed by the quotient of the surface of motions, divided by the depth of water; 5*th*, That the mean velocities resulting from the preceding observations are greater than the mean velocities adduced from the velocity of the surface by means of the formula adopted for gauging streams; 6*th*, That the position of the ordinates, which expresses the mean velocity of each surface of partial motion, is nearer the bottom than the surface, or $\frac{2}{3}$ds of the depth, reckoning from the surface, and half the depth when the bottom is very regular (Rennie's *Reports*).

369. It appears from Brünnings' table (365) that there is a gradual though small diminution (about $\frac{1}{10}$th) between the surface and mean velocity; the relation ranges between 0·93 and 0·96. Ximenes found this relation from his experiments on the Arno to be 0·92; and Defontaine, from his experiments on the Rhine, about 0·87. For great rivers, however, the relation is a little above 0·90. In all the preceding tables, which contain the mean and surface or maximum velocity, the former will be found to be nearly equal to $\frac{4}{5}$ths of the latter; and conversely, by adding $\frac{1}{4}$th or so of the mean to itself we find the surface velocity.

370. In gauging a river, a station is selected, and soundings of the vertical transverse section at that point are taken. The transverse area is divided into partial areas, each of which is calculated. Then by means of a boat and Woltmann's mill, the mean velocity at each of the places where soundings are taken is deduced from five, six, or seven direct experiments. The mean of these mean velocities gives the mean velocity of the river, which, multiplied by the sum of the partial areas, or the whole area of the trapezium, will give the waste of the river.

In order to find an approximate gauge a station may be selected on the river, the bed of which, for some hundred yards, is very regular. From a few soundings the area of a transverse section is determined. By means of a float, the velocity of the fluid thread in the length taken is found, and consequently of that in the measured section. M. Prony's formula (331) furnishes us with the mean velocity of the section, the product of which, with the area, will be the discharge required.

371. The following table illustrates pretty correctly, by its velocities and inclinations, the nature of the rivers of Great Britain, which frequently in their course embrace nearly all the eight descriptions:—

Characteristics of Rivers.	Velocity in feet per minute.	Inclination in inches per mile.
1. Channels where the resistance from the bed and other obstacles equal the current acquired from the declivity, so that the waters would stagnate were it not for the impulse of back water.....	50 to 120	2·00 to 5·28
2. Rivers in low flat countries, full of turnings and windings, and of a very slow current, subject to frequent and lasting inundations	60	12·18
3. Artificial canals in the Dutch and Austrian Netherlands	30 to 40	2·00 to 9·05
4. Rivers in most countries that are a mean between flat and hilly, which have good currents, but are subject to overflow; also the upper parts of rivers in flat countries	90	15·84
5. Rivers in hilly countries, with a strong current, and seldom subject to inundations; also all rivers near their sources have this declivity and velocity, and often much more.....	130	19·8
6. Rivers in mountainous countries, having a rapid current, and straight course, and very rarely overflowing	180	24·37
7. Rivers in their descent from among mountains down into the plains below, where they run torrentwise	300	31·68
8. Absolute torrents among mountains	480	37·27

SECTION X.—ON THE INFLUENCE OF HEAT ON THE MOTION OF FLUIDS.

372. In all the experiments related in this chapter, and in those of the Chevalier Dubuat, which are given in the article WATER-WORKS, the temperature of the water employed has never been taken into consideration. That the

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fluidity of water is increased by heat can scarcely admit of a doubt. Plutarch informs us that the clepsydræ or water-clocks went slower in winter than in summer, and he seems to attribute this retardation to a diminution of fluidity. It is therefore obvious, that warm water will issue from an aperture with greater velocity than cold water, and that the quantities of fluid discharged from the same orifice, and under the same pressure, will increase with the temperature of the fluid. Hence we may discover the cause of the great discrepancy between the experiments of different philosophers, performed in different climates and at different seasons of the year.

373. M. Dubuat and M. Girard are the only persons who have made experiments on this interesting subject. M. Dubuat employed tubes of a large diameter, and hence the effects of heat were not very conspicuous. The following table contains the results which he obtained:—

Experiments on the Motion of different Fluids, at different degrees of Temperature, in Tubes of Glass.

Names of the fluids.	Diameter and length of the pipe.	Head of water above the top of the tube.	Height of the expanse in a minute expressed in inches.	Velocity in a second in inches.	Degrees of heat above the freezing point.
Rain water	Horizontal tube 2·9 lines, or 0·24166 of an inch in diameter, and 36·25 inches long.....	2·0833	5·2777	13·057	3
Salt water		2·0833	5·1666	12·7823	3
Salt water		2·0833	5·2222	12·9197	11
Salt water		4·9166	9·25	22·8845	10 to 11
Alcohol ...		5·0000	7·5833	18·7611	12
Mercury...		0·8124	3·75	9·2775	10 to 12
Mercury...		0·9166	4·0833	10·1021	10 to 12
Mercury...		2·1944	6·6111	16·3558	10 to 12
Rain water	Horizontal tube 2 lines, or 0·16666 of an inch in diameter, and 36·25 inches long.....	8·875	5·2777	27·455	55
Rain water		15·2916	6·9166	35·980	30
Rain water		15·2916	7·0833	36·847	36
Rain water		15·2916	7·2013	37·461	56
Alcohol....		5·292	2·50	13·005	12
Alcohol....		5·875	3·8338	19·941	12
Mercury...		1·125	1·75	9·103	10 to 12
Mercury...		2·7082	3·00	15·606	10 to 12
Mercury...		5·1666	4·25	22·108	10 to 12
Mercury...		0·0555	0·0000	0·000	10 to 12
Alcohol....	Horizontal tube 1½ line in diameter, and 34·16666 inches long...	9·292	1·125	10·402	12

Hence our author concludes that the velocity of water diminishes as its temperature approaches to that of the freezing point, and *vice versa*; that salt water has a less velocity than rain water, that alcohol runs slower than water, and mercury more rapidly.

374. The general result of M. Girard's experiments has been already given in the History of Hydrodynamics. His experiments were made with copper tubes of exactly the same internal diameter, and drawn upon steel mandrils; and he employed two sets of these tubes of different diameters. The first set consisted of tubes whose length was *two* decimetres, and diameter 2·96 millimetres, and they screwed into each other so as to form tubes of various lengths, from 20 to 222 centimetres. The second set consisted of smaller tubes, whose diameter was 1·83 millimetres. These tubes were then fixed horizontally in the sides of a reservoir, which was a cylinder of white iron 25 centimetres in diameter, and 5 decimetres high. The reservoir was kept full by the usual contrivances; and the water discharged by the tube subjected to trial was received into a copper vessel horizontally, whose capacity had been accurately ascertained. The filling of the vessel was indicated by the instant when the water which it contained had wetted equally a plate of glass which covered almost the whole of its surface, and the time employed to fill this vessel was measured with great accuracy. The temperature of the water was also carefully noted. The results thus obtained amounted to 1200, and were arranged by M. Girard into thirty-four tables, according to the different circumstances of the experiment. When the capillary tube has such a length, that the term proportional to the square of the velocity disappears in the general formula, the velocity with which the fluid is discharged is affected in a very singular manner by a variation of temperature. If the velocity is expressed by 10 when the temperature is 0° of the centigrade thermometer, the velocity will be so great as 42, or increased more than four times, when the temperature amounts to 85° centigrade. When the length of the capillary tube is below the above mentioned limit, a variation of temperature exercises but a slight influence upon the velocity of the issuing fluid. If the length of the adjutage, for example, is 55 millimetres, and if the velocity is represented by 10 at 5° of the centigrade thermometer, it will be represented only by 12 at a temperature of 87°. In conduit pipes of the ordinary diameter, a change of temperature produces almost no perceptible change in the velocity of efflux. M. Girard also found, that the quantity of water discharged by capillary tubes, varied not only with the fluids which were used, but with the nature of the solid substance of which the tubes were composed.

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SECTION XI.—INDIVIDUAL EXPERIMENTS.

1. *Experiments of M. Hachette.*

375. The experiments of M. Hachette were communicated to the National Institute in 1816. The first thing that engaged his attention was to determine what effect the figure of the orifice in a wall or plate had upon the waste in a given time. Making trial of circular, triangular, and elliptic apertures, and one formed of a circular arc and two straight lines, he found that when the areas of the opening and pressure are constant, the volume discharged is the same: but when he made use of an aperture with re-entrant angles, the waste was either in excess or defect. He found, also, that when the plane in which the aperture is pierced is not horizontal, the issuing fluid vein describes a curve, which is a parabola corresponding to a certain initial velocity.

376. The ratio of the contracted area to that of the orifice was particularly attended to. It appears that the smallest contraction observed, and which answered to the smallest aperture, was 0·78 of the orifice. The diameter of the orifice was 0·039 of an inch; but for diameters in excess of 0·39 of an inch, the contracted section was nearly constant, ranging between 0·60 and 0·63. The contraction varied a little with the altitude of the fluid, but was independent of the direction of the jet.

Another result reached by M. Hachette was that, all things remaining the same, the waste is a minimum when the surface in contact with the fluid is convex; when the surface is plane it increases, and is a maximum when the surface is concave. The waste was found to vary about $\frac{1}{10}$th, according as one or other side of the *plano-convex* copper disc containing the orifice was turned towards the fluid; sometimes it was greater.

377. With respect to the form of the fluid vein when the aperture was a regular polygon, each side of the polygon became a base, not of a plane but of a surface, convex externally from the orifice to the contracted section. The concavity of the surface, after having reached a maximum, diminishes near the contracted section; beyond which it changes, in consequence of the velocity acquired, into a sensible convexity, so as to show a salient edge where

before there was a hollow. The hollow and the salient edge succeeding it are produced on the middle of the side, and are situated in a perpendicular plane. If the orifice present in its outline a re-entrant angle, an edge, hollow at first and then convex, passes by the summit of this angle.

378. M. Hachette next made experiments on additional tubes, that is, on tubes fitted into the orifice. These were to explain the fact of cylindrical tubes in orifices giving a greater discharge than through a simple orifice. His object was to show that the attraction of the sides of the pipe was the principal if not the main element in producing this. The fluid employed was mercury, and the pipe of iron. When the mercury was pure, the flow took place as through a simple orifice, for the iron had no affinity for the fluid; but when impure, the discharge increased, for the walls were *wetted*. Again, when he greased or waxed the interior of the pipe, the flow was as through a simple orifice. When the discharge, however, was continued for some time, the wax got wet, the water filled the tube, and the discharge increased.

379. The phenomena respecting the discharge of a fluid into a *vacuum* was observed by this experimenter. From his experiments on this subject under the exhausted receiver, it appears that no increase in the discharge by pipes takes place. In order to show this, a full stream flowed through a tube under the receiver of an air-pump; when the pressure of the remaining air was reduced to 23 centimetres, the external pressure being 76 centimetres, the fluid vein was seen to detach itself from the sides of the tube. As the air within was more and more rarified, the effect of the external pressure increased, and, at the same time, was transmitted to the pipe by means of the fluid contained in the vessels, add to which also the pressure of the fluid itself. But on repeating the experiment in air, he required over the orifice a column of water equal to 22·8 met. high, to detach the vein from the sides of the tube; the external pressure being still 76 centimetres. Hence, the difference, as measured by water, between the superior and inferior pressure was $22{\cdot}8 - 10{\cdot}33 = 12{\cdot}47$ met., or equivalent to 91 centimetres of mercury.

If in this rarified state of the receiver, the external air be re-admitted within it, the water does not begin to flow again in a full stream as it did at first; the detachment of the vein from the sides of the pipe continues, as it did under the exhausted receiver, although the full pressure of the atmosphere is now acting on the water.

From experiments of this nature Hachette concluded that adhesion of the fluid to the sides of the tube takes place only at the commencement of the motion, before the fluid has acquired a sensible velocity in a direction which separates it from the side. He verified this in the following manner:—He allowed water to flow in a full stream by a pipe outside the receiver of an air-pump, when on making a small hole in the pipe near the orifice, the external air entered the pipe, interposed itself between the fluid and the sides of the pipe, the contraction took place inside the tube, and the water ceased to flow in a full stream. The little hole was now shut, but the adhesion of the water and the pipe was not again produced, the flow taking place as if the pipe had been removed.

380. Besides making experiments on long and short tubes emanating from the side of a reservoir, he took the case of a pipe penetrating the orifice inside the vessel containing fluid; and found that when the inserted end of the pipe was very thin, the effect was the same as when the orifice was made in a plate convex towards the inside of the vessel, the waste by such a pipe necessarily diminishing.

381. In order to show that the contraction of the vein diminished with the height of the fluid, he made an orifice 27 millimetres in diameter, and, under a pressure of 15 centimetres, obtained a contraction of about 0·40, or a contracted section of 0·60; while the same orifice, under a pressure of 16 millimetres, gave only a contraction of 0·31. Hence, since the vein contracts as the pressure increases, the vein in passing through a pipe may be made to detach itself altogether from the sides of the pipe, as has been already stated.

382. When the pressure or head of water over the orifice is very small, the fluid vein assumes a particular form, very different from what it had before, and Hachette came to the conclusion that it was independent of the outline of the orifice. He observed these particular forms with orifices and pipes of all figures and sizes; they go by the name of *secondary veins*.

383. Besides experimenting on water, Hachette employed other fluids passing out of orifices and pipes. The phenomena of mercury he found to be the same with those of water. Alcohol, a more volatile fluid than water, flows out more readily; and, consequently, a smaller pressure is required to detach its particles from the walls of the pipe than for those of water. When oil was used, its viscosity increases very considerably the duration of flow through small orifices. In the case of an orifice 1 millimetre broad, the time of flow was three times greater than for water. The discharge, indeed, by a fine tube a millimetre broad, and 5 centimetres long, was, with oil, drop by drop, but when water passed through the same pipe there was a fine stream. The head of oil was 1 met. high.

384. Hachette also made experiments to show the effect of the medium in which the experiments were made; how it modified the pressures on the orifice when a flow took place; and how it opposed a certain resistance to the discharge or motion of the fluid. He also experimented on the impediment to the motion of water arising from the fluid vein impinging on fixed planes, placed at different distances from the orifice. A vein issued out of a large vessel by a circular horizontal opening 20 millimetres in diameter, and was received in a vessel at some distance from the orifice. The level of the fluid in the vessel was depressed about 6 decimetres in $10^m\ 20^s$. The plane face of an obstacle at different distances from the orifice was then presented to the jet impinging perpendicularly.

The distances in millim. were 128, 80, 50, 24, 4; the times in sinking six decim. were respectively $10^m\ 21^s$, $10^m\ 25^s$, $10^m\ 26^s$, $11^m\ 13^s$, $15^m\ 24^s$; which shows that, at the distance of 128 millimetres, or 5 inches, the obstacle presents no sensible effect; but at 4 millimetres, or 0·157 of an inch, the time is increased rather more than one-half.

2. *Experiments of Dr Matthew Young relative to the discharge of fluid through additional tubes.*

385. Dr Young's paper containing an account of these experiments will be found in the 7th volume of the *Transactions of the Royal Irish Academy*. The most interesting part of the memoir is that relating to the increased discharge through additional tubes. They were performed about the year 1798.

When a tube, *mnrs* (fig. 66), is inserted into the vessel ABCD, it is found that the velocity is increased nearly in the subduplicate ratio of the length of the pipe when the tubes are short; and that it approaches nearer to that subduplicate ratio, according as the length of the pipe is increased. The explanation of this increase of velocity is somewhat difficult, since the water cannot issue at *rs* with a greater velocity than it enters the tube at *mn*; and it does not appear how the velocity of the fluid can be increased by the insertion of a tube in its bottom. In order to explain this, we must consider that the weight pressing down the plate

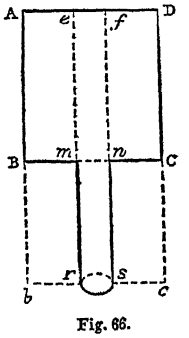


Fig. 66.

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mn is the weight of a fluid column $emnf$, together with the atmospheric column of the same sectional area, while the upward pressure on the plate mn is a corresponding column of air, less the weight of a fluid column $mnsr$; hence the plate mn is pressed down by the weight of a fluid column $efsr$. The velocity, then, with which the fluid lamina mn will issue through the orifice mn, will be the same as through the orifice rs in the vessel AbcD; or that which a heavy body would acquire in falling down through the vertical height er; and the same will be the case for all the laminæ between mn and rs; for they cannot descend faster, since otherwise a vacuum would be left in the tube, which cannot take place owing to the upward pressure of the atmosphere. The velocity of escape will be the same, whatever be the pressure of the atmosphere, provided only that the weight of a column of air, of a base rs, and a height equal to that of the atmosphere, be either greater than or equal to the weight of the fluid cylinder $mnrs$. This might be proved experimentally by inserting a pipe in the bottom of a vessel of water or mercury, and the whole placed under the exhausted receiver. Let x be the defect of the measure from the standard altitude, it will determine the pressure of the air on the mercurial surface; let also y be the height of the mercury in the vessel above the upper orifice of the pipe, and l the length of the pipe, then the whole downward pressure on the plate of mercury which is immediately in the upper orifice of the pipe, is $x+y$; and the upward force pressing the same plate or layer of mercury is $x-l$: the difference between these two quantities or forces equals the absolute force pressing that plate downwards, and will be expressed by $y+l$ so long as x is greater than l; if $x=l$, then $x-l=0$, and the force pressing the plate downwards is $x+y=l+y$; hence, therefore, no variation in the time of efflux will be perceived while the height of the mercury in the gauge or measure is equal to or less than the difference between the length of the pipe and the standard altitude. Let x be less than l, then there is no upward force; and as before the force pressing the plate downward is $x+y$, which varies as x when y is constant, and which will therefore decrease as x decreases; if x vanish or is equal to nothing, or when the receiver is absolutely exhausted, the force is y, and the time of efflux will be the same as if the pipe had not been inserted in the bottom of the vessel.

386. In order to test his theory, Dr Young inserted a tube 7·8 inches long, in a cylindrical vessel, closed the orifice of the pipe, and filled the vessel to a depth of 6 inches with mercury; he then placed the whole apparatus under the receiver of an air-pump, the barometer being at 30 in., and the gauge at 28·5; the time of efflux was found to be 26 seconds: when the experiment was repeated under the same circumstances, but in the open air, the time of efflux was found to be 19 seconds. Now, since the gauge stood at 28·5 inches, the defect x was $30-28{\cdot}5=1{\cdot}5$; and as the pressure on the mercurial plate was $6+1{\cdot}5=7{\cdot}5$, but in the open air was $6+7{\cdot}8=13{\cdot}8$, therefore the ratio of the velocity of efflux in both cases, which is the same as the inverse ratio of the times, was as $\sqrt{7{\cdot}5}:\sqrt{13{\cdot}8}=2{\cdot}73:3{\cdot}71=19:26$ nearly. The times of efflux were the same in the open air and under the exhausted receiver, except when the gauge stood higher than 22·5 inches; *i.e.*, unless the height of mercury in the gauge exceeded the difference between the length of the pipe and standard altitude. In another experiment which he made, the gauge standing at 27·9, and the barometer at 29·9 inches, the defect was found equal to 2, and the pressure was 8. But $\sqrt{8}=2{\cdot}828$, and $\sqrt{13{\cdot}8}=3{\cdot}71$, now $2{\cdot}828:3{\cdot}7=19:24$ nearly; by experiment the time of efflux was found to be 23 seconds. When the efflux is made *in vacuo*, the pipe is not filled during the efflux, as it is while the discharge is made in the open air.

Since the water column in pipe $mnsr$ adds to the pressure which the plate mn sustains, by diminishing the upward pressure of the air through the pipe, it appears that it produces this increase of pressure in the plate mn alone, without producing any lateral pressure in the water on a level with mn; for, by inserting a pipe in the side mB or nC, the velocity of escape would not be affected, and, therefore, the plate mn, immediately over the orifice of the pipe, is the only one on the same level the tendency of which downwards is increased by the insertion of the pipe. Wherefore, the fluid particles of the edge of the aperture will issue through the orifice mn perpendicularly, since they have their vertical pressure increased by the weight of a column $mnsr$, while the lateral pressure is unchanged; the sides also of the tube $mnsr$ will prevent the converging tendency of the particles, and, therefore, on both accounts, the volume of water discharged through a pipe thus inserted, will exceed that discharged through a simple orifice in a ratio greater than the subduplicate of the height of the water. If the pipe be lengthened, the ratio of the volume actually discharged to that determined by theory, will also increase, since the ratio of the perpendicular to the horizontal pressure increases in the ratio of the sum of the depth of the vessel, and length of pipe to the depth of the vessel. Hence in experiments of this sort, results will more nearly coincide with those of theory than when made with a simple orifice, except when the tube is so long that the friction of its sides will retard the fluid; or when so short that the particles have not acquired a vertical direction. All this agrees with the experiments of Mr Vince, an account of which is given in the *Phil. Trans.* for 1795. Mr Vince, *e.g.*, inserted a tube a fourth of an inch long into a cylindrical vessel twelve inches deep, and found that the velocity did not sensibly differ from that through the orifice; the cause of which was that the stream did not fill the pipe, but that the vein contracted as if it flowed through a simple orifice; when the pipe was half an inch long and inserted into a vessel of the same depth, the velocity from this pipe and from the orifice was in the ratio of 4 : 3 nearly; whereas, by theory, it is $\sqrt{12{\cdot}5}:\sqrt{12}=49:48$ nearly. Now, if 49 : 48 be increased in the ratio of 7 : 6, since the latter is the ratio of the diminution of velocity, and the contraction either nearly or entirely vanishes in a pipe, it will give the ratio of 3·57 : 3. When the pipe was one inch long, the ratio of the velocity from the pipe and from the orifice was as 4 : 3 nearly; whereas, by theory it is expressed by $\sqrt{13}:\sqrt{12}=26:25$; and if 26 : 25 be increased in the ratio of 7 : 6, we have the ratio of 3·64 : 3. When Mr Vince employed longer pipes, the velocity of efflux by experiment approached nearer to that which ought to have been discharged by theory; hence, in long pipes, he says, the difference between theory and experiment was not greater than what might have been expected from the friction of the pipes, and other retarding causes. On inserting a pipe of the same diameter with the aperture which terminated in a truncated cone fixed in the orifice, he expected from this arrangement, that the volume discharged in a given time would be less than otherwise, since the water issuing through the orifice would have room in the enlarging cone to form the *vena contracta*; but the result was, that the same volume was discharged as if the pipe had continued throughout of the same diameter with the orifice. The reason of this is, that the pressure of the air will not allow the truncated cone to remain partly empty, as it would if the *vena contracta* were formed; hence, it continues full, and, therefore, the water will pass through it in the same manner as if the water in the cone surrounding the pipe were congealed.

387. Mr Vince next inserted into the bottom of the vessel a perpendicular pipe in the form of a truncated cone, the narrow end being in the orifice, and found that the efflux

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increased more than if he had inserted a cylindrical pipe of the same length, the diameter of which was equal to the narrowest section of the conical tube. Mr Vince explains this on the same principle as that by which we account for the swelling of the diameter of a vertical fluid vein, flowing through a simple orifice with a considerable velocity. For when a vertical pipe is inserted, the velocity of discharge being increased, the resistance from the air will be so also, and thus the diameter of the vein tends to enlarge itself. Now, the truncated cone pipe, the wide end outwards, is just a pipe to admit of this thickening or swelling of the vein; and the water in escaping discharges a larger volume, and with an increased velocity than when through a straight pipe; whereas, in the cylindrical pipe, the fluid cannot enlarge itself, and, thus confined, the efflux must be retarded, and the volume discharged in a given time diminished. Accordingly, under the receiver of the air-pump, with even a moderate degree of exhaustion, there is no difference observed between the velocities with which a fluid is discharged through a conical or cylindrical pipe.

Dr Young made also several experiments on the contraction of veins, for an account of which see vol. ii. of the *Irish Academy*.

3. *Experiments of Poncelet and Lesbros.*

388. The experiments of Poncelet and Lesbros were made at Metz, in the years 1827 and 1828. The series was a very extensive one on the expenditure of water through rectangular orifices of considerable dimensions; and as they were undertaken by order of the French government, no expense was spared in making them as complete as possible. The objects which the experimenters had principally in view, were to ascertain the exact measure of the coefficient of contraction, and to determine the forms of the fluid veins under different charges and areas.

389. In order to get a correct form of the vein, several veins were projected on the plane of the orifice. These projections were taken by means of an iron rod, having, over nearly its whole surface, threads of a screw, and ending at its lower extremity in a delicate point, which was put successively in contact with every point of the exterior surface of the jet. The screw worked perpendicularly into a wooden nut, and which, when the screw was acting, glided along one side of a rectangular or octagonal frame of wood, placed between the orifice and the *vena contracta*.

The orifice that especially claimed their attention while taking these projections, was a square of 0·2 met. in the side, and the mean charge over the centre was 1·68 met. This orifice was selected, because the jet spouted with much stability, its dimensions were such as to admit of manipulating very accurately, and because of its distinctness. Projections, then, of the jet from this orifice were taken first of all at a distance of 0·05 met. from the plane of the orifice; but they confined themselves to the space between 0·064 met. and 0·50 met., since the former was too near, and the latter was just at the limit where the chances of error begin to multiply. At the distance of 0·05 met., however, the jet was perfectly stable. The error in taking the projections did not exceed a millimetre. Two of those veins projected are represented in fig. 67. ACEG is the square orifice of 0·20 met. in the side, and under the charge 1·68 met.; at the distance of 0·15 met. from the orifice, the section of the vein was *abcdefgh*; but at the distance of 0·30 met. the jet had the form represented by *a'b'c'd'e'f'g'h'*. This last, of all the nine projections taken, had the least section; its area was to that of the orifice as 0·562 : 1, while the ratio of the real to the theoretic waste was 0·605 : 1; they would have been equal, if the velocity at this the least section had been that due to the height of the reservoir. The particles *b'*, *d'*, *f'*, *h'*, in the plane of the section of the vein, are those which issue from the middle points, B, D, F, H, of the side of the square. The section, also, of the vein is apparently a kind of square, the angles of which correspond to the middle points of the sides of the orifice, or that it has turned round part of a revolution. The vein *a'b'd'f'h'* made an eighth of a revolution. A phenomenon of this kind taking place in a vein issuing from an orifice not circular, is known by the *renversement*, the *turning* or *inversion*, of the fluid vein.

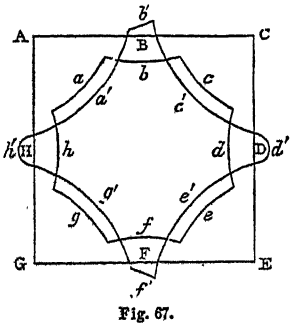


Fig. 67.

390. In the course of experiment it was observed, that as the height of the fluid in the reservoir diminished, the phenomenon of the vein *turning* also diminished; that is to say, that the mass of particles all round the central axis gradually approached that axis, more so on the upper part of the vein, for gravity acting on all the fluid particles of the vein bends the whole mass, especially the horizontal sheets. Poncelet and Lesbros could not observe, as Hachette and other experimenters had done, spiral fluid threads crossing each other at certain angles on the surface of the vein, nor the successive swellings and shrinkings of Savart and Bidone. The former they attributed to very fine ridges on the lower edge of the orifice; and the reason why the latter were not seen was owing to the small extent of vein observed.

391. With respect to rectangular orifices, where the breadth exceeds the height, the *turning* of the vein was less distinct than for the square orifice, and still less when the height of the reservoir decreased. In the case of an orifice of a centimetre of an opening, the angles and jutting parts were scarcely perceptible, which shows that the greatest contraction tends to take place at a great distance from the orifice. This vein presented the appearance of a very thin liquid plate, which continually shrunk in its horizontal, but thickened in its vertical direction, indicating that the liquid masses belonging to the angles bordering the outline of the orifice, tend here naturally to reunite into one and the same mass.

In order to explain this *turning* of the vein, they suppose that those particles which in the plane of the orifice form the centre of the vein, come principally from parts of the reservoir bordering the prolongation of the horizontal axis of this orifice, and describe paths sensibly parallel to this axis; while those particles belonging to the other parts of the orifice come from points of the reservoir as distant from this axis as they belong to points more remote from its centre; and hence the particles not only come into the plane of the orifice under inclinations greater and greater with respect to the axis of the vein, but they come in greater abundance.

392. The following table will show the contractions which a vein experienced at different distances from the plane of the orifice, the areas of the different sections being deduced by means of Simpson's Method of Quadratures. The orifice was a square of twenty centimetres, under a charge of 1·68 met. It appears from the table, that the maximum of contraction of the section takes place at nearly thirty centimetres' distance from the orifice, or nearly 1·5 times the side of the orifice; but beyond this distance the contraction continually diminishes, either because the vein dilates over its whole extent, or because its profile becomes more and more oblique with respect to the central thread. The amount of error does not exceed the 150th of the true value, and hence the maximum contraction may be taken equal to 0·437 of the area of the orifice, and the corresponding coefficient as 0·563. This coefficient is sensibly equal

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to $\frac{225}{400} = (\frac{3}{4})^2$; that is to say, that this section may be taken as equivalent to a square, the side of which is equal to $\frac{3}{4}$ths that of the orifice.

Horizontal distance of section from plane of orifice in centimetres.	Surface of section in square centimetres.	Absolute contraction of section in square centimetres.	Ratio of absolute contraction to area of orifice.	Coefficient of natural contraction, or ratio of section to orifice.
0·0	400·00	0·00	0·000	1·000
6·4	252·05	147·95	0·370	0·630
11·0	245·12	154·88	0·387	0·613
15·0	237·46	162·54	0·406	0·594
20·0	233·01	166·99	0·417	0·583
25·0	232·04	167·96	0·420	0·580
30·0	225·06	174·94	0·437	0·563
35·0	239·48	160·52	0·401	0·599
40·0	243·62	156·38	0·391	0·609
50·0	244·27	155·73	0·389	0·615

393. In order to show the variation in the value of the coefficient for different charges and for different orifices, curves were traced wherein the coefficients were regarded as ordinates, and the charges as abscissæ of a curve constructed for each orifice, and by its aid the ordinates were determined; that is, the coefficients intermediate to those directly determined by experiment. These curves followed, in general, a very regular motion, although distinct for each orifice; and their continuity was somewhat perfect, for they were subjected to pass through points deduced from experiment. The nature of these curves was shown by Lesbros to be one of a parabolic kind,—the real wastes, however, instead of the coefficients, being substituted for the ordinates, and the charges as the abscissæ. Lesbros found also the common and equilateral hyperbola on varying the quantities representing the ordinates and abscissæ. The curves relative to orifices of 20, 10, 5, and 3 centim. always presented their concavity to the axis of abscissæ, and had one ordinate a maximum; whereas for those of 2 and 1 centim. of an opening, the maximum point apparently disappeared. Some of the curves presented a very remarkable appearance, indicating a peculiarity in the law of the coefficients for the orifices of 3 and 5 centim. Other curves, again, presented points of inflection, which were not seen in those of the orifices of 10 and 20 centim., showing again that the law of coefficients was different from those of 10 and 20 centim. of an orifice. The law, then, of the coefficients is peculiar when points of inflection enter the lines, for the degree of curvature necessarily increases with the numerous and sudden alterations of curvature. The curves also indefinitely approach the axis of abscissæ, which will thus be an asymptote.

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394. The interpretation of the curves contains the substance of all the experiments, for they served to construct, by interpolation, a general table of the values of the coefficients, from formulæ of the theoretical waste for charges over the orifices, increasing from the smallest charge of 0·0046 met. to the greatest of 3 met.

395. The following is an abstract from this general table of coefficients as drawn up by Poncelet and Lesbros. It will give one an idea of the labour and care which they bestowed upon the experiments. The coefficients were determined by the usual formula for the discharge (179), the data given being portions of the curves corresponding to the weaker and stronger charges in the reservoir; but those not thus obtained are separated from the others by a transverse line. The values of the quantities D and D′ are the same as in 398 following:—

Orifices shut at the upper part.																		
Charges on the summit of orifices in metres.	The height of the level of the water being measured																	
	From the orifice to a point where the fluid is perfectly stagnant.												Immediately above the orifice.					
	Coefficients of formula D, for heights of orifice of						Coefficients of formula D′, for heights of orifice of						Coefficients of formula D, for heights of orifice of					
	20 cent.	10 cent.	5 cent.	3 cent.	2 cent.	1 cent.	20 cent.	10 cent.	5 cent.	3 cent.	2 cent.	1 cent.	20 cent.	10 cent.	5 cent.	3 cent.	2 cent.	1 cent.
0·0000	...	...	...	...	...	...	...	...	...	...	...	...	0·615	0·660	0·708	0·769	0·839	0·978
0·0046	...	...	...	...	...	0·706	...	...	...	...	...	0·715	...	...	...	...	...	...
0·0091	...	...	0·606	...	...	...	...	...	0·622	...	...	...	...	...	...	...	...	...
0·02	0·572	0·596	0·616	0·639	0·660	0·695	0·592	0·611	0·625	0·644	0·663	0·696	0·594	0·618	0·638	0·665	0·690	0·719
0·08	0·589	0·610	0·628	0·638	0·656	0·671	0·599	0·614	0·630	0·639	0·656	0·671	0·594	0·614	0·634	0·643	0·660	0·674
0·18	0·597	0·615	0·631	0·634	0·651	0·657	0·601	0·617	0·631	0·634	0·651	0·657	0·598	0·616	0·631	0·635	0·651	0·658
0·60	0·604	0·617	0·627	0·630	0·638	0·641	0·604	0·617	0·627	0·630	0·638	0·641	0·604	0·617	0·627	0·630	0·638	0·641
1·20	0·604	0·614	0·623	0·625	0·627	0·623	0·604	0·614	0·623	0·625	0·627	0·623	0·604	0·614	0·623	0·625	0·627	0·623
1·40	0·603	0·612	0·621	0·622	0·622	0·619	0·603	0·612	0·621	0·622	0·622	0·619	0·603	0·612	0·621	0·622	0·622	0·619
1·90	0·601	0·608	0·614	0·614	0·614	0·613	0·601	0·608	0·614	0·614	0·614	0·613	0·601	0·608	0·614	0·614	0·614	0·613
2·00	0·601	0·607	0·613	0·613	0·613	0·613	0·601	0·607	0·613	0·613	0·613	0·613	0·601	0·607	0·613	0·613	0·613	0·613
3·00	0·601	0·603	0·606	0·607	0·608	0·609	0·601	0·603	0·606	0·607	0·608	0·609	0·601	0·603	0·606	0·607	0·608	0·609

396. It appears from the above table that the coefficients increase as the charges become greater, but only up to a certain point, for they then begin to diminish, although the charge be increased. In the general table it is seen that the coefficients approach an equality in each column as the charge increases.

397. Besides numerous experiments which they made on weirs, Poncelet and Lesbros endeavoured to determine the limiting case, or the point of natural transition between a closed and an open orifice; that is, between a simple orifice and a weir. In one of their experiments on weirs, where the charge over the base of the orifice was 0·217 met., the corresponding coefficient was very near that for a simple orifice. But, in order to determine it experimentally, they lowered very gently the level of the water in the reservoir, beginning at the instant when the summit of the orifice was entirely covered with water; they then opened the sluice of their canal a little more than was requisite, in order that the total quantity of water spent by this sluice and by the orifice, might be exactly equal to that which flowed into the reservoir. In this manner they easily determined the precise instant when the fluid was detached from the summit of the orifice. The operation being repeated at various times, always gave a total charge of 0·2205 met. over the base of the orifice; when the charge exceeded this, the water ceased to adhere to the upper wall in a manner sufficiently stable to obtain accurately the waste. The charge of 0·217 met. over an orifice will thus correspond to the same instant when the adherence of the water to this wall is overcome, and when the orifice tends to form itself into a weir.

398. Before closing what we have to say on the experi-

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ments of Poncelet and Lesbros, we append the following table, which contains several results of the experiments on an orifice 20 centim. of a base, and of various heights: we give it not only to show the care with which they conducted their labours, but also to exhibit at one view several of the tabulated results. We have selected two—the first and the last—from each of the six tables in the *Expériences Hydrauliques sur les lois de l'Ecoulement de l'Eau*, &c. The headings over each of the columns refer to the following quantities:—l = 0·20 met. = horizontal length common to all the orifices; h = charge of fluid on the lower fixed border; h' that on the upper variable edge; $Q = h - h'$ = the height of the orifice; D = the theoretical waste, or volume escaped in a certain time relative to the velocity V; D′ = the theoretical waste on taking into account the influence of the opening; E the actual waste as determined by observation, H = mean charge over centre of orifice $= \frac{1}{2}(h + h')$.

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Temperature of Water	Temperature of Air	Numbers of Experiments.	The height of the level of the water in the reservoir being measured — From 3·50 met above the orifice. Charge on centre of orifice, or value of H in metres.	Values of: Relation of $\frac{H}{h-h'}=\frac{H}{Q}$	Values of: Velocity due to H, or of V in metres.	Theoretical waste per second, or value of D in litres.	Real waste per second, or value of E in litres.	Value of coefficient of $\frac{E}{D}$, or relation of $\frac{E}{D}$.	Mean value for each charge of coefficient: $\frac{E}{D}$	Mean value for each charge of coefficient: $\frac{E}{D'}$	Immediately above the orifice. Charge on centre of orifice, or value of H in metres.	Values of: Relation of $\frac{H}{h-h'}=\frac{H}{Q}$	Values of: Theoretical velocity, or V in metres.	Theoretical waste per second, or D in litres.	Value of coefficient of $\frac{E}{D}$, or relation of $\frac{E}{D}$ in litres, as in column 9th.	Mean value for each charge of coefficient: $\frac{E}{D}$	Mean value for each charge of coefficient: $\frac{E}{D'}$	Definite values of coefficients on taking account of the variations that the temperature experiences at the height of the orifice, the charge of the fluid in the reservoir being measured — From 3·50 met. above the orifice: $\frac{E}{D}$	From 3·50 met. above the orifice: $\frac{E}{D'}$	Immediately above the orifice: $\frac{E}{D}$	Immediately above the orifice: $\frac{E}{D'}$
in degrees centig.																					
18·5	19·3	1	1·1720	7·36	5·3738	214·952	129·527	0·6026	0·6026	0·6028	1·4718	7·36	5·3734	214·936	0·6026	0·6026	0·6028	...	...	..	...
18·5	18·5	24	0·1220	0·61	1·5470	61·880	35 378	0·5717	0·5732	0·5928	0·1136	0·57	1·4928	59·712	0·5925	0·5941	0·6186	...	...	...	...
Orifice 10 centimetres high, 20 centimetres wide.																					
17·0	19·0	1	1·5574	15·55	5·5239	110·478	67·568	0·6116	0·6111	0·6112	1·5533	15·55	5·5238	110·476	0·6116	0·6111	0·6112	0·6109	0·6110	0·6109	0·6110
17·0	13·8	11	0·0630	0·63	1·1117	22·234	13·191	0·5933	0·5926	0·6113	0·0525	0·58	1·0148	20·296	0·6499	0·6491	0·6622	0·5919	0·6106	0·6484	0·6615
Orifice 5 centimetres high, 20 centimetres wide.																					
17·0	17·5	1	1·6001	33·80	5·7581	57·581	35·596	0·6182	0·6175	0·6175	1·69006	33·80	5·7581	57·581	0·6182	0·6175	0·6175	0·6168	0·6168	0·6168	0·6168
18·0	24·0	26	0·0363	0·73	0·8439	8·439	5·137	0·6087	0·6088	0·6225	0·0310	0·62	0·7798	7·798	0·6588	0·6589	0 6805	0 6093	0·6230	0·6594	0·6810
Orifice 3 centimetres high, 20 centimetres wide.																					
17·2	20·0	1	1·3810	46·03	5·2049	31·229	19·469	0·6234	0·6229	0·6229	1·38096	46·03	5·2049	31·229	0·6234	0·6229	0 6229	0·6224	0·6224	0·6224	0·6224
19·0	19·7	17	0·0201	0·67	0·6280	3·768	2·370	0·6290	0 6262	0·6433	0·0128	0·43	0·5011	3·007	0·7882	0·7847	...	0·6261	0 6433	0·7849	...
Orifice 2 centimetres high, 20 centimetres wide.																					
18·0	20·8	1	1·4002	70·01	5·2411	20·964	13 033	0·6217	0·6217	0 6217	1·4001	70·01	5 2409	20 964	0·6217	0·6217	0 6217	0·6216	0·6216	0·6216	0·6216
18·0	20·8	12	0·0203	1·02	0·6311	2·524	1·664	0·6593	0·6605	0·6676	0·0160	0 80	0·56025	2·241	0·7425	0·7439	0·7374	0·6604	0·6675	0·7488	0·7573
Orifice 1 centimetre high, 20 centimetres wide.																					
17·2	20·0	1	1·4020	140·20	5·2444	10·489	6·507	0·6204	0·6204	0·6204	1·40197	140·20	5·2444	10·489	0·6204	0·6204	0·6204	0·6189	0·6189	0·6189	0·6189
19·0	24·0	17	0·0174	1·74	0·5843	1·169	0·814	0·6963	0·6955	0·6980	0·01461	1·46	0·5454	1·071	0·7600	0·7591	0·7630	0·6992	0·7017	0·7632	0·7671

399. The principal results from the experiments of Poncelet and Lesbros may be reduced to the following:—That with an orifice 20 centim. square, the coefficient is 0·601 under altitudes of 1·68 met. But when the altitude is reduced to 4 or 5 times the opening of the orifice, the coefficient is increased to 0·605, then falls rapidly to 0·593 as the altitude decreases; that with orifices of smaller dimensions, as a square of 10 or 5 centim., the coefficients observe the same law, being 0·611, 0·618, and 0·611 for the first, and 0·618, 0·631, and 0·623 for the second; for orifices of lesser dimensions, the coefficients rose gradually to 0·698. In the case of weirs, the mean coefficient was 0·400.

4. *Miscellaneous experiments of*—(α.) *Savart*, (β.) *Borda*, (γ.) *Bidone.*

400. (α.) M. Savart, in his book *De la Constitution des Veines Liquides lances par des Orifices Circulaires en mince Paroi*, 1833, gives some curious information on drops relative to fluid veins. We have already seen that, when a fluid issues by an orifice from the bottom of a vessel, a vein is produced. Now this vein is not, as might be supposed, a uniform cylindrical mass of fluid; it is nearly a solid cylinder between the orifice and the contracted section, but at a small distance beyond this section, a series of successive *swellings* and *shrinkings* take place, which are nicely seen by a strong light; and at last the swellings end in drops and detached masses. Savart observed that these drops were alternately big and little, that between each drop there was a space eight or ten times their mean diameter, and their form oscillated betwixt a prolate and an oblate spheroid. He found that the clear, limpid, untroubled part of the vein, as well as the swellings of the troubled part, were proportional to the diameter of the orifice and to the charge.

With respect to the drops which become detached from the troubled part, their formation is not, as in descending jets, an effect of acceleration due to gravity; for the drops are detached in the same manner from a vein when it is directed upward. Savart attributed the effect to an oscillation in the fluid of the reservoir, whereby the molecules of the fluid, being pressed sometimes more or less in issuing from the orifice, moved with a velocity more or less great. These movements may be seen very nicely in experiments on the resistance that the air experiences in pipes: the air may then be seen advancing irregularly as if by undulations; the waves, on propagating themselves, accelerate and retard the velocity.

401. M. Savart, moreover, found that the waves or undulations of the atmosphere had a very singular effect on the fluid vein. When the troubled part of the vein is received on the bottom of a vessel, the sound arising from the shocks of the successive drops can easily be heard; and if this sound be in unison with a musical instrument sounding at a small distance from the vein, immediately the clear, untroubled part of the jet shortens, and sometimes disappears; the swellings of the troubled part increase, shorten, and the space separating them is greater also.

These vibrations of the atmosphere have considerable influence on a descending jet, but less effect on an ascending one; for in the latter case the transverse section increases instead of diminishes in proportion as it recedes from the contracted section, which is never so small that the effect of these vibrations may become sensible.

402. Besides these peculiarities connected with a fluid vein, Savart investigated the action of a jet against an immovable plane, and also of two directly opposing jets. When a jet is directed against a vertical plane surface, the

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surface receiving the jet must be considerably larger than the magnitude of the orifice. Were it less than this, then evidently the water would turn over the edges of the plane; but that this be not the case, the area of the plane surface must be about eight times that of the orifice. It will now be seen that the liquid threads from the vein will spread out in all directions on the surface till they be parallel to it. As soon as they have attained their parallelism, the pressure of the jet against the plane is at a maximum, and can easily be measured.

If the plane be oblique upward, the water will spread itself more on the upper part than on the lower: the jet also does not press with so much intensity on the plate as in the last case.

When two equally powerful and equally broad jets directly meet each other, so that both will form a straight line, the water at the section of opposition forms a most beautiful transparent disc, which is surrounded by a circular rim, having watery spikes radiating from it in all directions.

403. (β.) Borda completely realized the case when a pipe with thin sides and entirely penetrating the wall of a reservoir, is employed for the purposes of discharge. Having taken a white-iron tube, 0·135 met. long, and 0·032 in diameter, and wholly placed within the reservoir, he produced, under a charge of 0·25 met., a fluid vein which was altogether detached from the walls of the tube, and the actual was only 0·515 of the theoretic waste. Various considerations led Borda to think that it might even be reduced to 0·50, or one-half of the theoretical discharge.[1]

404. (γ.) George Bidone of Turin, in his *Experiences sur la Forme et la Direction des Veines et Courans d'Eau lances par diverses Ouvertures*, 1829, gives us something very interesting on the phenomena of a fluid vein. Among his numerous experiments, he took a regular pentagonal orifice 0·014 met. in the side, pierced in a thin vertical copper-plate: the escape took place under a charge of 1·97 met. At a distance of 0·012 met. from the orifice, the transverse section, perpendicular to the axis of the vein, was a very regular decagon. The greatest contracted section, or *first shrinking*, was distant from the orifice by 0·030 met. Beyond this, however, the vein entirely changed its form; it presented, at a distance of 0·095 met. from the orifice, a system of five fluid radial blades, or *spokes*, symmetrically disposed around the axis of the vein; the breadth of these spokes increased up to the swelling of the vein, then it diminished, and the spokes reunited anew so as to form a *second shrinking* at a distance of 0·86 met. Beyond this the vein continued round but shapeless.

Besides a rectilineal pentagon, he successively substituted orifices which were regular pentagons, but in a convex and a concave disc, and also with salient and re-entrant angles like a star with five radiations, and the vein preserved always the same form, together with the same five radial blades or *spokes*.

When the orifice had 6 and 8 sides, the number of blades was 6 and 8; and the *turning* or *inversion* (389) of the vein was a 12th and a 16th of the circumference. When the opening was a narrow rectangle, but prolonged horizontally, at a certain distance the vein had no longer a broad vertical blade,—the turning appeared complete.

405. With respect to the phenomena of the troubled part of the vein, we see sometimes, beyond the second shrinking, the vein dilating itself anew, and dividing itself a second time into the same number of blades. These blades increase in breadth up to a *second swelling*, and then diminish so as to form a *third shrinking*, beyond which a third dilatation ensues, or a third swelling is formed, then a fourth shrinking. Eytelwein, in his German translation of Michelotti's *Sperimenti Idraulici*, gives a description and representation of the different forms of these swellings and shrinkings.

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406. The main cause of the forms and turnings of veins is the oblique direction which the fluid fillets take on approaching the orifice, and this direction tends to urge them beyond the orifice. The action of these fillets on the forms of the veins is greater when the fluid issues out of a very acute angular opening; the latter opening compresses the vein more strongly than do other orifices, and hence the blades form at parts intermediate to those where they exercise their action. Lastly, the resistance of the air, and the mutual attraction of the particles, contribute to contract the blades, and to form a second shrinking.

407. Bidone, also, by numerous experiments at the Water-works of Turin, endeavoured to solve the question of augmented waste when the contracted vein was suppressed on one side. This suppression has been noticed already in 171. The following table gives the result of experiments to determine this point:—

The contraction being suppressed on	Portion of orifice without contraction.	Coefficient.	Ratio of increase.
No side	0	0·608	1·000
One small side	$\frac{1}{8}$	0·620	1·020
One large side	$\frac{2}{8}$	0·637	1·049
One large and one small side	$\frac{3}{8}$	0·659	1·085
Two small and one large side	$\frac{4}{8}$	0·680	1·119
Two large and one small side	$\frac{5}{8}$	0·692	1·139

The figure of the orifice was confined to the rectangular form, the base of which was 0·054 met., and height 0·027. The plates, which were attached sometimes on one side, sometimes on another, and sometimes on two or three of the sides, were 0·067 met. long; that is, they advanced thus much into the reservoir. The flow took place under charges of from 2 to 6·88 met. The coefficients are noted in the table, wherein the last column indicates that unity has been taken when the orifice is entirely free; as the column of coefficients increase, so also it appears that a corresponding increase takes place in the discharge column. M. Bidone has deduced from his results the general expression $1+0{\cdot}152\times\frac{n}{p}$, in which n is the length of the part of the perimeter where the contraction is suppressed, and p the whole perimeter of the orifice. Since this expression gives as its maximum error a 39th part only, the formula representing the waste by a rectangular orifice, when one part of the contraction is suppressed, will be represented by

$$Q=mS\sqrt{2gH}\times\left(1+0{\cdot}152\times\frac{n}{p}\right).$$

408. Bidone made also experiments on circular orifices, one of which was 0·04 met. in diameter; and, by the aid of plates curved cylindrically, first 1-eighth of the contracted perimeter was destroyed, then, successively, 2, 3, 4, 5, 6, and 7 eighths. The annexed table shows the results obtained. By it we see that the numbers of the last column increase less rapidly than in the case of rectangular orifices, and the general expression is now only $1+0{\cdot}128\times\frac{n}{p}$.

$\frac{n}{p}$	Coefficient.	Ratio of increase.
0	0·597	1·000
$\frac{1}{8}$	0·603	1·011
$\frac{2}{8}$	0·615	1·032
$\frac{3}{8}$	0.625	1·048
$\frac{4}{8}$	0·639	1·072
$\frac{5}{8}$	0·649	1·087
$\frac{6}{8}$	0·664	1·112
$\frac{7}{8}$	0·670	1·123

409. After having destroyed 7-eighths of the contracted section, Bidone, to destroy it entirely, introduced within

[1] *Mémoires de l'Académie des Sciences de Paris*, 1766.

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the reservoir 0·067 met. of cylindrical pipe, 0·04 met. in diameter. The coefficient which he now obtained was 0·767, and 1·285 for the ratio of increase. From the expression mentioned above, this number would be 1·128, where the augmentation is not one-half that really obtained. He concluded, therefore, that the phenomena of interior additional tubes, in the case where the contracted section is wholly suppressed at the exterior edges of the orifice, is not of the same nature as when the contraction is only destroyed in part, however great that part may be: there is no intermediate case between them.[1]

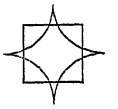
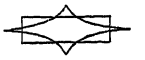
M. Bidone experimented also on Weirs; and the remarks which he made on this subject were among the first worthy of notice. See his *Expériences sur la Dépense des Reversoirs*, 1824.

5. *Experiments of Mr George Rennie.*

410. Mr Rennie, in the year 1830, experimented on the waste by orifices and tubes of different diameters and lengths, and at different altitudes. The area, length, and altitude were the three main elements that entered into these experiments. The apparatus consisted of a wooden cistern 2 feet square in the base, and 4½d feet high. The water was maintained at a constant height by means of a regulating cock; a float with an index indicated the exact height at which the water stood in the cistern above the centre of the orifice. The orifices were in brass discs, about a 60th of an inch thick; the discs were fitted into a hole in the wall of the cistern, and closed by a valve of brass, ground truly to each of the plates. A lever opened the valve, and a chronometer noted the time. The following table contains the wastes from different-sized orifices, the vessel being kept constantly full, and at different heights:—

Height or charge over centre of orifice.	Real time in discharging one cubic foot.	Theoretical time in discharging one cubic foot.	Ratio of theoretical to real waste.	Vena contracta.
Circular orifice in brass plate 1 inch diameter, $\frac{1}{60}$th inch thick.				
Feet.	Seconds.	Seconds.		
4	19·5	11·4	1 : 0·584	Not accurately measured.
3	21 0	13·2	1 : 0·628	
2	26·0	16·1	1 : 0·619	
1	36·0	22·8	1 : 0·633	
Circular orifice in brass plate 0·75 inch diameter, $\frac{1}{60}$th inch thick.				
4	33	20·3	1 : 0·614	At $\frac{6}{10}$th inch from orifice the diameter contracted to 0·685.
3	37	23·4	1 : 0·632	
2	44	28·7	1 : 0·652	
1	63	40·6	1 : 0·644	
Circular orifice in brass plate 0·5 inch diameter, $\frac{1}{60}$th inch thick.				
4	73	45·7	1 : 0·626	At 0·5 inch beyond orifice the diameter contracted to 0·37 inch.
3	83	52·8	1 : 0·636	
2	104	64·6	1 : 0·621	
1	144	91·4	1 : 0·634	
Circular orifice in brass plate 0·25 inch diameter, $\frac{1}{60}$th inch thick.				
4	276	182·9	1 : 0·662	At 0·25 inch beyond orifice, the diameter contracted to $\frac{1}{10}$ inch less than the orifice.
3	320	211·3	1 : 0·660	
2	396	258·6	1 : 0·653	
1	545	365·7	1 : 0·671	

Experiments on the Wastes from rectangular and triangular orifices in brass plates, $\frac{1}{60}$th inch thick, and of equal areas, from a vessel kept constantly full, and at different heights.

Charge over centre of orifice.	Time in discharging 1 cubic foot.	Theoretical time in discharging 1 cubic foot.	Ratio of real to theoretical discharge.	Form of orifice.
Equilateral triangular orifice 1 inch, apex uppermost.				
Feet.	Seconds.	Seconds.		Vena contracta about ½ inch beyond orifice; but the jet with angles reversed, and taking the sides of the triangle, the jet then expanded and lost its form.
4	15	8·9	1 : 0·593	
3	18	10·3	1 : 0·572	
2	22	12·7	1 : 0·577	
1	30	17·9	1 : 0·596	
Equilateral triangular orifice as before, apex downwards.				
4	15	8·9	1 : 0·593	Vena contracta same as before, but the jet having its angle upwards, being the reverse of the former experiments.
Rectangular orifice 1 inch square.				
4	15	8·9	1 : 0·593	Vena contracta 0·75 inch beyond orifice, when each angle of  the jet took the place of a side, and dissipated its spray.
3	17	10·3	1 : 0·606	
2	20	12·7	1 : 0·635	
1	29	17·9	1 : 0·617	
Rectangular orifice 2 inches by ½ inch, long side horizontal.				
4	15	8·9	1 : 0·593	Vena contracta as before; each angle of  the jet took the place of a side.
3	17	10·3	1 : 0·606	
2	20	12·7	1 : 0·635	
1	29	17·9	1 : 0·617	
Rectangular orifice 1·5 inch by 0·625 inch, placed as before.				
4	15	8·9	1 : 0·593	Vena contracta as before; and figure as in that immediately above.
3	17	10·3	1 : 0·606	
2	19	12·7	1 : 0·668	
1	27	17·9	1 : 0·663	

From the above table it appears that, with equal areas, the waste by different orifices, whether circular, triangular, or rectangular, is nearly the same, the increase being with rectangular orifices.

411. The next table contains the waste by cylindrical glass orifices and tubes, from 1 inch to 1 foot in length, and of different diameters, from a vessel kept constantly full, and at different heights.

It appears—1*st*, That the wastes in equal times from orifices and additional tubes, are as the areas of the orifices; 2*d*, That the wastes in equal times by the same additional tubes and orifices, under different heads, are nearly as the square roots of the corresponding heights; 3*d*, That the wastes in equal times by different additional tubes and ori-

[1] *Recherches Expérimentales et Theoriques sur les Contractions Partielles des Veines d'Eau*, etc., 1836.

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fices, under different heights, are to each other in the compound ratio of the areas of the apertures, and of the square roots of the heights.

Constant charge over orifice.	Time in discharging 1 cubic foot.			
	1 inch.	0·75 inch.	0·5 inch.	0·25 inch.
Feet.	Seconds.	Seconds.	Seconds.	Seconds.
4	11·5	24·5	55	145
3	15·0	28·5	63	157
2	17·5	35·0	77	205
1	25·0	53·0	110	297
Glass tubes 1 foot long.				
4	14·0	30	63	200
3	17·0	33	73	227
2	21·5	40	88	283
1	30·0	58	130	410

412. From the preceding experiments, the mean coefficient for

Altitudes of 4 feet with circular orifices is.....0·621
But with altitudes of 1 foot, the coefficient is.....0·645
With triangular orifices at 4 feet altitude.....0·593
... ... 1 foot ... .0·596
With rectangular orifices at 4 feet ... .0·593
... ... 1 foot ... .0·616

413. Mr Rennie has also made experiments on the volume discharged by leaden pipes of different diameters and lengths, from a vessel kept constantly full, and at different altitudes.

The time in discharging 1 cubic foot is nearly double the time occupied by glass tubes of equal lengths and areas.

Straight pipes 15 feet long.			
Constant height over centre of pipe.	Time in discharging 1 cubic foot.		
	1 inch.	½ inch.	¼ inch.
Feet.	Seconds.	Seconds.	Seconds.
4	28	54	143
3	33	63	164
2	41·25	79	208
1	61·25	117	312

The following table shows the wastes from leaden pipes 0·5 inch of bore, the lengths varying from 1 foot to 30 feet:—

Glass tubes 1 inch long, 0·5 inch in diameter.		Brass bore, ·5 in. in diam.	1 foot long.	3¾ feet long.	7½ feet long.	11¼ feet long.	15 feet long.	30 feet long.
Feet.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	ec.
4	55	73	55	78	102	122	143	203
3	63	83	63	92	120	145	164	240
2	77	104	93	113	151	184	208	303
1	110	144	133	170	226	278	312	450

The ratio of the waste by glass tubes with pipes 30 feet long is as.....1 : 4
And with brass orifices, is as.....1 : 3 } nearly.

Hence the expenditure of water through pipes of equal diameters, but different in length, and under different altitudes, will be as follows:—

The length being as 30 : 1, the wastes are as 3·7 : 1
... ... 8 : 1, ... 2·6 : 1
... ... 4 : 1, ... 2·0 : 1
... ... 2 : 1, ... 1·4 : 1

The wastes by leaden and glass tubes are nearly the same. The length of a pipe may be increased from 3 to 4 feet, without diminishing the discharge, as compared with the plate orifices.

414. The experiments on leaden pipes in order to show the effect of bends, are very interesting. Mr Rennie took the straight pipe, ·5 inch of bore, on which the former experiments were made, and carefully bent it into one, two, and fourteen semicircular bends respectively, each bend being 7·5 inches in the semi-diameter, and two of the fourth part of a circle of 3·25 inches radius. The results are shown in the annexed table.

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Pipe 15 feet long, ·5 inch bore, with 1 semicircular and two ¼th circle bends.		
Constant height over centre of orifice.	Time for 1 cubic foot from pipe with 3 bends.	Time for 1 cubic foot from straight pipe.
Feet.	Sec.	Sec.
4	147	143
3	175	164
2	213	208
1	316	312
Pipe 15 feet long, ·5 inch bore, with 14 semicircular and two ¼th circle bends.		
4	162	143
3	200	164
2	247	208
1	351	312

This table shows us that, with one semicircular and two quadrantal bends, when compared with a straight pipe of equal length and bore, the resistance is greater than that of the straight pipe by a 36th to a 70th of the latter. With fourteen semicircular and two ¼th circle bends, the increased resistance varies from a 19th to a 39th of that of the straight pipe. The increased number of bends also does not increase the resistance in the ratio of the number of the bends, but only shows an increase of resistance, as compared with the four bends, of a 15th to a 35th.

415. In the case, again, where the bends are rectangular, the same dimensions of a pipe were employed, and the bends were in the form of right-angled *elbows*, each side being 6·75 inches long. The number of *elbows* varied from 1 to 24. The experiments in the following table show us that in the first three the waste diminishes as 2·5 : 1 ; and in the last, as 3 : 1 nearly. The whole number, however, indicate that with one right-angled pipe the waste differs only from that given by a pipe with twenty-four right angles, as 2 : 1, however natural it might be to infer that the diminution of waste would be greater as the number of right angles increased :—

Height over the centre of orifice.	1 right angle 8·5 in. from end of pipe.	Straight pipe 15 feet long.	24 right angles.
Feet.	Seconds.	Seconds.	Seconds.
4	180	143	395
3	214	164	465
2	246	208	584
1	371	312	872

6. *Professor Magnus's Experiments.*

416. In the year 1848, Professor Magnus of Berlin communicated to the Royal Academy of that city the results of his experiments *on the motion of fluids.* He was led to the subject by doubting the truth of an inference at which Venturi had arrived in one of his experiments relative to the *lateral communication of fluids.* The two main proofs in support of Venturi's opinion are those already mentioned in 262 ; and, as a consequence of the first experiment, he asserts that if any very mobile body—a light feather for example—be brought near a jet of water spouting in the atmosphere, the jet will impart a motion to it, and the body will be carried forward by the air. Professor Magnus applied to such a jet as delicate a test as he could conceive : he held the flame of a candle to the transparent portion of the vein, but was unable to detect the slightest motion. But on applying it to the second or third of the swellings of the vein, the flame became slightly disturbed ; and at that part where the jet is broken up into detached masses it was violently agitated, and at last put out by the spray. This was the case when the jet was regular and steady ; but if it oscillated under the vibrations of the air, then the flame was carried forward at an anterior part of the jet.

Now it is clear that, if the air were, in consequence of its

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adhering to the jet, carried along by the water, this action must be strongest where the velocity of the fluid particles is greatest, that is, near the *vena contracta*. But as this is not the case, as the flame begins to oscillate only at the time when the jet begins to be unsteady, it is very probable that if this motion in the jet were to cease, the irregularity in the flame would also vanish.

417. The other experiment of Venturi, mentioned in 262, was ingeniously modified by Professor Feilitzsch (Poggendorff's *Annalen*, vol. lxiii., p. 216). He took a rectangular vessel EDGF, divided into two parts by a partition HI. A cylindrical pipe ABC, 2·5 inches in diameter, and 8 inches long, with both ends open, and close to the bottom EF, was a means of communicating with both divisions. The supply pipe, about 6 feet long, is, by *hb*, bent horizontally at *b*, and having in this extremity a jet tube *ab*, which spouts within ABC near BC. Suppose, then, the water to be at the same level in both divisions of DF, say to the opening K, and let the jet begin to work into the pipe ABC, then the level of the water in the part FGHI begins to sink.

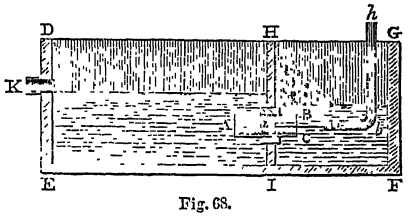


Fig. 68.

418. It was while repeating this experiment that Professor Magnus observed the water in GI lowering to the pipe ABC, and air was found to enter that pipe along with the stream. Since this was the case, it occurred to him, that a jet projected horizontally with considerable velocity against the orifice of a vessel full of water, would prevent that water from flowing out. In order to show this, he had a reservoir kept constantly full, from the bottom of which a right-angular tube *ghf*, proceeded, *gh* being 7 feet long; the horizontal jet entered a tube *de*, communicating with the vessel A, 8 inches wide and 10 high. The tube *de* did not exceed 6 inches, *f* was distant from *e* by 6 inches, and the diameters of *f* and *e* were as 1 : 4. Under such conditions, the jet from *f* raised the surface of A to a height of 10 inches, without a single drop escaping from *e*; but when *e* had its diameter increased, a small portion of water flowed out from *e* ere the above height was attained. During the experiment a violent foaming took place within the tube *de*, which caused a vibratory motion in A.

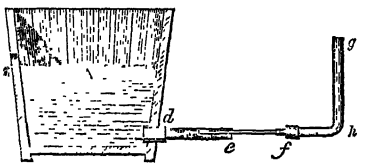
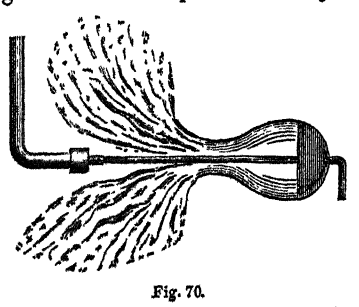


Fig. 69.

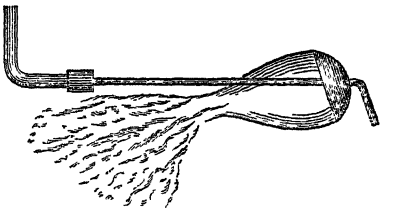
He modified the above experiment by making the orifice of the vessel in the bottom, and projecting the jet vertically upwards, the diameters of tube and orifice being as 1 : 2. This diminution of the orifice was necessary from the fact, that the motion of the fluid exerts here a more disturbing influence than in the experiment with the horizontal tube.

419. After performing M. Savart's experiments of jets impinging on fixed planes, and against each other, the jet was directed against the interior surface of a hollow hemisphere of 24 mill. diameter. The jet issued from an orifice 3 mill. in diameter, and under a pressure of 2·3 met.; the hemisphere was at right angles to the jet, and at a distance from the orifice of 0·5 met. The water, on leaving the hemisphere, directs itself to a point in the jet, but here it meets the coming stream, and so causes a peculiar foaming and streaming of the water, as represented in fig. 70.


Fig. 70.

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When the jet was directed against the same hemisphere, obliquely situated with respect to the horizon, then the reflected water seeks to unite at a point below the line of jet, forming a figure similar to the preceding. The meeting point of the reflected water would be at a point above the jet were the hemisphere turned the other way.


Fig. 71.

420. These last two experiments are very important in the case where a jet, as we have seen, projected against an orifice prevents a flow from taking place; for the whole of the reflected water converges to a point in the jet, and, thus arrested, it must be thrown back so as to form a new surface. Hence, also, we can understand how a small jet can keep back a flow from a wide orifice, and also how a large surface cannot be formed, for it is broken up into a great number of little masses constituting foam.

421. In order to show this very clearly, Professor Magnus modified the experiment, by fixing on the horizontal tube *de*, fig. 72, a vertical part *nm*, the whole appearing like a T reversed (⊥). The experiment was so arranged that *k*, the point where the jet met the water from A, lay between *d* and *m*; water was then poured in by the tube *nm*, but none of it escaped by *e*, for the whole was driven into A. The point *k* evidently depends on the pressure of A when *f* is constant; hence an increase of pressure throws *k* nearer to *e*.

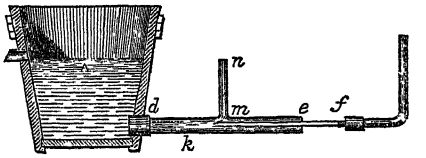


Fig. 72.

He next inserted tightly a tube on *n*, passing under one side of the jet into a large empty bottle having a double head; a bent tube passed from the other head of this bottle into a jar, the open end of the former dipping into a coloured liquid or mercury. On the jet being set a-working, its action drew out the air from the new tubes by *nm*, and accordingly the coloured fluid or mercury rose from its vessel.

422. When the jet meets the water in *de*, a foaming takes place, and the air inclosed in the foam enters the vessel A. That this is the case may very easily be seen when A is a glass vessel; bubbles of air will then stream up to the surface-opening of A. Savart had previously noticed this same thing, but thought it of no consequence; Prof. Magnus, on the contrary, thinks it highly important. Almost every individual has noticed, of a morning, bubbles of air clinging to the sides of the tumbler; how have these obtained entrance? Prof. Magnus thinks he can account for it, and the explanation of it brings him a second time to refute Venturi's assertion that light bodies are carried along with the jet. For if this were the case, then air would enter the vessel A by the friction of the air and jet; but this is impossible, for the air cannot be put in circulation by a jet spouting perpendicularly from a vessel by a long tube, its mouth being distant from the surface of the water impinged on by 1 mill., as was shown by Prof. Magnus.

But the phenomenon appears to be caused in the following manner: When a jet strikes the water a hollow is immediately formed on the surface; this closes in very quickly, as soon as the least motion is imparted to the surface, and

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while closing up, so much air is carried downwards. When the jet is continuous, these hollows, which are distinctly visible, are so speedily formed and so quickly closed up, that it is almost impossible to detect how the air gets introduced. Prof. Magnus, however, found that when a jet falls on a tranquil surface placed at a small distance from the orifice, and before it has attained its greatest contraction, a considerable concavity may be seen around the jet without any air entering; let the surface now be slightly disturbed by a few drops falling upon it from a height of a few inches, and at a small distance from the jet. The drops do not of themselves carry any air downwards; but whenever they meet the surface, a peculiar sound proceeds from the part of the surface impinged on by the jet, and at the same instant air-bubbles form which carry air downwards.

423. Prof. Magnus now directed his attention to the action which a jet has on a body placed in a fluid, or to determine experimentally if the resistance varies with the distance from the orifice. In order to render the results as complete as possible, experiments were first made in air, to ascertain how far it is necessary that the plates used should be flat; and to render the results independent of the gravity of the water, a horizontal stream was applied. The resistance was in each instance measured by a kind of balance to which the plate was attached. Smooth flat plates and hollow hemispheres were preferred. The diameter of the plates varied from 100 to 200 mill. The plates were placed in a vessel of water, first vertically at a certain distance from the orifice of a horizontal jet, and second, horizontally or parallel with the surface, and subject to a vertical jet. The tables, as under, will show the results of the several experiments.

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HORIZONTAL JET.

Orifice.	Vertical pressure in metres.	Diameter of plate in mill.	Distance of plate from orifice in mill.	Weight in grammes necessary to bring the plate to its place.		
				No. 1.	No. 2.	No. 3.
In thin plate, diameter 3 mill.	2·145	100	20	20·0	20·0	20·0
			50	21·0	21·0	20·75
			100	21·5	21·5	21·5
			150	21·5	21·5	21·5
			200	21·	20·5	20·5
				No. 4.	No. 5.	No. 6.
In thin plate, diameter 3 mill.	2·145	150	20	20·0	20·0	18·0
			50	21·0	21·0	19·0
			100	22·0	22·5	20·0
			150	23·0	23·5	20·0
			200	23·0	23·5	21·0
			250	23·0	23·0	21·0
			300	22·5	22·5	20·5
				No. 7.		No. 8.
In brass 1 mill. thick, diameter 3 mill.	2·229	200	20	16·0		16·2
			50	16·7		16·7
			100	18·0		18·0
			150	18·0		18·0
			200	18·0		18·0
			250	17·5		17·7
				No. 9.		
Small glass tube, 10 mill. long, diameter 3 mill. nearly.	2·229	150	20	21·0		
			50	21·6		
			100	23·2		
			150	23·3		
			200	23·3		
			250	23·2		
				No. 10.		
Small glass tube 20 mill. long, diameter a little under 3 mill.	2·229	150	20	14·3		
			50	14·9		
			100	15·2		
			150	15·4		
			200	15·2		

VERTICAL JET.

Orifice.	Vertical pressure in metres.	Diameter of plate in mill.	Distance of plate from orifice in mill.	Weight in grammes necessary to bring the plate to its place.	
				No. 11.	No. 12.
In thin plate, diameter 3 mill.	2·772	200	50	29·5	29·0
			100	30·5	30·5
			150	31·0	31·0
			200	30·5	30·5
				No. 13.	
The same. The jet made an angle of 10° with the vertical.	2·772	200	50	29·0	
			100	30·7	
			150	31·0	
			200	30·5	
				No. 14.	
Glass tube 10 mill. long, diameter nearly 3 mill.	2·772	200	20	26·0	
			30	26·5	
			50	27·5	
			100	28·5	
			150	29·0	
			200	28·5	
				No. 15.	
Glass tube 65 mill. long, 6 mill. diameter; smelted at the lower end to a width of 3 mill. nearly.	2·772	200	20	23·5	
			50	25·5	
			100	26·5	
			150	26·5	
			200	26·0	
				No. 16.	
Glass tube 65 mill. long, having everywhere a diameter of 3·3 mill.	2·772	200	20	28·5	
			50	29·5	
			100	30·8	
			150	31·3	
			200	30·9	

424. In determining the above results, it was found that, the distance from the orifice remaining constant, the force requisite to produce an equilibrium increased with the magnitude of the plate up to a certain limit, beyond which the force was constant. In the case of the horizontal jet, the pressure on the plate, up to a length of 150 mill., increased with the distance from the orifice. None of the experiments showed a decrease within the distance of 100 mill. But the increase was not always equal, and this was owing to the imperfect nature of the apparatus.

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A similar increase was shown in the case of the vertical jet, both when it struck the centre of the plate vertically, and when at an angle of 10°.

425. The last thing that Prof. Magnus endeavoured to resolve in these experiments, was the important one of how a jet of water mixes with the water of a vessel into which it is projected. He first of all introduced into a large tank, nearly full of water, various bodies, as *Semen lycopodii* and milk; but on the jet playing into the vessel, the motion of the fluid was unsteady and violent, so that nothing could be determined. A very curious phenomenon, however, was observed; no sooner had the jet begun to play in the vessel, at a distance of 2 inches under the surface, than the fluid surface immediately over the jet was more or less depressed, according to the greater or less power of the jet. Sometimes the surface was a little above, sometimes a little below the jet; at the jet the surface was very uneven and wavy. The backward and forward motion of the water under the action of the jet, showed that a considerable portion of the motionless water must be carried forward by the jet; this causes a whirling motion in the water, which, owing to its opacity, prevents the nature of the action from being known.

The next process which he adopted so as to arrive at a knowledge of what he wanted, was to cause water, free from salt and hydrochloric acid, to spout into a vessel containing water, into which was dissolved about 1 per cent. of salt. The exact amount of salt in the mass was accurately determined by a solution of nitrate of silver. In order then to take water from the jet streaming into and below the surface of this solution, he took a long bent tube such that one extremity was in the water and opposite the jet, while the other extremity rose above the surface of water, and emptied into a tumbler any water that flowed through it. If now a jet spout into the vessel, and one extremity of the bent tube be applied at certain distances from, and in opposition to the jet, so much fluid will enter the tube and pass into the tumbler; by the proper test the amount of salt in the tumbler may easily be detected. When the distance between the tube and the orifice of the jet was considerable, the fluid received by the tube into the tumbler was the same as that in the vessel. Three separate portions were taken in the glass and examined, and when the second and third were of the same composition, the result was considered as correct. As the jet continued to spout in, the water in the vessel was more and more diluted, but before each experiment the fluid was always tested.

It was of the utmost importance to know whether the salt solution penetrated the middle of the flowing jet; and to this end the tube was accurately fixed in direction with the jet while the vessel was empty. The following table will show the results of the several experiments.

The Tube Point in the middle of the Jet.

Number of experiments.	Diamet. of orifice through which water entered, in mill.	Distance of point from orifice, in mill.	Quantity of salt contained in vessel before experiment.	Quantity of salt in fluid obtained through tube.	The fluid obtained through tube consisted of	
					Salt solution.	Water.
			per cent.	per cent.	per cent.	per cent.
1	3	10	0·92	0·50	54·4	45·6
2	3	20	0·90	0·54	60·0	40·0
3	3	20	0·78	0·46	59·0	41·0
4	5	10	0·89	0·03	3·4	96·6
5	5	20	0·93	0·14	15·1	84·9
6	5	20	0·98	0·16	16·4	83·6
7	5	30	0·93	0·27	29·0	71·0
8	5	30	0·90	0·27	30·0	70·0
9	5	30	0·88	0·23	26·2	73·8
10	5	30	0·82	0·19	23·2	76·8
11	5	30	0·99	0·22	22·0	78·0
12	5	50	0·98	0·44	44·9	55·1

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When the point of the tube was brought close up to the orifice, the pure water of the jet flowed by the tube into the tumbler, and the test showed not the smallest trace of salt. The results, however, were different when the tube point was slightly inclined to the direction of the jet. These results are shown in the following table:—

The Tube Point inclined to the Jet.

Number of experiments.	Distance of tube from orifice, in mill.	The tube was situate	Quantity of salt in vessel before experiment.	Quantity of salt received through tube.	The fluid obtained through tube consisted of	
					Salt solution.	Water.
			per cent.	per cent.	per cent.	per cent.
13	10	In the middle.	0·89	0 03	3·4	96·6
13	10	1°·75 sidewards.	1·08	0·23	21·3	78·7
13	10	3°· sidewards.	0·94	0·42	44·7	55 3
6	20	In the middle.	0·98	0·16	16·4	83·6
6	20	1°·75 sidewards.	1·06	0·40	37·7	62 3
6	20	2°·5 sidewards.	0·99	0·45	45·5	54·5
11	30	In the middle.	0·99	0·22	22·0	78·0
11	30	1°·75 sidewards.	0·97	0·46	47·4	52 6
11	30	2°·5 sidewards.	0·96	0·56	58·3	41·7

This table lets us see that the amount of salt in the drawn off fluid, increases considerably as the deviation from the direction of the jet increases.

426. In order to explain the preceding phenomena, suppose that a jet enters an indefinite mass of fluid, by an orifice at a depth below the fluid surface, then the velocity of the jet will decrease as its distance from the orifice increases, and its dimensions will also increase. Take the volume which will enter the mass in a unit of time; then this volume expands in a direction perpendicular to the axis of the jet, and its dimension in the direction of the jet must diminish. If the velocity decrease in such a manner, that both velocity and thickness are inversely as the cross section during the same time, then the same mass will pass through all planes perpendicular to the axis of the jet in the same space of time; but, in such a case, the force imparting motion to the water must decrease as the velocity decreases. The moving force, however, cannot be destroyed, since the resistance to motion from the sides of the indefinite fluid mass is nothing, and the surface is supposed to continue horizontal. The jet, doubtless, is resisted by the particles of the indefinite mass, but since that is due to the inertia of the mobile particles, the moving force in the direction of the jet is unaltered; and hence, as soon as the motion has attained a degree of permanency, the same amount of force is exerted during the unit of time in all planes perpendicular to the axis of the jet. If, when the jet widened, the volume underwent a change of shape, such that its cross section became greater while the velocity remained unchanged, the time occupied by the mass in passing through the different cross sections would be less and less as the width increased. Were this the case, the different layers of the jet must either separate, or their density must change. If care be taken that the same mass alone expands, and no addition be made to it, then a decrease of pressure, without a change of density taking place, will be the result. But again, since the mass moves in a fluid of the same kind, an increase of volume will take place from the lateral communication of the jet and surrounding fluid. This increase of mass diminishes the velocity; but the moving force being constant, a greater volume of fluid will pass through a distant section in a certain time, than through one nearer the orifice.

We shall see presently that the pressure of a moving fluid is less than if it were still; and therefore to say that no portion of the moving force is lost when the jet is in action might seem somewhat inconsistent, since part of this force

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would seem necessary to balance the difference of pressure in liquids. But there is no inconsistency in this, for the diminution of pressure is caused by the forward portions of the fluid passing through a cross section of the jet quicker than those which follow. If, then, the difference of pressure lessens the velocity of the original mass, it also sets the fluid at each side in motion, and in this way is the loss of force compensated.

The consequences which follow from the above are,—

1. That a jet streaming into a fluid, similar to itself, sends more water, in the same time, through a cross section situate at a distance from the orifice, than through one nearer the same.

2. That in consequence of this, the pressure of the fluid when in motion is less than when in a state of rest.

These two propositions will explain the preceding phenomena. In the experiment stated in 262, more water passes through a cross section of the current EG, than passes in the same time through the tube ACD; wherefore a portion of the water must be carried off from the vessel CDG. So also (fig. 68), more water passes through the communicating tube ABC, than through the narrow tube a; and as no lateral motion takes place, a portion of the water in HF will pass along ABC, and its level falls. If the surface in HF should sink, while the overplus of water in HE flows out by K, or if there be a constant level in HE, then the jet is affected by the pressure due to the difference of level, and the moving force is diminished, so that it is less at a cross section of ABC at A, than in the jet tube a. Therefore, the volume of fluid which passes in a unit of time through A will decrease, and the fluid surface in HF will continue to sink, until the volume of fluid passing through a section of A in a unit of time, be equal to a volume which, during the same time, passes through A. The difference of level will enable us to determine the pressure.

If, on the fluid surface of HF reaching the lower face of ABC, it happen that the above condition of equality of volumes be not fulfilled, then the water in the tube is less pressed in the direction from A to B than from B to A, although the statical pressure in the latter direction is that due to the atmosphere, while in the former it is the atmospheric pressure plus the weight of a column the height of which is that due to the difference of levels. This excess of pressure at B causes the air to enter the tube in bubbles.

427. The same is the explanation of the phenomena attendant on the experiment (fig. 69) where a thin jet prevented the flow of water from an orifice in a vessel: the air entered the water through that tube, and it continued to do so till the fluid in the vessel attained such a height, that the pressures at each end of the tube were equal. If the inner pressure be in excess, the water flows out by the orifice.

428. In conducting these experiments, he found that the pressure of a moving fluid was less than that of a fluid at rest. Thus, when the fluid is stopped by the plate, the water, being resisted in its progress, now moves along parallel to the plate, which, when of a proper magnitude, must diminish the pressure against the plate. Therefore, necessarily, since fluids press equally in all directions (art. 48), the pressure from behind the plate must be greater than on that side facing the jet. This difference will increase if we increase the velocity of the jet and the magnitude of the plate. If the plate be brought nearer the orifice, the velocity of the jet will be greater upon the plate, for then the vein has not had time to widen, and consequently the space through which the water has to pass parallel to the plate is increased. Hence, the nearer that the plate is to the orifice, the greater is the difference of pressure before and behind, and the less will be the force required to bring the plate back to its position of equilibrium. This result continues till the difference of pressure vanishes. This fact may be shown experimentally, by having one plate parallel to another, both vertical, one fixed and having an orifice, the other free and connected with a balance; then when a jet is sent through the former, the difference of pressure on the latter will force it nearer to the fixed plate. The same thing will take place when a column of air is made to act on a plate similarly circumstanced as the above.

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429. The whirling motion stated in article 425 is due to the lateral motion imparted to the water by a strong jet. If the orifice be not too small and expanded vertically, and if the water have a sufficient velocity, funnel-shaped concavities are formed; for the water within these small whirlpools continually streams towards their outer rim, and so the pressure at the centre is diminished. Many other phenomena are dependent on this lateral motion.

7. *Experiments of M. V. Regnault.*

430. In the *Mémoires de l'Institut* for 1847, M. Regnault gives an account of his experiments, which were undertaken for the purpose of determining *the principal laws and numerical data which enter into the calculation of steam-engines.* The nature of his investigations necessarily led him to experiment on the compressibility of water and mercury, and his deductions on this subject may be considered as very accurate. The process which Oersted, Colladon and Sturm, and Aimé adopted was very simple, and, generally speaking, may be described as follows:—A liquid is placed in a kind of thermometer or vessel of considerable capacity surmounted by a graduated capillary tube, open at the top, the divisions being for finding the ratio of the volume between any two divisions, and that of the vessel. This apparatus or *piezometer*, is placed in an experimenting glass vessel, with strong walls, and furnished with a metal covering, which communicates on one side with a forcing-pump, and on the other with a manometer. The latter strong vessel is filled with water, and as soon as the pump begins to work, a pressure, more or less great, is exercised on the sides of the vessel; at the same time the internal and external walls of the piezometer are subjected to compression, and the liquid acted on is diminished in volume. The level of the liquid in the graduated tube now falls, it may be, through several divisions; but this will be a means of calculating the diminution of volume that the liquid, subject to pressure, as measured by the manometer, has experienced. It is only, however, the apparent, not the absolute compressibility, owing to the change of dimension of the piezometer during the operation. Oersted supposed that no change took place.

431. M. Regnault's apparatus consisted also of a piezometer, but so disposed that he obtained at once the compressibility of the liquid, and that of the envelope containing it. He employed air to exercise the compression, because it presents greater advantages than when water is pumped in; the pressures, *e.g.*, are always constant, and they may be measured with great precision. The piezometers he used were most carefully constructed, being first made into hemispheres, and then soldered together. The following table will show us the mean results obtained:—

Envelope or Piezometer.	Pressure in atmospheres varying from	Compressibility of water.	
		Apparent.	Theoretical.
Spherical, copper	2·8033 to 7·8220	0·000046392	0·000047709
Spherical, brass	1·5842 to 9·1206	0·000046847	0·000048288
Cylindrical, glass	2·5387 to 10·3528	0·000044304	0·000046677
		Compressibility of Mercury.	
Cylindrical, glass	3·3368 to 9·5408	0·000001234	0·000003517

The tabulated results of M. Regnault, of which the first on the table is the mean, show that as the pressure in-

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creased, the compressibility of the water sensibly diminished, and that of the envelope was irregular; this was owing to the high malleable and low elastic power of the copper. The results of those tables, of which the second and the third are the mean, did not show this diminution, owing, perhaps, to the high elastic power of the brass and glass, and the low malleable nature of the former. Hence, when water is subjected to a pressure of 15 lbs. on the square inch, or one atmosphere, it is diminished by 48 volumes in one million of the same; *i.e.*, if there be a million cubic inches of water, then if the mass be subjected to a pressure of 1, 2, 3, 4, &c., atmospheres, the diminution of its volume will be 1×48, 2×48, 3×48, 4×48, &c., cubic inches.

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When mercury was subjected to pressure, the tabulated results, of which the fourth is the mean, showed that the apparent differed much from the theoretical compressibility, owing probably to the difficulty of the operation. The liquid, however, is regarded as compressible to the extent of 35 volumes in every 10 million, for each compressing atmosphere.

CHAPTER III.—ON THE RESISTANCE OF FLUIDS.

432. The celebrated Coulomb has very successfully employed the principle of torsion, to determine the cohesion of fluids, and the laws of their resistance in very slow motions. When a body is struck by a fluid with a velocity exceeding eight or nine inches per second, the resistance has been found proportional to the square of the velocity, whether the body in motion strikes the fluid at rest, or the body is struck by the moving fluid. But when the velocity is so slow as not to exceed four-tenths of an inch in a second, the resistance is represented by two terms, one of which is proportional to the simple velocity, and the other to the square of the velocity. The first of these sources of resistance arises from the cohesion of the fluid particles which separate from one another, the number of particles thus separated being proportional to the velocity of the body. The other cause of resistance is the inertia of the particles, which, when struck by the fluid, acquire a certain degree of velocity proportional to the velocity of the body; and as the number of these particles is also proportional to that velocity, the resistance generated by their inertia must be proportional to the square of the velocity.

When the *body in motion, therefore, meets the fluid at rest*, Sir Isaac Newton, Daniel Bernouilli, and M. Gravesende maintained that the formula which represents the resistance of fluids consists of two terms, one of which is as the square of the velocity, and the other constant. The experiments of Coulomb, however, incontestably prove that the pressure which the moving body in this case sustains, is represented by two terms, one proportional to the simple velocity, and the other to its square, and that if there is a constant quantity, it is such as escapes detection.

433. In order to apply the principle of torsion to the resistance of fluids, M. Coulomb made use of the apparatus represented in fig. 73. On the horizontal arm LK, which

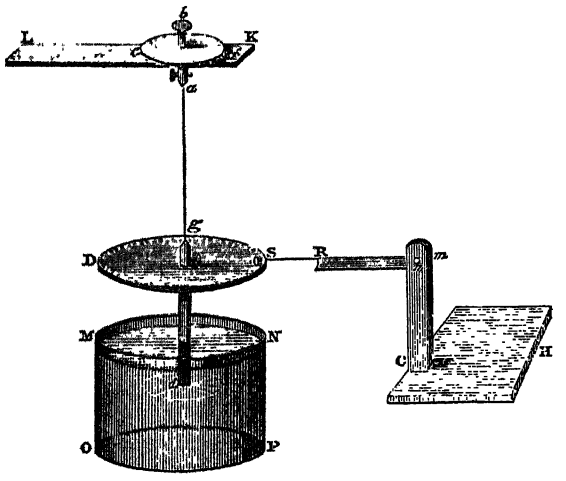


Fig. 73.

may be supported by a vertical stand, is fixed the small circle *fe*, perforated in the centre, so as to admit the cylindrical pin *ba*. Into a slit in the extremity of this pin is fastened, by means of a screw, the brass wire *ag*, whose force of torsion is to be compared with the resistance of the fluid; and its lower extremity is fixed in the same way into a cylinder of copper *gd*, whose diameter is about four-tenths of an inch. The cylinder *gd* is perpendicular to the disk DS, whose circumference is divided into 480 equal parts. When this horizontal disk is at rest, which happens when the torsion of the brass wire is nothing, the fixed index RS is placed upon the point 0, the zero of the circular scale. The small rule R*m* may be elevated or depressed at pleasure round its axis *n*, and the stand CH which supports it may be brought into any position round the horizontal disk. The lower extremity of the cylinder *gd* is immersed about two inches in the vessel of water MNOP, and to the extremity *d* is attached the planes, or the bodies whose resistance is to be determined when they oscillate in the fluid by the torsion of the brass wire. In order to produce these oscillations, the disk DS, supported by both hands, must be turned gently round to a certain distance from the index, without deranging the vertical position of the suspended wire. The disk is then left to itself; the force of torsion causes it to oscillate, and the successive diminutions of these oscillations are carefully observed.

434. The method employed by Coulomb, in reducing his experiments, is similar to that adopted by Newton and other mathematicians, when they wished to determine the resistance of fluids, from the successive diminutions of the oscillations of a pendulum moving in a resisting medium; but is much better fitted for detecting the small quantities which are to be estimated in such researches. When the pendulum is employed, the specific gravity of the body, relative to that of the fluid, must be determined; and the least error in this point leads to very uncertain results. When the pendulum is in different points of the arc in which it oscillates, the wire or pendulum rod is plunged more or less in the fluid; and the alterations which may result from this are frequently more considerable than the small quantities which are the object of research. It is only in small oscillations too, that the force which brings the pendulum from the vertical, is proportional to the angle which the pendulum rod, in different positions, forms with this vertical line; a condition which is necessary before the formulæ can be applied. But small oscillations are attended with great disadvantages; and their successive diminutions cannot be determined but by quantities which it is difficult to estimate exactly, and which are changed by the smallest motion either of the fluid in the vessel, or of the air in the chamber. In small velocities, the pendulum rod experiences a greater resistance at the point of flotation than at any other part. This resistance too, is very changeable; for the water rises from its level along the pendulum rod to greater or less heights, according to the velocity of the pendulum.

435. These and other inconveniences which might be mentioned, are so inseparable from the use of the pendulum, that Newton and Bernouilli have not been able to determine the laws of the resistance of fluids in very slow motions. When the resistance of fluids is compared with

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the force of torsion, these disadvantages do not exist. The body is in this case entirely immersed in the fluid; and as every point of its surface oscillates in a horizontal plane, the relation between the densities of the fluid and the oscillating body has no influence whatever on the moving force. One or two circles of amplitude may be given to the oscillations; and their duration may be increased at pleasure, either by diminishing the diameter of the wire, or increasing its length; or, which may be more convenient, by augmenting the momentum of the horizontal disk. Coulomb, however, found that when each oscillation was so long as to continue about 100 seconds, the least motion of the fluid, or the tremor occasioned by the passing of a carriage, produced a sensible alteration on the results. The oscillations best fitted for experiments of this kind continued from 20 to 30 seconds, and the amplitude of those that gave the most regular results was comprehended between 480 degrees, the entire division of the disk, and 8 or 10 divisions reckoned from the zero of the scale. From these observations, it will be readily seen, that it is only in very slow motions that an oscillating body can be employed for determining the resistance of fluids. In small oscillations, or in quick circular motions, the fluid struck by the body is continually in motion; and when the oscillating body returns to its former position, its velocity is either increased or retarded by the motion communicated to the fluid, and not extinguished.

436. In the first set of experiments made by Coulomb, he attached to the lower extremity of the cylinder *gd* a circular plate of white iron, about 195 mill. in diameter, and made it move so slowly that the part of the resistance proportional to the square of the velocity wholly disappeared. For if, in any particular case, the portion of the resistance proportional to the simple velocity should be equal to the portion that is proportional to the square of the velocity when the body has a velocity of one-tenth of an inch per second, then, when the velocity is 100-tenths of an inch per second, the part proportional to the square of the velocity will be a hundred times greater than that proportional to the simple velocity; but if the velocity is only the hundredth part of the tenth of an inch per second, then the part proportional to the simple velocity will be 100 times greater than the part proportional to the square of the velocity.

437. When the oscillations of the white-iron plate were so slow, that the part of the resistance which varies with the second power of the velocity was greatly inferior to the other part, he found, from a variety of experiments, that the resistance which diminished the oscillations of the horizontal plate was uniformly proportional to the simple velocity; and that the other part of the resistance, which follows the ratio of the square of the velocity, produced no sensible change upon the motion of the white-iron disk. He also found, in conformity with theory, that the momenta of resistance in different circular plates moving round their centre in a fluid, are as the fourth power of the diameters of these circles; and that, when a circle of 195 mill. (7·677 English inches) in diameter, moved round its centre in water, so that its circumference had a velocity of 140 mill. (5·512 English inches) per second, the momentum of resistance which the fluid opposed to its circular motion was equal to one-tenth of a gramme (1·544 English troy grains) placed at the end of a lever 143 mill. (5·63 English inches) in length.

438. M. Coulomb repeated the same experiments in a vessel of clarified oil, at the temperature of 16 degrees of Reaumur. He found, as before, that the momenta of the resistance of different circular disks, moving round their centre in the plane of their superficies, were as the fourth power of their diameters; and that the difficulty with which the same horizontal plate, moving with the same velocity, separated the particles of oil, was to the difficulty with which it separated the particles of water, as 17·5 to 1, which is therefore the ratio that the mutual cohesion of the particles of oil has to the mutual cohesion of the particles of water.

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439. In order to ascertain whether or not the resistance of a body moving in a fluid was influenced by the nature of its surface, M. Coulomb anointed the surface of the white-iron plate with tallow, and wiped it partly away, so that the thickness of the plate might not be sensibly increased. The plate was then made to oscillate in water, and the oscillations were found to diminish in the same manner as before the application of the unguent. Over the surface of the tallow upon the plate, he afterwards scattered, by means of a sieve, a quantity of coarse sand which adhered to the greasy surface; but when the plate, thus prepared, was caused to oscillate, the augmentation of resistance was so small that it could scarcely be appreciated. We may therefore conclude, that the part of the resistance which is proportional to the simple velocity, is owing to the mutual adhesion of the particles of the fluid, and not to the adhesion of these particles to the surface of the body.

440. If the part of the resistance varying with the simple velocity were increased when the white-iron plate was immersed at greater depths in the water, we might suppose it to be owing to the friction of the water on the horizontal surface, which, like the friction of solid bodies, should be proportional to the superincumbent pressure. In order to settle this point, M. Coulomb made the white-iron plate oscillate at the depth of two centimetres (·787 English inches), and also at the depth of 50 centimetres (19·6855 English inches), and found no difference in the resistance; but as the surface of the water was loaded with the whole weight of the atmosphere, and as an additional load of 50 centimetres of water could scarcely produce a perceptible augmentation of the resistance, M. Coulomb employed another method of deciding the question. Having placed a vessel full of water under the receiver of an air-pump, the receiver being furnished with a rod and collar of leather at its top, he fixed to the hook, at the end of the rod, a harpsichord wire, number 7 in commerce, and suspended to it a cylinder of copper, like *gd*, fig. 89, which plunged in the water of the vessel, and under this cylinder he fixed a circular plane, whose diameter was 101 millimetres (3·976 English inches). When the oscillations were finished, and consequently the force of torsion nothing, the zero of torsion was marked by the aid of an index fixed to the cylinder. The rod was then made to turn quickly round through a complete circle, which gave to the wire a complete circle of torsion, and the successive diminutions of the oscillations were carefully observed. The diminution for a complete circle of torsion was found to be nearly a fourth part of the circle for the first oscillation, but always the same whether the experiment was made in a vacuum or in the atmosphere. A small pallet 50 millimetres long (1·969 English inches), and 10 millimetres broad (0·3937 English inches), which struck the water perpendicular to its plane, furnished a similar result. We may therefore conclude, that when a submerged body moves in a fluid, the pressure which it sustains, measured by the altitude of the superior fluid, does not perceptibly increase the resistance; and, consequently, that the part of this resistance proportional to the simple velocity, can in no respect be compared with the friction of solid bodies, which is always proportional to the pressure.

441. The next object of M. Coulomb was to ascertain the resistance experienced by cylinders that moved very slowly, and perpendicular to their axis; but as the particles of fluid struck by the cylinder necessarily partook of its motion, it was impossible to neglect the part of the resistance proportional to the square of the velocity, and there-

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fore he was obliged to perform the experiments in such a manner that both parts of the resistance might be computed. The three cylinders which he employed were 249 mill. (9·8031 English inches) long. The first cylinder was 0·87 mill. (0·0342 English inches, or $\frac{1}{29}$th of an inch) in circumference, the second 11·2 mill. (0·4409 English inches), and the third 21·1 mill. (·83070 English inches). They were fixed by their middle under the cylindrical piece Dg, so as to form two horizontal radii, whose length was 124·5 mill. (4·9015 English inches) or half the length of each cylinder. After making the necessary experiments and computations, he found that the part of the resistance proportional to the simple velocity, which, to avoid circumlocution, we shall call r, did not vary with the circumferences of the cylinders. The circumferences of the first and third cylinders were to one another as 24 : 1, whereas the resistances were in the ratio of 3 : 1. The same conclusion was deduced by comparing the experiments made with the first and second cylinder.

442. In order to explain these results, M. Coulomb very justly supposes, that, in consequence of the mutual adhesion of the particles of water, the motion of the cylinder is communicated to the particles at a small distance from it. The particles which touch the cylinder have the same velocity as the cylinder, those at a greater distance have a less velocity, and at the distance of about one-tenth of an inch the velocity ceases entirely, so that it is only at that distance from the cylinder that the mutual adhesion of the fluid molecules ceases to influence the resistance. The resistance r, therefore, should not be proportional to the circumference of the real cylinder, but to the circumference of a cylinder whose radius is greater than the real cylinder by one-tenth of an inch. It consequently becomes a matter of importance to determine with accuracy the quantity which must be added to the real cylinder in order to have the radius of the cylinder to which the resistance r is proportional, and from which it must be computed. Coulomb found the quantity by which the radius should be increased to be 1·5 mill. ($\frac{5}{100}$ths of an English inch), so that the diameter of the augmented cylinder will exceed the diameter of the real cylinder by double that quantity, or $\frac{11}{1000}$ths of an inch.

443. The part of the resistance varying with the square of the velocity, or that arising from the inertia of the fluid, which we shall call R, was likewise not proportional to the circumferences of the cylinder; but the augmentation of the radii amounts in this case only to $\frac{1}{100}$ths of an inch, which is only one-fifth of the augmentation necessary for finding the resistance r. The reason of this difference is obvious; all the particles of the fluid when they are separated from each other oppose the same resistance, whatever be their velocity; consequently, as the value of r depends only on the adhesion of the particles, the resistances due to this adhesion will reach to the distance from the cylinder where the velocity of the particles is 0. In comparing the different values of R, the part of the resistance which varies as the square of the velocity, all the particles are supposed to have a velocity equal to that of the cylinder; but as it is only the particles which touch the cylinder that have this velocity, it follows that the augmentation of the diameter necessary for finding R must be less than the augmentation necessary for finding r.

444. In determining experimentally the part of the momentum of resistance proportional to the velocity, by two cylinders of the same diameter, but of different lengths, M. Coulomb found that this momentum was proportional to the third power of their lengths. The same result may be deduced from theory; for supposing each cylinder divided into any number of parts, the length of each part will be proportional to the whole length. The velocity of the corresponding parts will be as these lengths, and also as the distance of the same parts from the centre of rotation. The theory likewise proves that the momentum of resistance depending on the square of the velocity, in two cylinders of the same diameter but of different lengths, is proportional to the fourth power of the length of the cylinder.

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445. When the cylinder, 9·8031 inches in length, and 0·4409 inches in circumference, was made to oscillate in the fluid with a velocity of 5·51 inches per second, the part of the resistance r was equal to 58 milligrammes, or ·8948 Troy grains. And when the velocity was 0·3937 inches per second, the resistance r was 0·00414 grammes, or ·0638 Troy grains.

446. The preceding experiments were also made in the oil formerly mentioned; and it likewise appeared, from their results, that the mutual adhesion of the particles of oil was to the mutual adhesion of the particles of water as 17 to 1. But though this be the case, M. Coulomb discovered that the quantity by which the radii of the cylinder must be augmented in order to have the resistance r, is the very same as when the cylinder oscillated in water. This result was very unexpected, as the greater adhesion between the particles of oil might have led us to anticipate a much greater augmentation. When the cylinders oscillated both in oil and water with the same velocity, the part of the resistance R produced by the inertia of the fluid particles which the cylinder put in motion, was almost the same in both. As this part of the resistance depends on the quantity of particles put in motion, and not on their adhesion, the resistances due to the inertia of the particles will be in different fluids as their densities.

447. The subject of the resistance of fluids has been treated by Dr Hutton of Woolwich. His experiments were made in air with bodies of various forms, moving with different velocities, and inclined at various angles to the direction of their motion, and the following conclusions were deduced from them:—1. That the resistance is nearly proportional to the surfaces, a small increase taking place when the surfaces and the velocities are great. 2. The resistance to the same surface moving with different velocities, is nearly as the square of the velocity; but it appears that the exponent increases with the velocity. 3. The round and sharp ends of solids sustain a greater resistance than the flat ends of the same diameter. 4. The resistance to the base of the hemisphere is to the resistance on the convex side, or the whole sphere, as $2\frac{1}{3}$ to 1, instead of 2 to 1, as given by theory. 5. The resistance on the base of the cone is to the resistance on the vertex nearly as $2\frac{3}{10}$ to 1; and in the same ratio is radius to the sine of half the angle at the vertex. Hence in this case the resistance is directly as the sine of the angle of incidence, the transverse section being the same. 6. The resistance of the base of a hemisphere, the base of a cone, and the base of a cylinder, are all different, though these bases be exactly equal and similar.

448. The experiments of Mr Vince were made with bodies at a considerable depth below the surface of water; and he determined the resistance which they experienced, both when they moved in the fluid at rest, and when they received the impulse of the moving fluid. In the experiments contained in the following table, the body moved in the fluid with a velocity of 0·66 feet in a second. The angles at which the planes struck the fluid are contained in the first column. The second column shows the resistance by experiment in the direction of their motion in Troy ounces. The third column exhibits the resistance by theory, the perpendicular distance being supposed the same as by experiment. The fourth column shows the power of the sine of the angle to which the resistance is proportional, and was computed in the following manner:—Let s be the sine of the angle, radius being 1, and r the resistance at that angle. Suppose r to vary as s^m, then we have

$r^m : s^m = 0{\cdot}2321 : r$; hence $s^m = \frac{r^{m+1}}{0{\cdot}2321}$, and therefore $m = \frac{\log. r - \log. 0{\cdot}2321}{\log. r - \log. s}$, and by substituting their corresponding values, instead of r and s we shall have the values of m or the numbers in the fourth column.

Resistance of a Plane Surface moving in a Fluid, and placed at different angles to the path of its motion.

Angle of inclination.	Resistance by experiment.	Resistance by theory.	Power of the sine of the angle to which the resistance is proportional.
Degrees.	Troy ounces.	Troy ounces.	Experiments.
10	0·0112	0·0012	1·73
30	0·0769	0·0290	1·54
50	0·1552	0·1043	1·51
70	0·2125	0·1926	1·42
90	0·2321	0·2321	...
1	2	3	4

449. According to the theory the resistance should vary as the cube of the sine, whereas from an angle of 90° it decreases in a less ratio, but not as any constant power, nor as any function of the sine and cosine. Hence the actual resistance always exceeds that which is deduced from theory, assuming the perpendicular resistance to be the same. The cause of this difference is partly owing to our theory neglecting that part of the force which after resolution acts parallel to the plane, but which, according to experiments, is really a part of the force which acts upon the plane.

450. Mr Vince made also a number of experiments on the resistance of hemispheres, globes, and cylinders, which moved with a velocity of 0·542 feet per second. He found that the resistance to the spherical side of a hemisphere was to the resistance on its base as 0·034 is to 0·08339; that the resistance of the flat side of a hemisphere was to the resistance of a cylinder of the same diameter, and moving with the same velocity, as 0·08339 is to 0·07998; and that the resistance to a complete globe is to the resistance of a cylinder of the same diameter, and with the same velocity, as 1 : 2·23.

When the plane was struck by the moving fluid, Dr Vince found that the resistance was one-fifth greater than when the plane moved in the fluid. In both these cases the actual effect on the plane must be the same, and therefore the difference in the resistance can arise only from the action of the fluid behind the body in the former case.

CHAPTER IV.—ON THE OSCILLATION OF FLUIDS, AND THE UNDULATION OF WAVES.

451. PROP. I.—The oscillations of water in a siphon, consisting of two vertical branches and a horizontal one, are isochronous, and have the same duration as the oscillations of a pendulum whose length is equal to half the length of the oscillating column of water.

Into the tube MNOP (fig. 74), having its internal diameter everywhere the same, introduce a quantity of water. When the water is in equilibrio, the two surfaces AB, CD will be in the same horizontal line AD. If this equilibrium be disturbed by making the siphon oscillate round the point y, the water will rise and fall alternately in the vertical branches after the siphon is at rest. Suppose the water to rise to EF in the branch MO, it will evidently fall to GH in the other branch, so that CG is equal to AE. Then it is evident, that the force which makes the water oscillate, is the weight of the column EFKL, which is double the column EABF; and that this force is to the whole weight of the water, as 2 AE is to AOPD. Now, let P (fig. 75) be a pendulum whose length is equal to half the length of the oscillating column AOPD, and which describes to the lowest point S arcs PS, equal to AE; then 2 AE : AOPD = AE : QP, because AE is one-half of 2 AE, and QP one-half of AOPD. Consequently, since AOPD is a constant quantity, the force which makes the water oscillate is always proportional to the space which it runs through, and its oscillations are therefore isochronous. The force which makes the pendulum describe the arc PS, is to the weight of the pendulum, as PS is to PQ, or as AE is to PQ, since AE = PS; but the force which makes the water oscillate, is to the weight of the whole water in the same ratio; consequently, since the pendulum P, and the column AOPD, are influenced by the very same force, their oscillations must be performed in the same time. Q. E. D.

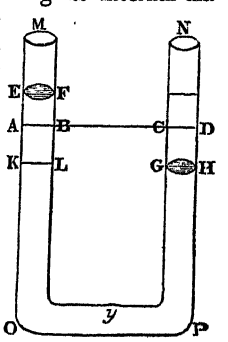


Fig. 74.

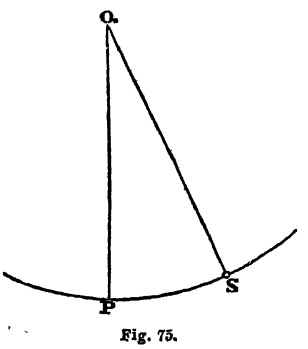


Fig. 75.

452. COR.—As the oscillations of water and of pendulums are regulated by the same laws, if the oscillating column of water is increased or diminished, the time in which the oscillations are performed will increase or diminish in the subduplicate ratio of the length of the pendulum.

453. PROP. II.—The undulations of waves are performed in the same time as the oscillations of a pendulum whose length is equal to the breadth of a wave, or to the distance between two neighbouring cavities or eminences.

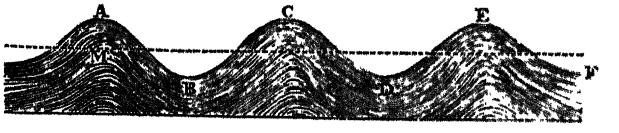


Fig. 76.

In the waves ABCDEF (fig. 76), the undulations are performed in such a manner, that the highest parts ACE become the lowest; and as the force which depresses the eminences A, C, E is always the weight of water contained in these eminences, it is obvious, that the undulations of waves are of the same kind as the undulations or oscillations of water in a siphon. It follows, therefore, from Prop. I., that if we take a pendulum, whose length is one-half BM, or half the distance between the highest and lowest parts of the wave, the highest parts of each wave will descend to the lowest parts during one oscillation of the pendulum, and in the time of another oscillation will again become the highest parts. The pendulum, therefore, will perform two oscillations in the time that each wave performs one undulation, that is, in the time that each wave describes the space AC or BD, between two neighbouring eminences or

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cavities, which is called *the breadth of the wave.* Now, if a pendulum whose length is one-half BM perform two oscillations in the above time, it will require a pendulum four times that length to perform only one oscillation in the same time, that is, a pendulum whose length is AC or BD, since $4 \times \frac{1}{2}$ BM = 2 BM = AC or BD. Q. E. D.

On Water-Wheels.

PART III.—ON HYDRAULIC MACHINERY.

454. To describe the various machines in which water is the impelling power, would be an endless and unprofitable task. Those machines which can be driven by wind, steam, and the force of men or horses, as well as they can be driven by water, do not properly belong to the science of hydraulics. By hydraulic machinery, therefore, we are to understand those various contrivances by which water can be employed as the impelling power of machinery; and those machines which are employed to raise water, or which could not operate without the assistance of that fluid.

455. A *Hydraulic Machine* will thus be one composed of a number of pieces, levers, or wheel-work, made up in such a way, that the movement impressed by water-power transmits itself from one part to another, and produces a certain result.

Hydraulic machines are of two kinds,—1*st*, Machines having a *motion of rotation;* and, 2*d*, Machines having an *alternate motion.* Under the first are comprehended *hydraulic wheels,* with *turbines* and *reacting machines;* and the second comprises *water-column machines,* and the *hydraulic ram.*

456. When a *mover,* as water, acts on a machine, it exercises on the part impinged on a pressure or effort: the immediate effect of this effort will be to make the part struck move in the direction of the power, or in some constrained direction; in either case space will be passed through by the part. Let a = the effect in lbs., and s = the space passed through, then $a \,.\, s$ = the sum of all the partial efforts developed by the machine, or the *quantity of action* developed by the mover in the operation; by some writers it is termed the *mechanical work,* or the *work done.*

Again, the *dynamical force,* or the *force* of a mover, will be the quantity of action developed in a unit or second of time; it will thus be the product of the *effort and velocity,* or, $a \,.\, s = a \,.\, v$, since in 1 second $s = v$.

457. Before, however, the force impressed on the palettes of a wheel can transmit its effect to the machinery to be set in motion, it experiences resistance from the pivots and from the air, friction from the teeth of wheels, and shocks of the teeth against the spindles. These resistances combined, make up a force which necessarily diminishes that originally derived from the mover. Hence, it is this diminished force that turns the machinery of a mill, and surmounts the resistance that the corn, for example, opposes to the grinding. The force necessary to overcome this resistance is named the *useful effect;* Montgolfier's definition of the same thing is—the *active force is that which pays itself.* There are, again, as it were inherent resistances connected with various pieces of the apparatus, which are called the *passive resistances* of the machine, the useful effect being taken for the active resistance surmounted. The total action of the passive resistances, together with the useful effect produced, make up the *dynamical effect.* It is clear, also, that the mechanical axiom, *what is gained in power is lost in time or velocity,* will hold good in hydraulics. Lastly, the *total effect produced is equal to the force impressed on the machine.*

CHAPTER I.—MACHINES HAVING A MOTION OF ROTATION.

WATER-WHEELS have either a vertical or horizontal axis, and named respectively *Horizontal* and *Vertical Wheels.* The following table is a classification of machines having a *motion of rotation:*—

- Wheels.
  - Vertical.
    - with palettes
      - plane, in a
        - course
          - rectilineal. *Undershot Wheels.*
          - circular.
        - indefinite fluid. *Suspended Wheels.*
      - curved. *Poncelet Wheels.*
    - with buckets receiving water
      - at the summit. *Overshot Wheels.*
      - under the summit. *Breast Wheels.*
  - Horizontal.
    - with palettes
      - struck by an isolated vein.
      - placed in a cylinder. *Tub or Spoon Mills.*
      - out of a cylinder. *Turbines of Fourneyron.*
    - with passages. *Burdin's Turbine.*
    - with reaction. *Segner's Wheel or Barker's Mill; Euler, &c.*

SECTION I.—VERTICAL WHEELS, AXIS HORIZONTAL.

(*a.*) *Undershot Wheels with plain Palettes.*

458. Wheels with plain palettes are very simple in their parts and also in their construction. They generally consist of a horizontal axis, an inner and outer circle, on the latter of which perpendicular palettes or flat boards are fixed, and radii unite the several parts to the horizontal axis. Such a wheel (fig. 77) is set in motion by water conveyed to it by a *course,* which may be rectilineal or circular. In the former case, there is a flood-gate close to the wheel, collecting a head of water which is distributed by the gate when a very little uplifted, so that the water may just strike the lower palettes, and not pass between their edge and the course. In the latter we may have a course curved like that in fig. 77. The fall in that figure answers the same purpose as the flood-gate a little uplifted.

When a flood-gate is used, it should be set as near the wheel as possible, in order that the water might lose none of its velocity from the resistance of the bottom or side-walls of the course. The opening of the flood-gate should be so disposed that the contraction of the water might be reduced to its least value; and the flood-gate itself should be inclined, which is the same thing as if the opening were brought nearer the wheel. It has been found that in a flood-gate inclined at an angle of 63° to the horizon, having 1 for base and 2 for height, the coefficient of contraction is 0·75; under an inclination of 45° the coefficient is 0·80, having 1 for base and 1 for height; and when the gate is vertical, in the same circumstances, it is about 0·70.

459. The course should be slightly inclined towards the wheel; its breadth should be determined by the volume of water which it is to convey; and the thickness of the fluid sheet escaping from under the flood-gate should never exceed 0·820 ft., nor be less than 0·492 ft. When it is smaller than this, so much water passes between the lower edge of the palettes and course, without producing any effect, thus diminishing the work of the water. The space between the walls of the course and the palettes should be from 0·032 ft. to 0·065 ft. The course should never be purely rectilineal; it should be somewhat inclined before reaching the flood-gate, where the water ought to strike the second palette at least from the vertical; then it must be concentrical with the exterior border of the palettes, and immediately after a palette has become vertical, the course should suddenly fall 3·93 inches at least; the water may then be conveyed away according to the locality. The

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breadth of the course before reaching the palettes is a little narrower than the breadth of the wheel, but now it widens, and just embraces the wheel.

460. The breadth of the palettes will depend on that of the course, and on the magnitude of the intervals; their height will be about three times the thickness of the sheet issuing from under the flood-gate, never exceeding 2·13 ft. The distance between one board and another, measured on the periphery of the wheel, is a little less than their height. The number of palette-boards will depend on the diameter or circumference of the wheel. The dynamical effect of the wheel is not dependent on the diameter; it takes account of the velocity of the boards, or rather on the number of turns that the wheel makes in a certain time, so that the useful effect may be communicated to the machinery set in motion. Let u be the velocity per second of the extremity of the boards, n the number of turns in one minute; then 1 turn will be effected in the nth part of 1 min., or the diameter will be expressed by $\frac{60 \cdot u}{\pi \cdot n} = 19{\cdot}1 \times \frac{u}{n}$. It has been found that, for a good effect, $u = 1{\cdot}7 \times \sqrt{H}$; and so the diameter of the wheel will be $\frac{32}{n} \times \sqrt{H}$, where H is the total fall of water. Generally, the diameter is never less than 13 ft., and never in excess of 26 ft.

With respect to the number of palettes, artificers generally adopt the rule, that—

Under a diameter of		13·1 ft.	the number	of boards is	28
...	...	16·4 ...	...	...	32
...	...	19·7 ...	...	...	36
...	...	23·0 ...	...	...	40

and so on. Four boards being added for every 3 feet of breadth to the diameter of the wheel.

461. It is not advantageous to have the palettes inclined to the direction of the radius, when the water is conveyed by a course, for Bossut found that when he inclined the boards at angles of 0°, 8°, 12°, and 16°, the effects were respectively as the numbers 1, 0·949, 0·956, 0·998. Inclined paddles are very useful when plunged in an indefinite fluid.

462. In order that such a wheel may be put in motion, the water leaves the opening under the flood-gate with a velocity due to the head pent up behind the flood-gate; this water impinging on the palettes with a considerable pressure, imparts a movement of rotation to the wheel. But this velocity depends on the resistance to be overcome, so that if the resistance be considerable, the velocity will be lessened. Again the pressure exercised by the water on the boards, is not the same when they are moving as when they are at rest, for the pressure is feebler in proportion as the wheel moves quicker. Hence, therefore, the wheel must take a particular velocity by overcoming a given resistance, that the pressure on the boards may correspond with this resistance. The wheel, however, may be made to take any velocity, by regulating the resistance which it has to overcome; but the amount of work given to the wheel by the water will not always be the same unless the wheel turn with a certain velocity. This velocity must be neither too great nor too small; it must be such that the work done by the wheel will exceed that which it would produce with any other velocity. Experiment has shown that this maximum work is attained when the velocity of the wheel, measured by its circumference, is 0·45 times that of the water on arriving at the palette boards. When the wheel has this velocity, it is found that the work done by it does not exceed 0·25 the work of the water, so that nearly 0·75 of this latter work is lost.

463. It is very important, for those especially who employ water-wheel power, to know the work which their wheels are capable of giving out. The general equation for this kind of wheel is the following:—Let a constant stream impinge perpendicularly on the boards of a water-wheel moving with a certain velocity, W being the weight of a current thrown on the paddle-board every second; V, and V″ the velocity of the water on striking and on leaving the board; and V′ that of the moving board; then the velocity lost will be V − V′, and the work lost by impact

$$= \frac{W}{2g}(V - V')^2;$$

and the work which the stream is capable of giving out

$$= \frac{W.V^2}{2g} - \frac{W}{2g}(V - V')^2 = \frac{W}{2g}\left\{V^2 - (V - V')^2\right\} =$$

$P + \frac{W.V''^2}{2g}$; which last = the useful work + the work remaining in the water after leaving the paddle.

464. In the case of this *Undershot wheel*, $P = \frac{W}{g}(V - V')V'$, for V′ only is variable and = V″; if V′ = 0, the wheel does no useful work, and so also when V = V′; also V′ can never exceed V. Thus the effect increases as the velocity of the wheel, starting from zero, increases, but only up to a certain point, for it evidently diminishes when it approaches V. Hence, there is a maximum effect between these two extremes, that is to say, (V − V′) V′ is to be a maximum;

$$\therefore V.dV' - 2V'.dV' = 0; \text{ or } V' = \tfrac{1}{2}.V;$$

or an undershot wheel produces its utmost effect when its velocity is one-half that of the current.

Borda first showed the truth of the above result; it has been fully confirmed by the experiments of Smeaton, Bossut, and others.

465. Many experiments have been made on undershot wheels. Smeaton has given the results which he obtained in the *Royal Society Trans.* for 1759. It is supposed that his model wheel was of too small dimensions to give very accurate results for practice. The value which Smeaton allowed for the velocity of the wheel, or V′, was V′ = 0·40 × V. Bossut reckoned it of the same value. More recent experiments, however, regard it as = 0·45 × V for the case of the maximum effect. The coefficient also for reducing the theoretical to the real effect may be taken as = 0·6. Smeaton's was 0·64. It is necessary, therefore, to multiply the expression $P = \frac{W}{g}(V - V')V'$ by m, the coefficient, to obtain the true result.

466. When an undershot wheel has a fall, the float-boards disposed on its circumference receive the impulse of the water conveyed to the lowest point of the wheel by an inclined canal. It is represented in fig. 77, where WW is the water-wheel, and ABDFHKMV the canal or mill-

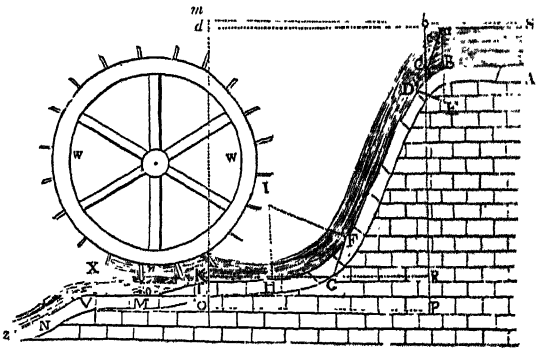


Fig. 77.

course, which conveys the water to K, where it strikes the plane float-boards *no*, &c., and makes the wheel revolve about its axis.

467. In order to construct the mill-course to the greatest advantage, we must give but a very small declivity to the canal which conducts the water from the river. It will

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be sufficient to make AB slope about one inch in 200 yards, making the declivity, however, about half an inch for the first 48 yards, in order that the water may have sufficient velocity to prevent it from falling back into the river. The inclination of the fall, represented by the angle GCR, should be 25° 50′, or CR, the radius, should be to GR, the tangent of this angle, as 100 to 48, or as 25 to 12; and since the surface of the water S*b* is bent from *ab* into *ac* before it is precipitated down the fall, it will be necessary to incurvate the upper part BCD of the course into BD, that the water in the bottom may move parallel to the water at the surface of the stream. For this purpose, take the points B, D, about 12 inches distance from C, and raise the perpendiculars BE, DE. The point of intersection E will be the centre from which the arc BD is to be described; the radius being about $10\frac{1}{10}$th inches. Now, in order that the water may act more advantageously upon the float-boards of the wheel WW, it must assume a horizontal direction, with the same velocity which it would have acquired when it came to the point G. But, if the water were allowed to fall from C to G, it would dash upon the horizontal part HG, and thus lose a great part of its velocity. It will be necessary, therefore, to make it move along FH, an arc of a circle to which DF and KH are tangents in the points F and H. For this purpose make GF and GH each equal to three feet; and raise the perpendiculars HI, FI, which will intersect one another in the point I, distant about 4 feet 9 inches from the points F and H, and the centre of the arc FH will be determined. The distance HK, through which the water runs before it acts upon the wheel, should not be less than 2 or 3 feet, in order that the different filaments of the fluid may have attained a horizontal direction. If HK were too large, the stream would suffer a diminution of velocity by its friction on the bottom of the course. That no water may escape between the bottom of the course KH and the extremities of the float-boards, KL should be about 3 inches, and the extremity *o* of the float-board *no* ought to reach below the line HKX, sufficient room being left between *o* and M for the play of the wheel; or KLM may be formed into the arc of a circle KM, concentric with the wheel. The line LMV, which has been called the course of impulsion, should be prolonged so as to support the water as long as it can act upon the float-boards, and should be about 9 inches distant from OP, a horizontal line passing through O the lowest point of the fall; for, if OL were much less than 9 inches, the water, having spent the greatest part of its force in impelling the float-board, would accumulate below the wheel, and retard its motion. For the same reason another course, which has been called the course of discharge, should be connected with LMV by the curve VN, to preserve the remaining velocity of the water, which would otherwise be discharged by falling perpendicularly from V to N. The course of discharge which is represented by the line VZ, sloping from the point O, should be about 16 yards long, having an inch of declivity for every 2 yards. The canal which reconducts the water from the course of discharge to the river should slope about 4 inches in the first 200 yards, 3 inches in the second 200 yards, decreasing gradually till it terminates in the river. But if the river to which the water is conveyed should, when swollen by the rains, force the water back upon the wheel, the canal must have a greater declivity to prevent this from taking place. Hence it is evident that very accurate levelling is requisite to the proper formation of the mill-course.

(β.) *Breast or Side Wheels, with plain Palettes.*

468. If we suppose that the wheel of fig. 77 is moved so far to the right, that the extreme edges of its boards, when turning round, will all but graze the circular part of the course, and if the walls of the passage box in the wheel so that no water will escape between the palette edges and the passage, or at the side walls, we shall have a *Breast* or *Side wheel*. These breast-wheels are divided into *High Breast* or *Low Breast*, according as they receive the water above or below their horizontal diameter. The breast-wheel, fig. 78, is driven partly by the impulse, but chiefly by the weight of the water. The water may be received on the palettes, as in fig. 77, or by means of a flood-

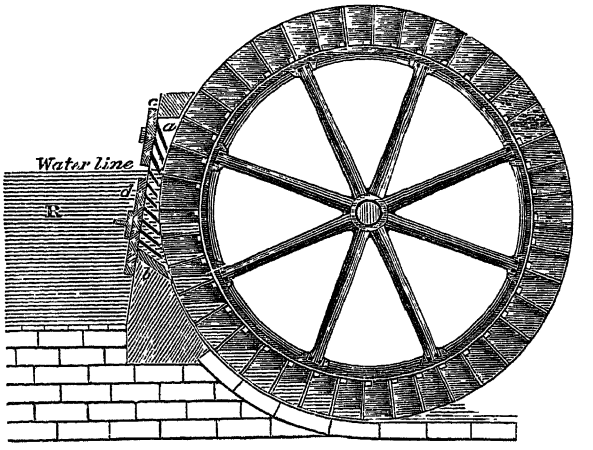


Fig. 78.

gate, or by means of a vertical passage communicating with a reservoir at a height above the wheel; in either case the water will be delivered on the plane-boards of the wheel.

In fig. 78 the water passes through an iron grating *ab*, and its admission is regulated by two shutters *c*, *d*, the lowest of which is adjusted till a sufficient volume of water passes over it; and the other shutter, *c*, is made to descend by machinery when the wheel is to be stopped, and the water retained in the reservoir R. When the water enters on any board, it is generally retained there till it arrives at the lowest part of the wheel, and is discharged into the course.

469. Mr Lambert, of the Academy of Sciences of Berlin, experimented on these wheels, and observes, that a breast-wheel should be used when the fall of water is above four feet high and below ten.[1] M. Morin has recently made experiments on this wheel, which may be seen in his *Expériences sur les Roues Hydrauliques*, &c. It appears from experiment that the diameter of these breast-wheels should vary from 16 to 23 ft. The number of palettes is found from art. 460, and generally they are a little inclined to the radius.

470. In determining the formula for wheels having a fall of water, we have to take into account the additional height that the water descends with the wheel, where, consequently, an additional amount of work will be performed. Let this amount of work be that due to the vertical space *h*, through which the water falls. Then, work applied to the wheel in one second $= \frac{W}{2g}\left\{V^2-(V-V')^2\right\} + Wh$ = the useful work P performed by the wheel + that due to the water on leaving the wheel. Let V″ be the velocity of the water on leaving the board; its effective work will be $\frac{W \cdot V''^2}{2g}$;

$$\therefore P+\frac{W \cdot V''^2}{2g}=\frac{W}{2g}\left\{V^2-(V-V')^2\right\}+W \cdot h;$$

$$\text{or, } P=W \cdot h+\frac{W}{2g}\left\{2VV'-V'^2-V''^2\right\};$$

[1] *Nouv. Mém. de l'Académie de Berlin*, 1775.

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which is the general equation for the effective work of a water-wheel when the water has a fall.

In the case, therefore, of the *Breast-wheel*, h is the vertical height of the fall where the water meets the paddle, and $V'' = V'$;

$$\therefore P = W\left\{h + \frac{1}{g}(V - V')V'\right\}.$$

The latter member is to be multiplied by the coefficient, which, according to M. Morin, is 0·74.

This wheel may be wrought very efficiently with velocities varying from $\frac{1}{3}$ V to $\frac{2}{3}$ V.

471. *Suspended wheels* are such as work in an indefinite course of water. The plane palettes are plunged in the current of a river, the force of which acting on the immersed boards, communicates a rotatory motion to the wheel. They are generally to be seen established on the sides of boats, or other supports properly fixed. The diameter of these wheels never exceeds 16 ft. The palette-boards may number 12, 18, or even with advantage 24; their height may be about the 4th part or more of the entire radius of the wheel, and the breadth from 8 to 16 ft.[1] From experiments on this kind of wheel, it appears that the velocity of the palettes, at the middle of their height, should be, for the greatest possible effect, 0·40 that of the water.

(γ.) *Undershot Wheels with curved Palettes—Poncelet Wheel.*

472. The undershot wheel already mentioned in art. 458 loses a considerable amount of the force impressed upon it by water, and so the useful effect is much reduced. It was of importance to have a wheel possessing the conveniences of the undershot wheel, but avoiding the loss of force which is always incident to the use of it. Such a wheel is the *Poncelet wheel*, devised by M. Poncelet in 1824. This wheel, represented in fig. 79, is an undershot wheel, but,

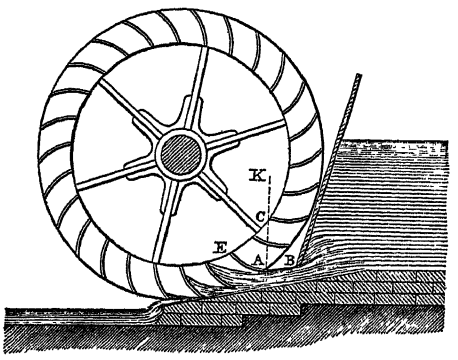


Fig. 79.

unlike that in fig. 78, has curved palettes; the curves are tangents to the exterior rim of the wheel; the lower element of curvature is horizontal, the upper vertical. It is with boards so disposed that the work transmitted by the water to the wheel exceeds that given out by plain boards.

473. The course, till arriving at the lowest part of the wheel, is here inclined at about 1 in 10, so that the water might regain the velocity which it lost by the friction of the sides and bottom of the course: the inclination may be lessened, when the sheet of water is considerable that issues from under the flood-gate. The course also is uniform, and where it embraces the wheel is a little narrower than its breadth. In order that the wheel may work in a course narrower than itself, the lower parts of the upright sides of the course are hollowed out, so that the projecting curved boards of the wheel might work in them. At the lowest part of the wheel the course is suddenly depressed, in order that the back-water might not affect the working of the machine. With respect to the head of water pent up behind the flood-gate, the latter is very much inclined, so that the sheet of escaping water might just issue without losing any of its velocity by the resistance of the course.

On Water-Wheels.

474. If we suppose that water is admitted by the opening on the curved boards, it will take a velocity, say V, and enter horizontally on the lower element of the curve. The water now glides along this curve, rises, and gradually, by the action of gravity, loses its velocity of entering, till, at the highest part of its course, V is lost altogether, that is, when it has attained a height $= \frac{V^2}{2g} = 0{\cdot}051 \text{ met.} \times V^2$. The water now begins to fall down the curve, and, acquiring an increased velocity as it reaches the horizontal or lowest part of the curve, quits the palette with the same velocity as it entered upon it. Let the uniform velocity of the perimeter of the wheel be V′, then $V - V'$ is the relative velocity with which the water rises through the length of the curve, and $\left(\frac{V - V'}{2g}\right)^2 = 0{\cdot}051 \text{ met.} \times (V - V')^2$ = the height to which it will rise on the curve; and at last, on quitting the horizontal part of the board, will have a velocity $= V - V'$. But the lower part of the curve works with a velocity V′ in the opposite direction; $\therefore V - V' - V' = V - 2V' =$ the absolute velocity of the water as it leaves the wheel. If we wish to have a maximum effect, $V - 2V' = 0$, or $V' = \frac{1}{2}V$; that is to say, were the wheel to take one-half the velocity of the current on its arrival at the board, the absolute velocity of the water on quitting the boards would be nothing.

Wherefore we have a current *mover*, experiencing neither shock nor loss of velocity at the moment of its entering on the wheel, and which possesses none at the moment of leaving it; the current then spends its whole motion, and communicates its whole force to the wheel. These two conditions suffice to produce the greatest possible effect. For this let W be the weight of fluid furnished by the current in 1 second, and h = height due to velocity, the effect will be expressed by Wh. This is true for a single fillet, but not for a sheet of water of a definite thickness; for the molecules strike the boards at an angle more or less great with respect to the parts struck, and consequently there is a loss of force and velocity. This mass of water, when it quits the boards, does not move exactly in a direction opposite to the boards; and again, since so much water is lost by every course, without producing any effect, the real effect will be something less than Wh.

475. M. Poncelet, in his *Mémoire sur les Roues Hydrauliques Verticales a Aubes Courbes*, mentions all the experiments which he made on this wheel. The practical results which Poncelet deduced from these experiments are—*1st.* That the velocity of the wheel which gives a maximum effect is 0·55 of the velocity of the current; it may vary from 0·50 to 0·60. *2d.* That the dynamical effect is not under 0·75 × Wh for small falls with large openings at the bottom of the flood-gate, and 0·65 for small openings and deep falls. *3d.* That this same effect, compared with the full force of the mover, is 0·60; and for small openings it will reach 0·50.

476. For the case which generally occurs in practice, when properly arranged wheels have a velocity not differing much from 0·55 that of the current, we may take the dynamical effect = 0·75 × Wh, and also = 0·60 × WH, the passive resistances being taken into account. H is the total fall of water.

With an opening under the flood-gate of from 0·100

[1] *Essai sur la Construction des Roues Hydrauliques*, etc., par M. Fabre.

On Water-Wheels.

met. to 0·304 met., h will vary from 1·43 to 1·26 met., and H from 1·59 met. to 1·52 met.; and the weight of water W, furnished by the current in 1 second, would be, for the first opening 279 kilogr., and for the second 809 kilogr. The coefficient which multiplies the quantity Wh, is fully double that obtained from wheels with plain palettes, which is sufficient to make us dispense with plain palette-wheels, and substitute for them wheels with curved palettes.

477. In the construction of these wheels with curved palettes—1*st*. The number of palettes will be double that required in wheels with plain palettes. 2*d*. Their height, in the direction of the radius, or the distance between the inner and outer circumference of the wheel, must be in excess of a fourth of the effective fall: if the fall be 1·40 met. it will be a third of this; for falls under this last it will be a half. 3*d*. The lower element of the curve, which makes an angle nothing, or nearly so, with the outer circumference, will, when the sheet of water is extremely thin, make an angle with it of 24°, 30°, and generally greater as the thickness of the moving sheet increases. The curves may be thus obtained:—From point A (fig. 79), where the fluid sheet BA meets the outer circumference, raise a vertical AK, and from point C, where it cuts the inner circumference, describe, from centre C, with radius CA, an arc AE; and so on for all the others. And 4*th*, Immediately under the vertical diameter, the bottom of the course must be suddenly lowered, so that the back-water might not interrupt the working of the wheel.

478. The work done then by the water entering on the Poncelet wheel = work done on the wheel + that done by the water on leaving the paddle, or $\frac{W.V^2}{2g} = P + \frac{W}{2g}(V-2V')^2$.

$$\therefore P = \frac{2W}{g}(V-V')V';$$

and we have seen that the work done by this wheel is nearly double that performed by the undershot wheel with plain palettes; the value of P being as in art. 470.

(δ.) *Overshot Wheels, or Bucket Wheels.*

479. An overshot or bucket wheel is so disposed, that the water, as the motive power, is received on its upper part; it is represented in fig. 80, where ABC is the circumference

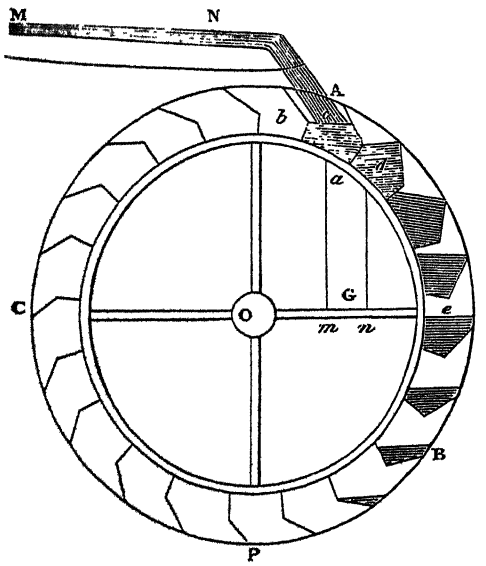


Fig. 80.

of the wheel furnished with a number of buckets. The canal MN conveys the water into the second bucket from the top Aa. The equilibrium of the wheel is therefore destroyed; and the power of the bucket Aa to turn the wheel round its centre of motion O, is the same as if the weight of the water in the bucket were suspended at m, the extremity of the lever Om; c being the centre of gravity of the bucket, and Om a perpendicular let fall from the fulcrum O to the direction cm, in which the force is exerted. In consequence of this destruction of equilibrium, the wheel will move round in the direction AB, the bucket Aa will be at d, and the empty bucket b will take the place of Aa, and receive water from the spout N. The force acting on the wheel is now the water in the bucket d, acting with a lever nO, and the water in the bucket Aa acting with a lever mO. The velocity of the wheel will therefore increase with the number of loaded buckets, and with their distance from the vertex of the wheel; for the lever by which they tend to turn the wheel about its axis increases as the buckets approach to e, where their power, represented by eO, is a maximum. After the buckets have passed e, the lever by which they act gradually diminishes, they lose by degrees a small portion of their water; and as soon as they reach P, it is completely discharged. When the wheel begins to move, its velocity will increase rapidly till the quadrant of buckets be is completely filled. While these buckets are descending through the inferior quadrant eP, and the buckets on the left hand of b are receiving water from the spout, the velocity of the wheel will still increase; but the increments of velocity will be smaller and smaller, since the levers by which the inferior buckets act are gradually diminishing. As soon as the highest bucket Ac has reached the point B, where it is emptied, nearly the whole semi-circumference of the wheel is loaded with water; and when the bucket at B is discharging its contents, the bucket at A is filling, so that the load in the buckets, by which the wheel is impelled, will be always the same, and the velocity of the wheel will become uniform.

480. In order to determine the best form of the buckets, we must consider that the power of the wheel would be a maximum if the whole of its semi-circumference were loaded with water. This effect would be obtained if the buckets had the shape shown in fig. 81, where ABC is the form of the bucket, AB being a continuation of the radius, and BC part of the circumference of the wheel, and nearly equal to AD. But as a small aperture at CE will neither admit nor discharge the water, the form shown in fig. 82 has been proposed by Sir David Brewster as the best. In this construction,

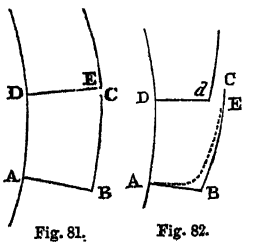


Fig. 81. Fig. 82.

BC is made a little larger than BE, and AB is diminished so as to make the angle ABC a little greater than 90°. The angles at B should be rounded off, so as to make ABC a curve, as indicated by the dotted line. The aperture at dE must be sufficient for the introduction and discharge of the water, and the side BE of the bucket should be as smooth and even as possible.

481. The distance of one bucket from another is about one foot. But the wheel is sometimes divided into four parts, and a whole number of buckets placed in each, so that the number of buckets will be proportional to the diameter. In forming the buckets, the space dE, fig. 82, must evidently be a little wider than the fluid sheet, so that the proper volume of water may be admitted. The angle also which the side AB makes with BE, is from 110° to 118°, according as the wheels are from about 13 to 39 feet in diameter; the angle then which BE makes with the circumference, is about 31°; it should never exceed 33°. The depth of the bucket is DE, where E is a point

On Water-Wheels.

of the circumference, fig. 81. AB is frequently taken as a third of DE, sometimes as a half. The buckets may receive water either by the method shown in fig. 80; or the water. without fall of any kind, may come in the opposite direction by a canal closed up at the end next the wheel, where one or two openings in the bottom of the course admit the water into the buckets. This principle is in very general use in Great Britain.

482. The breadth of the bucket is determined by the volume of water which it receives and carries. Let Q be the volume issuing in one second from the reservoir by which MN is supplied. V' the velocity of the circumference, d the distance, reckoned along AB (fig. 80), of one bucket from another; then in one second a number of buckets $=\frac{V'}{d}$ will pass before the mouth of MN, and each will carry away a volume = Q divided by $\frac{V'}{d}=\frac{Qd}{V'}$. Now, in order to be effective, the bucket must not only carry this, but a volume three times greater. Let l= the breadth of a bucket, s= the transverse section, then the capacity of the bucket or volume of water contained $=sl$. Now, let m be the number of buckets on the wheel, and n the revolutions of the wheel in one minute, or 60 seconds; then as the volume sl of water must be $=3Q\frac{d}{V'}=180\frac{Q}{m.n}$; for $m.d$=circumference, and $60.V'=n\times$ circumference;

$$\therefore sl=180.\frac{Q}{m.n};\text{ or } l=180.\frac{Q}{m.n.s}=$$

breadth of wheel given by the work. The volume Q is that which the wheel spends so as to produce its whole effect.

483. In the work performed by an overshot wheel, the mean vertical height h is nearly equal to the diameter of the wheel, and also $V''=V'$, for the velocity of the water on leaving the paddle is the same as that of the paddle.

$$\therefore P=Wh+\frac{W}{2g}\left\{2VV'-V'^2-V'^2\right\}$$
$$=W\left\{h+\frac{1}{g}(V-V')V'\right\}.$$

The latter member is to be multiplied by its coefficient.

484. Smeaton, in 1759, experimented on overshot wheels, and the principal results of his observations are—1*st*. That, relative to the effect produced, the fall should be divided into two parts; one equal to the diameter, the other a little above it. 2*d*. Since the action of the upper part of the fall is feeble, Smeaton sought a relation between the effect and the lower part of the fall; this was constantly 0·80 × W × diameter. 3*d*. When the fall exceeded the diameter by only a small quantity, he had 0·72 × W × total fall. And, 4*th*. That the velocity of a bucket-wheel should range from 3 feet to 6 feet per sec. In these observations he was guided mainly by the old principle, that a bucket-wheel gives most effect when it turns slowly, as was shown in the experiments of Deparcieux. Smeaton also concluded, from a series of experiments, that the higher the wheel is in proportion to the whole descent, the greater will be the effect.

Among other philosophers who have experimented on overshot wheels, we may mention the Chevalier D'Arcy, who showed that the less the velocity the greater is the effect produced; Borda, who showed that the maximum effect will be produced when the diameter equals the height of fall; and Bossut, Albert Euler, Lambert, Poncelet. Smeaton also showed, that when the work performed was a maximum, the ratio of the power to the effect was as four to three, when the height of the fall and the quantities of water expended were the least; but that it was as four to two, when the height of the fall and the quantities discharged were the greatest. By taking a mean between these ratios, we may conclude, in general, that in overshot wheels the power is to the effect as three to two. In this case the power is supposed to be computed from the whole height of the fall; because the water must be raised to that height in order to be in a condition of producing the same effect a second time. When the power of the water is estimated only from the height of the wheel, the ratio of the power to the effect was more constant, being nearly as five to four. According to Smeaton, the effect of a wheel driven in this manner is equal to the effect of an undershot wheel (458), whose head of water is equal to the difference of level between the surface of water in the reservoir, and the point where it strikes the wheel, added to that of an overshot (479), whose height is equal to the difference of level between the point where it strikes the wheel and the level of the tail water.

On Water-Wheels.

485. We have hitherto supposed the float-boards, though inclined to the radius, to be perpendicular to the plane of the wheel. Undershot wheels, however, have sometimes been constructed with float-boards inclined to the plane of the wheel. A wheel of this kind is represented in fig. 83, where AB is the wheel, and C, D, E, F, G, H, the oblique float-boards. The horizontal current MN is delivered on the float-boards, so as to strike them perpendicularly. On account of the size of the float-boards, every filament of the water contributes to turn the wheel; and therefore its effect will be greater than in undershot wheels of the common form. Albert Euler imagines that the effect will be twice as great, and observes, that in order to produce such an

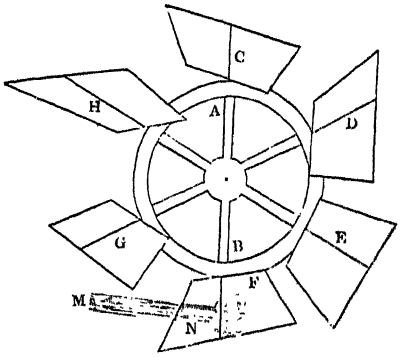


Fig. 83.

effect, the velocity of the centre of impression should be to the velocity of the water, as radius is to triple the sine of the angle by which the float-boards are inclined to the plane of the wheel. If this inclination, therefore, be 60°, the velocity of the wheel at the centre of impression ought to be to the velocity of the impelling fluid as 1 to $\frac{3\sqrt{3}}{2}$, that is, as 5 to 13 nearly, because $\sin 60°=\frac{\sqrt{3}}{2}$. When the inclination is 30°, the ratio of the velocities will be found to be as 2 to 3.

SECTION II.—HORIZONTAL WHEELS, AXIS VERTICAL.

(a.) *Wheels receiving an isolated Vein.*

486. Horizontal water-wheels have been much used on the Continent, and are strongly recommended to our notice by the simplicity of their construction. In fig. 84, AB is the large water-wheel which moves horizontally upon its

Horizontal Wheels.

arbor CD. This arbor passes through the immoveable mill-stone EF at D, and being fixed to the upper one GH, carries it once round for every revolution of the great wheel. The mill-course is constructed in the same manner for horizontal as for vertical wheels; it must be circular and concentric with the rim of the wheel, sufficient room being left between it and the tips of the float-boards for the play of the wheel. In this construction, where the water moves in a horizontal direction before it strikes the wheel, the float-boards should be inclined about 25° to the plane of the wheel, and the same number of degrees to the radius, so that the lowest and outermost sides of the float-boards may be farthest up the stream.

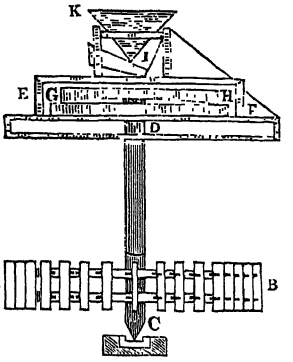


Fig. 84.

(β.) *Tub or Spoon Wheels.*

487. In many parts of the south of France, wheels are to be seen working in a cylindrical tub or hole of small depth, or into a conical hollow. Fig. 85 will show the nature of one of these wheels. It is constructed in the form of an inverted cone AB, with spiral palettes on its surface. The

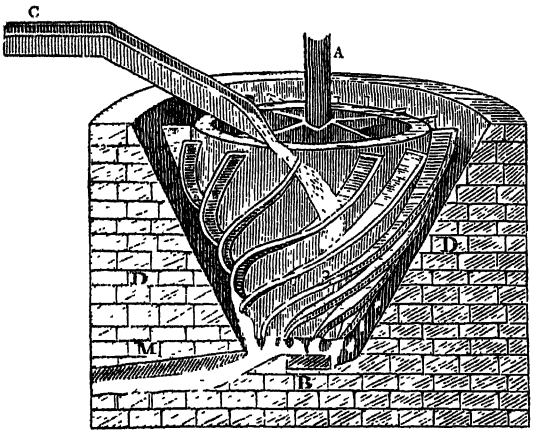


Fig. 85.

wheel moves on a vertical axis AB, and is driven chiefly by the impulse of water conveyed by the canal C, and falling obliquely on the float-boards at the place of impact: the spent water is carried away by the channel M in the solid walls D, D. But in the best constructed cylindrical tub-wheels the water issues from a canal in the walls, in a direction tangential to the circumference. In thus impinging on the float-boards, it preserves its gyratory motion, and makes the wheel whirl round. The useful effect of these wheels is never above 0·25 of the work given by the water.

Spoon-wheels are so named because their narrow, yet long, radial curved palettes, have a shape like a spoon.

(γ.) *Turbine of M. Fourneyron.*

488. Within the last 30 years wheels with vertical axes have been so much improved, that now they rank among the most perfect hydraulic machines which exist. They are termed *Turbines*, and were invented in 1827 by a young French mechanician named Fourneyron. During that year, Fourneyron erected one a few inches in diameter, of six horse-power, in Franche-Compté. To the surprise of all, when the machine was put in action, the effective work produced was 0·80 that of the water. The surprise was not diminished when it was found that the new wheel worked as well under as above water. Since their invention, turbines have been extensively adopted, especially in France and Germany.

Horizontal Wheels.

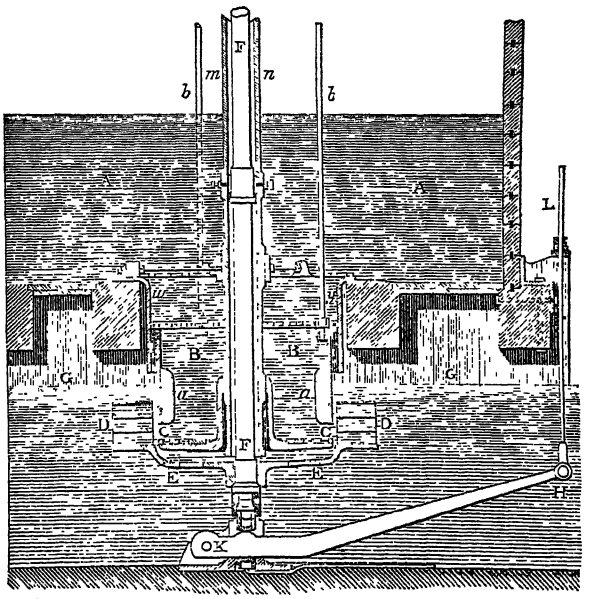


Fig. 86.

489. A turbine consists of three principal parts; the turbine proper DD (fig. 86), with its axis FF; the cylinder *w*CC*y*, with its bottom CC and the apparatus *mn* which carries it; and the cylindrical flood-gate *aa*. The whole apparatus is made of metal.

Turbines are of two kinds —those which work below, and those which work above, the surface of the water.

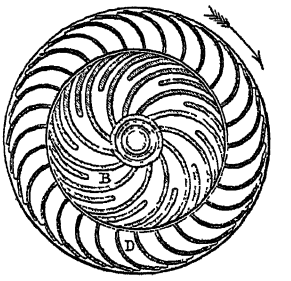


Fig. 87.

490. With respect to the first kind, or those immersed in water, in fig. 86 we have AA the upper or supplying canal, the water from which enters freely the cylinder BB, and finding no way of escape save by the circular lateral opening CC, issues by it and precipitates itself in every direction in a sheet upon the palette boards of the circular wheel DD. It thus puts the wheel in motion, and then loses itself in the lower water-course. The wheel DD is annular, and disposed horizontally all round the opening CC, such that the fluid sheet might impinge upon it. We shall have a proper idea of the disposition of the wheel DD if the Poncelet wheel, instead of working vertically, work horizontally; we have a section of it, however, in fig. 87. A kind of metal cap EE, binds the wheel to the central revolving axis FF, passing freely through a pipe in the middle of the cylinder. The wheel DD is in the present case wholly immersed in the lower water-course, the level of which is GG. The axial beam FF of the machine is terminated at its lower part by a pivot resting on a point of a lever HK, of which the fulcrum is K. A rod L is jointed to H the extremity of the lever, and the end of that rod works into a nut; on turning the nut, we may raise or lower at pleasure the axial beam, and therefore also the wheel which it carries, so that the latter may be brought exactly in opposition to the circular opening of the cylinder in order to receive the due supply of water.

Horizontal Wheels.

Although the wheel is immersed in the lower water-course, yet this does not prevent the water of the higher course, *i.e.*, of the cylinder, from passing through the opening CC, and acting on the boards of the wheel, the flow being due to the difference of the levels of the two water-courses. Again, there must be some arrangement within the cylindrical reservoir, so that the water which flows in may flow out in a uniform equable sheet; if this were not attended to, the escape would take place at different points, and would therefore be irregular; and, further, the water would not strike the boards of the wheel in the most effective manner. In order, therefore, to obviate this irregularity of the flow, M. Fourneyron disposed within the cylinder curved upright partitions B, as in fig. 87, which is the projection of the interior of the cylinder on its bottom; at a small distance from this, and disconnected with it, is the working wheel D, with its curved boards disposed opposite to the curved partitions of B. The water enters and fills the chambers of B, and the consequence is, that the water, on issuing from the reservoir, moves everywhere obliquely to the surface of the same, encounters the boards of the wheel which offer an opposition to its motion, and exercises on the palettes, pressures which tend to turn the wheel in the direction of the arrow. Within the reservoir is a cylindrical flood-gate *aa* (fig. 86), which serves to widen or narrow the circular opening CC. This is done by raising or lowering the vertical rods *b, b*, their upper parts working into nuts which may be turned at pleasure. The flood-gate *aa* is of considerable thickness, and round, so as to widen the orifice of escape.

It would appear that the curved boards of the wheels presenting their surfaces nearly perpendicularly to the issuing water, ought to receive a shock from part of the liquid, but this entirely disappears when the wheel is moving in a proper manner. It must be observed, however, that these boards moving round a centre, are differently circumstanced than if they had been at rest. Whenever the water issues out of the reservoir it strikes on the boards, but no sooner does this take place than the wheel flies before the water; the palette boards are only acted upon in virtue of the relative velocity which the water possesses with respect to the boards. Now the boards are so disposed, that when the turbine assumes the velocity that it ought to take, the relative velocity of the water with respect to the wheel is directed tangentially to its inner edge; the result is that the water enters on the wheel without producing any shock. The water moves along the whole length of the wheel boards, entering at the inner and passing out by the exterior part of the board, and exercising a pressure at every point, whereby the velocity is constantly changing its direction. The water also, on leaving the wheel, leaves it with a relative velocity, and moves in a direction contrary to that of the boards. It is possible, then, that the turbine may be made to have a motion such that the velocity of the exterior circumference may be precisely the same as the relative velocity of the water. If this condition be fulfilled, the water, on its leaving the wheel, will only be animated by an insensible motion, and will thus become associated with that in the midst of which the wheel is plunged: the water will thus be deposited, so to speak, without velocity from the boards, which fly away without being retarded.

We see also that the water, acting at the same time on all the boards of the wheel, produces on these, horizontal pressures which tend in no ways to throw the axis of the wheel to one side or another; the consequence of which will be that the pressures cause no friction of the beam on its pivot, nor on the bodies which touch it at different parts of its height, and which tend to keep it in an exact vertical position. These conditions, which no wheel with axis horizontal can fulfil, enables the turbine to give results far more valuable than those of Poncelet's wheel.

Horizontal Wheels.

From the various experiments which have been made on turbines, the greatest amount of work done equals 0·75, and in some cases 0·85 of that expended by the water.

491. The Fourneyron turbine has several advantages of the most valuable kind. It may work when immersed, as we have seen, in the middle of the lower course, and thus disposed, it operates during the time of floods as well as when the water is very low, for otherwise it would be disturbed by the greater or lesser height of the level of the water in the lower course: the total height of fall is also rendered useful, which could not be the case were the wheel to be placed above the level of the lower water-course; and that the machine can work during hard frost, since the water seldom freezes in a rapid running stream. Another advantage which this machine has, consists in this, that we may make its velocity vary within sufficiently extensive limits, by means of the velocity which corresponds to the maximum effect, without which the ratio of work done to the work which the quantity of water expended represents, would diminish very much. This result is of great importance for the case in which a turbine ought to move with a uniform velocity, and where the height of the falling water varies. But the velocity of a turbine which corresponds to the maximum effect, depends on the height of the fall; it augments or diminishes according to this height. If a turbine move always with the same velocity under different heights of fall, it will not have a constant velocity capable of producing the maximum effect. It is then a very important matter that the machine, acting with a velocity different from the particular velocity, should furnish results nearly equal to the maximum effect.

The turbine may be adapted for all sorts of fall, provided that we adapt it to the quantity of water, more or less great, which ought to act upon it, and to the rapidity of motion which it ought to take. We have an idea of the value of a properly constructed turbine, when one erected in 1837 by M. Fourneyron, at St Blaise, in the Black Forest of Baden, moved by a column of water 172 feet, did work equivalent to 56 horse-power, and gave a useful effect of between 0·70 and 0·75 of that of the water; the wheel, together with the cylinder, which is 20 inches in diameter, weighed only 105 lbs. Another at the same place has a fall of 354 feet; the diameter of the wheel is 13 inches; it expends a volume nearly of 1 cubic foot per second, and makes from 2200 to 2300 revolutions per minute; its useful effect is from 80 to 85 per cent. of the work derived by the water. This machine sets in motion 8000 water spindles, with roving, carding engines, cleansers, &c. A turbine erected at Gisors, under a fall of 3·7 feet, utilized 0·75 the work of the fall. When the fall was 2 feet, the useful work was 66 per cent. of the fall, and when the fall was 1·11 feet, it was 60 per cent.

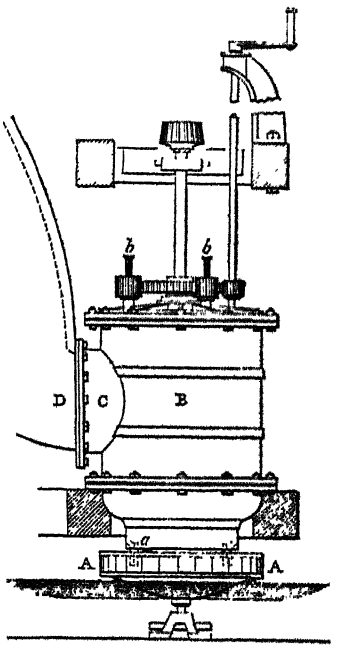


Fig. 88.

492. The second kind of turbines, or those which work out of the water, is represented in fig. 88, where B is the entire cylinder; C is that part of it which joins on to the supplying pipe D, conveying the water from an ele-

Horizontal Wheels.

vated reservoir or canal; AA is the turbine or wheel; *a*, is the circular flood-gate, which may be lowered or elevated by the rods *b*, *b*.

493. With all the advantages, however, which the Fourneyron turbine has, there is one thing which causes so much loss of work in the machine; the sheet of water issuing from the circular opening at the lower side of the reservoir, has a thickness more or less great, according to the contraction of the flood-gate; on this account the water does not always fill the wheel in its whole height. The upper part of the space comprised between the boards of the wheel is not, however, empty; but the water there does not possess the same velocity as that issuing from the reservoir; this occasions eddies, accompanied by a loss of velocity, which must therefore produce a diminution of useful effect. It was to remedy this waste that Fourneyron divided his wheel into several compartments, by means of horizontal partitions. But these partitions do not recover the whole, though a part, of the loss to the machine.

M. Callon endeavoured, by the following method, to restore the full effect of the machine. To this end he substituted for the single circular flood-gate within the reservoir of Fourneyron, a considerable number of partial flood-gates, all touching each other, and placed around the inside of the cylinder, several being open that the water might issue upon the wheel. By this means, the quantity of water flowing from the reservoir may be diminished without diminishing the thickness of the sheet; those of the flood-gates which are open and shut being uniformly distributed around the circumference. The disadvantage of Fourneyron's turbine is thus removed, but another is originated in the fact, that the different portions of the wheel are carried round successively before the open and before the shut flood-gates. At the time when the interval of two boards comes opposite a shut gate, the water which is there contained, and which has a considerable velocity, will only continue to move on producing a void behind it, which will necessarily occasion a sharp diminution in its velocity, and, therefore, also will entail a loss of work.

494. *Fontaine's turbine* differs from that of Fourneyron's in having the circular opening not in the side near the bottom, as in the latter, but in the bottom of the cylinder itself, with the wheel right under the same. The circular opening is not wholly open, but it consists of a considerable number of distinct orifices, each of which is furnished with a special flood-gate, by the aid of which the orifice may be more or less shut. This disposition of the machine does away in great part with the loss which takes place in Fourneyron's turbine.

495. The turbines which have been mentioned hitherto are difficult to repair, both when immersed, and when at a small distance above the lower water-course. The method of doing so is by raising a strong temporary barricade around the turbine, and pumping the water out so as to isolate it, the cylinder remaining full, while the flood-gate is firmly secured to prevent escape. But this method is inconvenient. A turbine, therefore, was invented by M. Jonval, and constructed and improved by M. Kœchlin for the special purpose of remedying this inconvenience. Kœchlin's turbine is somewhat peculiar. Let us suppose a hollow vertical cylinder open at both ends, and the upper and lower water-courses communicating with each other by means of this cylinder; the water which passes through this cylinder may be rendered useful by placing a turbine wheel within it, and at any part of its height; provided only that the water, on leaving the wheel, and traversing afterwards that portion of the cylinder lying between the bottom of the wheel and the surface of the lower water-course, is not in direct contact with the atmosphere till it arrives at the surface of the lower water-course. Now, it is clear that if the turbine be placed too high in the cylinder, the difference of level between the upper course and the wheel will be small, and so much force will be lost; but to make up for the loss, a gain is effected by the *drawing* or *sucking*, which takes place in the lower part of the cylinder under the wheel; this drawing effect being, very curiously, greatest when the wheel is highest above the surface of the lower water-course. We see, then, that the position which the machine now has, allows a workman to enter the cylinder from below, and repair the wheel.

Horizontal Wheels.

For an account of the best observations and experiments on the turbine, see Morin's *Expériences sur les Roues Hydrauliques Appelées Turbines*, 1838; *Comptes Rendus*, for July 1838; and the Notice on *Vortex Water-Wheels* in the *British Association Reports* for 1852.

(δ.) *Wheels with Passages.*

496. Under wheels of this kind we may mention the *Danaide* of M. Manouri d'Ectot. The principal piece of this machine is a tun or small tub of white iron, having a hole pierced in its bottom, through which passes the axis of rotation, and by which the water escapes. The axis turns with the trough upon a pivot, and is fixed above to a collar.

A drum of tin plate, closed above and below, is fixed upon the axis of, and placed within the trough, so as to be concentric with it, and to leave only between the outer circumference of the drum and the inner circumference of the trough, an annular space not exceeding $1\frac{1}{2}$ inches. This annular space communicates with a space less than $1\frac{1}{2}$ inches, left between the bottom of the drum and the bottom of the trough, and divided into compartments by diaphragms fixed upon the bottom of the trough, and proceeding from the circumference to the central hole in the bottom of the trough.

The water comes from a reservoir above by one or two pipes, and makes its way into this annular space between the trough and drum. The bottom of these pipes corresponds with the level of the water in the trough, and they are directed horizontally, and as tangents to the mean circumference between that of the trough and of the drum. The velocity which the water has acquired by its fall along these pipes, makes the machine move round its axis, and this motion accelerates by degrees, till the velocity of the water in the space between the trough and drum equals that of the water from the reservoir; so that no sensible shock is perceived of the affluent water upon that which is contained in the machine.

This circular motion communicates to the water between the trough and drum a centrifugal force, in consequence of which it presses against the sides of the trough. This centrifugal force acts equally upon the water contained in the compartments at the bottom of the trough, but it acts less and less as this water approaches the centre.

The whole water, then, is animated by two opposite forces, viz., gravity, and the centrifugal force. The first tends to make the water run out at the hole at the bottom of the trough; the second, to drive the water from that hole.

To these two forces are joined a third, viz., *friction*, which acts here an important and singular part, as it promotes the efficacy of the machine, while in other machines it always diminishes that efficacy. Here, on the contrary, the effect would be nothing were it not for the friction, which acts as a tangent to the sides of the trough and drum.

By the combination of these three forces, there ought to result a more or less rapid flow from the hole at the bottom of the trough; and the less force the water has as it issues out, the more it will have employed in moving the machine, and of course in producing the useful effect for which it is destined.

Horizontal Wheels.

The moving power is the weight of the water running in multiplied by the height of the reservoir from which it flows above the bottom of the trough; and the useful effect is the same product diminished by half the force which the water retains when it issues out of the orifice below.

In order to ascertain, by direct experiment, the magnitude of this effect, MM. Prony and Carnot fixed a cord to the axis of the machine, which passing over a pulley, raised a weight by the motion of the machine. By this means, the effect was found to be $\frac{7}{10}$ths of the power, and often approached $\frac{75}{100}$ths without reckoning the friction of the pulleys, which has nothing to do with the machine. This effect exceeds that of the best overshot wheels. See the *Report of the Institute*, 23d August 1813; or Thomson's *Annals of Philosophy*, vol. ii., p. 412.

M. Burdin, in 1833, invented a *Danaide* with axis vertical, which may be seen described in the *Annales des Mines* for 1836. D'Ectot's may be seen in the *Journal des Mines*, tom. 34.

(ε.) *Reacting Machines, or Wheels of Recoil.*

497. We have hitherto considered the mechanical effects of water as the impelling power of machinery, when it acts either by its impulse or by its gravity. The reaction of water may be employed to communicate motion to machinery; and it is believed that a given quantity of water, falling through a given height, will produce greater effects by its reaction than by its impulse or its weight.

Barker's Mill, or the Wheel of Recoil.

498. This machine, which is sometimes called Parent's mill, is represented in fig. 89, where MN is the canal that conveys the water into the upright tube TT, which communicates with the horizontal arm AB. The water will therefore descend through the upright tube into this arm, and will exert upon the inside of it a pressure proportioned to the height of the fall. But if two orifices, A and B, be perforated at the extremities of the arm, and on contrary sides, the pressure upon these orifices will be removed by the efflux of the water, and the unbalanced pressure upon the opposite sides of the arm will make the tube and the horizontal arm revolve upon the spindle D as an axis. This will be more easily understood, if we suppose the orifices to be shut up, and consider the pressure upon a circular inch of the arm opposite to the orifice, the orifice being of the same size. The pressure upon this circular inch will be equal to a cylinder of water whose base is one inch in diameter, and whose altitude is the height of the fall; and the same force is exerted upon the shut-up orifice. These two pressures, therefore, being equal and opposite, the arm A will remain at rest. But as soon as the orifice is opened, the water will issue with a velocity due to the height of the fall; the pressure upon the orifice will of consequence be removed; and as the pressure upon the circular inch opposite to the orifice still continues, the equilibrium will be destroyed, the arm will move in a retrograde direction.

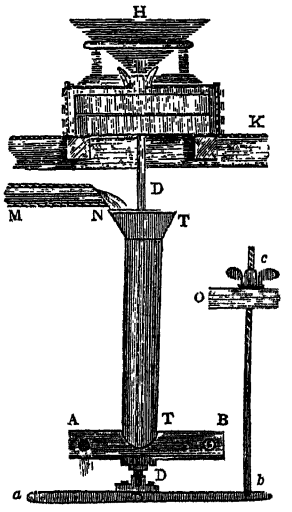


Fig. 89.

499. The upright spindle D, on which the arm revolves, is fixed in the bottom of the arm, and screwed to it below by a nut. It is fixed to the upright tube by two cross bars, so as to move along with it. If a corn-mill is to be driven, the top of the spindle is fixed into the upper millstone *m*. The lower quiescent millstone *n* rests upon the floor K, in which is a hole, to let the meal pass into a trough below. The bridgetree *ab*, which supports the millstone tube, &c., is moveable on a pin at *a*, and its other end is supported by an iron rod fixed into it, the top of the rod going through the fixed bracket O, furnished with a nut *c*. By screwing this nut, the millstone may be raised or lowered at pleasure. If any other kind of machinery is to be driven, the spindle D must be prolonged above the hopper H, and a small wheel fixed to its extremity, which will communicate its motion to any species of mechanism.

Horizontal Wheels.

500. Barker's Mill, or Segner's Wheel, as it is sometimes called, has not been extensively used in moving machinery, owing chiefly to the lower pivot D being made to bear the whole weight of the water in the cylinder, besides the weight of the apparatus. The considerable resistance, however, arising from this cause has been ingeniously set aside by Althans of Sayn, who has so arranged the machine that the water enters the horizontal cylinder DT from below. Such a mill may be had by removing the apparatus HK, the horizontal cylinder AB being above, and NT below. But in such an arrangement, the upright cylinder TT is now stable, and AB only rotates round a pivot, and the friction also is very much reduced, the weight of the wheel, and all that is fastened to it, being entirely supported by the column of water. An advantage is derived by having a rotating cylinder similar to an S, placed thus ∽; for water issuing from the orifices of a straight cylinder issues from it with a certain velocity, but in passing through a cylinder with curved arms, it gradually loses its impetus, till at last it falls from the orifices with no velocity whatever.

In several parts of Scotland these Barker's mills are known as Scotch Turbines.

(ζ.) *Albert Euler's Reacting Machine.*

501. This machine was first described in the *Mémoires de l'Académie de Berlin* for the year 1754: it consists of two parts, GH the upper (fig. 90), and EF the lower. The upper portion is immoveable, and forms a cylindrical and annular reservoir, receiving water within the annulus PP, from the canal R; at its lower part I, I, are a set of straight pipes, but inclined at an angle determined by calculation, so that the water may descend with proper obliquity into the lower vessel. These pipes are represented by the lines I *i*. The lower part is moveable round the common axis OO, and has also an annular trough EE, from the bottom of which, inside the vessel, pipes descend and discharge from a rectangular end F, the water which passes through them. The velocity with which the water issues is that due to the height EF; and a rotary and retrograde motion takes place in the lower half of the machine.

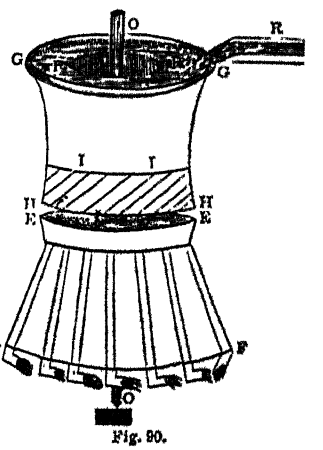


Fig. 90.

M. Burdin gives an account of a reacting turbine of his own invention, along with his experiments on it, in the *Annales des Mines* for 1828.

CHAPTER II.—MACHINES HAVING AN ALTERNATE MOTION.

Machines having an Alternate Motion.

502. The second kind of wheels which we come to describe, are those having an *alternate motion;* of these, two only are known in the arts,—the *Water-column Machine*, and *Montgolfier's Hydraulic Ram.*

(α.) *Water-column Machines.*

503. The water-column machine consists of a cylinder or great body of a pump, in which a piston is driven backwards and forwards by the weight of a high column of water contained in an upright pipe. To the piston-rod is adapted a working beam, which transmits a motion to the common pumps; sometimes also the up and down motion is transformed into a motion of rotation. The first machines of this kind were constructed in 1745 by Hæll, and were known as *Hæll Machines.* They were used at that time in the mines of Hungary, and in different parts of Germany; but were not very effective. It was only about 1817 that Reichenbach made them what they now are. One of these engines, as improved by him, was constructed at Illsang, which raised a column of salt water to a height of 1145·6 feet. One of the best of these machines is that which works at a depth of 410 feet below the surface in the mines of Huelgoat, in Bretagne, a description of which, by M. Junker the engineer, is given in the *Annales des Mines,* 1835; and in M. Theodore Fischer's *Handbuch der Hydraulik,* 1835.

(β.) *Whitehurst's Machine*, and the *Hydraulic Ram.*

504. Mr Whitehurst gives, in the *Phil. Trans.* 1775, an account of a machine for raising water to a considerable height by means of its momentum. This machine consisted of a reservoir AM, (fig. 91), having its surface M on a level with the bottom of another reservoir BN. The main AE is about 200 yards long; and F is 16 feet below MB. The valve-box D has a valve *a*, and into the air-vessel C are inserted the extremities *mn* of the main pipe, bent downwards to prevent the air being driven out when the water is forced into it. Now, from the distance of F below MB, as soon as the cock F is opened, a column of water 200 yards long is put in motion; and if the cock F be suddenly shut, the water rushes through the valve *a* and condenses the air in C. Since this condensation of the air must take place every time that F is suddenly stopped, the air in C will react on the water and force it up into the reservoir BN, by the pipe CB.

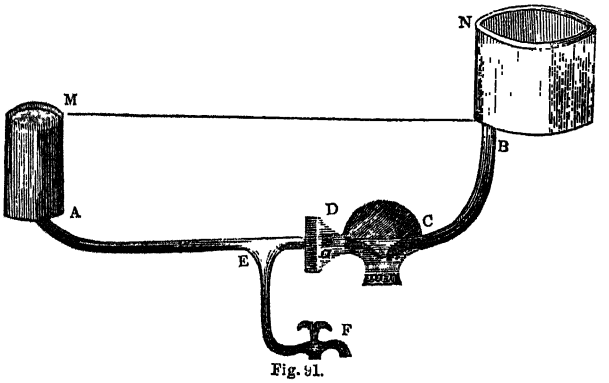


Fig. 91.

505. The *Hydraulic Ram* of Montgolfier is based on this same principle. Although this engine is evidently an improvement on *Whitehurst's Machine*, yet Montgolfier afterwards claimed the entire merit of the invention.[1]

The pipe A, or *body of the Ram*, conveys water from an elevated reservoir, not represented in fig. 92, to the working part of the machine, or *head of the Ram.* This *head* consists of the short pipe at B, opening upwards, where B is a valve connected with a kind of stirrup surmounting the

Machines having an Alternate Motion.

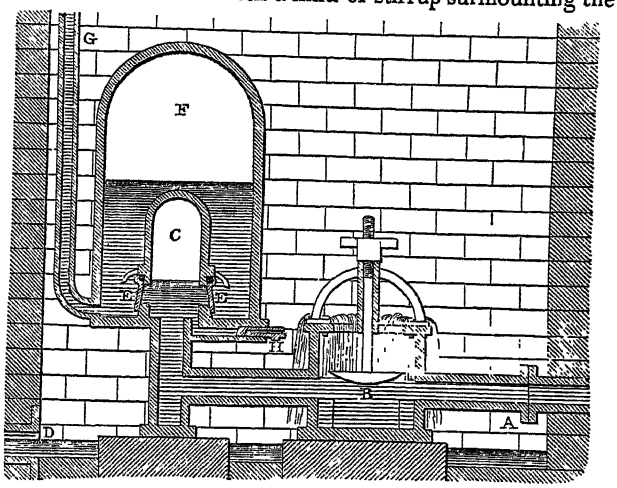


Fig. 92.

opening. When B is at its highest, the water enters the air-vessel C, and is forced from it into an outer air-vessel F, whence it is expelled into the ascension pipe G to the required height.

Suppose now, that the water is moving along the pipe A, and that B is at its lowest; then as B is in its way, and as it has no passage except by the circular sides of B, the valve B will be thus gradually forced upwards, till at last the water cannot escape by this opening. The head of water is now forced along the pipe with an increased velocity, exerting a pressure on the walls, and escaping by the valves E, E, the only yielding parts; a volume will therefore be poured into the vessel F, which, by the condensation of the air, will be forced up the ascension pipe G. When the valves E, E open, the velocity of the water in A immediately diminishes, and after a very short time, these valves close, for the water has now lost all its impetus. B also, which is no longer pressed upward, gradually falls to its original position, and then prepares anew for a second stroke.

The pressure of the air in C plays a very important part in the machine. When the water is sharply arrested from escaping, by the valve B closing, it produces a violent shock, in virtue of which the valves E, E open so as to admit water into the vessel F. But the air in C meeting this shock, produces the greatest amount of work; and when, by the agency of the air in C, the water has lost all its velocity, this air, in virtue of its elasticity, repels the water back into the pipe A. The valves E, E will then shut as soon as the pressure of the air and water of F inwards on E, E exceeds that outward pressure of C on E, E. The backward motion also of the water, in consequence of its acquired velocity, continues even though the pressure has been reduced to that due to the height of the fall; that is to say, although the pressure in C is less than that of the atmosphere, the water continues to move backwards in the pipe A. It is owing to this interior sucking that the valve B falls to prepare for a second stroke.

The air again in the vessel F has also to play an important part. It is of use in maintaining a uniform and continuous motion in the ascension of the water by the pipe G. When the valves E, E open, the water entering, compresses the air in F, but is not itself immediately forced up the pipe G, as it would be were there no air in F. The suppression of the air, therefore, in F, would require a greater force to raise a high column of water from a state

[1] See the *Journal des Mines*, vol. xiii., No. 73.

Machines having an Alternate Motion.

of rest, and the valves E, E would remain open a shorter time at each stroke of the ram; and, consequently, also, would throw in a smaller volume of water.

It is necessary, therefore, that the air in the vessels C and F be carefully supplied. Each volume of water, no doubt, brings along with it so much air; but as each is expelled, more air is carried out than is introduced. A small pipe H, then, having a valve opening inwards, and right under E, throws in a volume of air at the time when the backward motion of the water is taking place in pipe A, the pressure of the rarified air in C being less than that of the atmosphere. The vessel C being now full of air, then as soon as a new stroke of the ram takes place, the valves E, E open and introduce a volume of air into F. The water which passes over the valve B is conveyed away by the channel D.

Machines having an Alternate Motion.

506. The effect in this machine is the water raised a certain height during a certain given time. Let p = the weight and h = height to which the water is raised, the effect will be measured by ph. Let P be the corresponding force or weight of water furnished in the same time, and H = the height of the fall, the value of this effect = PH. Let also q = volume of water raised, and Q = volume of waste.

$\therefore$ Since $Q : q = P : p$, we have $\frac{ph}{PH} = \frac{qh}{QH} =$

the ratio of the volume raised to that used. This effect at a maximum is between 60 and 66 per cent. of the volume employed. The number of pulsations or strokes vary from 50 to 70 per minute.

CHAPTER III.—MACHINES FOR RAISING WATER.

507. The machines for raising water are—(α.) *Pumps;* (β.) *Screw of Archimedes;* and, (γ.) *Pail* or *Bucket Machines.*

(α.) *Pumps.*

508. Pumps have for their object the raising of water to any height. A pump consists of a cylinder or *body of the pump*, in which an upward and downward movement takes place by means of a cork or *piston*, which is closely fitted to the walls of the cylinder. By the intervention of *valves*, a communication is established between the cylinder and the various pipes necessary for the throw of the pump. There are two pipes especially to be attended to; the lower is the *sucking pipe*, the upper is the *forcing pipe.*

Pumps are divided into three classes, and named according to the circumstances in which the piston acts,—(a.) *Sucking Pumps.* (b.) *Forcing Pumps.* (c.) *Sucking and Forcing Pumps.*

(a.) 1. *The Sucking Pump.*

509. The *common sucking pump* consists of the cylinder DCCD (fig. 93), and the suction pipe BAAB of smaller diameter. These two parts are united by flanges E, F, tightened by bolts C, C. The level of the water in which the pump is plunged is ZY, and AA has a grating across it to prevent filth from entering the pump. OPM is a conical air-tight piston, and A′ its rod; the mouth-piece, by which the water issues, may be at V or at X. The valves opening upwards are H and N: and R joins piston and rod. In order to explain the action of the common pump, suppose that the piston is at the top of the barrel, or at TS, then the top of the piston-rod is at its highest; let also the valves H and N be shut. Now, as the piston-rod A′ descends, there is a tendency of the air within the barrel to be compressed; the valve N must necessarily fly open upward, whereby the air escapes. When the piston M has reached GE, or the bottom of the cylinder, the valves are closed and a volume of air has escaped by N equal to the capacity of the barrel. Were the valve H permanently fixed, and were the piston to rise, then a vacuum would be formed between H and the bottom of the piston; but as H is hinged, immediately on M rising, the elastic force of the air between H and YZ forces up that valve, and the cylinder will now be filled with rarified air from pipe B, when the piston is again at the top. Let the piston redescend, and that volume of air will also be expelled, and so on. But it is clear, that as more and more air is withdrawn, the pressure of the rarified air is less and less able to balance the atmospheric pressure on the surface YZ of the water, and the elastic force being proportional to the density, the water will rush up and fill the barrel.

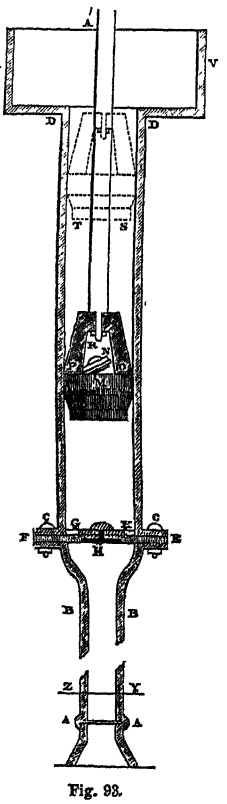


Fig. 93.

Suppose now that the air is completely exhausted, and that M as well as the water is at H; then on M rising to D, the atmospheric pressure at YZ will force the water from the suction pipe into the barrel so as to fill it; but on M descending, since it cannot penetrate without displacing the water, the valve H must close, and N open, so that the whole volume of water which was below will now be above M. As the piston is again raised it will turn all the volume of water above it into the reservoir VX, so that it may be emptied by a mouth-piece in the side; the barrel is again filled, however, and must be discharged as before.

This is the action of the common suction pump. Before the time of Galileo, or rather before Torricelli showed experimentally the pressure of the atmosphere, it was believed that the water was *sucked* up in the pipe HA, owing to the *abhorrence of nature to a vacuum.* But as Torricelli showed that an atmospheric column, extending through the whole height of the atmosphere, would balance a column of water 32 feet high of the same sectional area, it follows that, in order to raise water by the common pump, the valve H must on no account be more than 32 feet above the surface YZ of the water. If it exceed that height no water will be raised.

With respect to the pressures which the faces of the piston experience, we see that on M descending, when the barrel is full, the pressure on the upper and lower face is not exactly the same, for the faces are not of the same depth, and the water is slightly resisted while passing through the valve H, which shows us that this opening should be as large as possible. As the difference, however, is excessively small, the piston may be regarded as having no resistance to overcome in passing from D to C. It is otherwise when the piston is rising. It then acts as a full piston, and has to support different pressures on its two faces. The upper face supports the atmospheric and the fluid column, while the lower face is only pressed by the atmosphere, less a fluid column extending from the bottom of the piston to the level YZ of the water. The difference of these pressures may be regarded as the pressure of a fluid column, having a section of the piston for its base, and its depth the vertical distance between the mouth-piece, say V and YZ. The descent and ascent of the piston constitute one stroke of the pump.

510. In the *common pump*, let A = area of piston; l = length of stroke; h = vertical height of the bottom of the

Machines for Raising Water.

barrel above the surface of the water to be raised; $h' = h + l =$ vertical height of the pipe by which the water is discharged from the water to be raised; $w =$ the weight of a cubic foot of water; P = the work applied at each double stroke; m = the ratio of the work done to the work applied, or the relative efficiency of the pump. Then work in raising water into the barrel $= Alw\,(h + \frac{1}{2}l)$, and work in raising water from the barrel $= Alw \,.\, \frac{1}{2}\,l$.

$\therefore$ Total work $= Alw\,(h + \frac{1}{2}\,l) + Alw \,.\, \frac{1}{2}\,l = Alw \,.\, (h + l)$;

hence $m\mathrm{P} = Alw\,(h + l) = Alwh'$, and $l = \dfrac{m\mathrm{P}}{Ah'w}$.

2. *Self's Pump, with Suction Air Chamber.*

511. In the agricultural department of the Great Exhibition of 1851, Mr Self exhibited a *pump* with *suction air chamber*. The peculiarity in the construction of this pump consists in its having an air chamber connected with a *common suction pump*, the air chamber communicating with the suction pipe immediately below the barrel. When working the common pump, a sudden jerk given at the beginning of the stroke, sometimes separates the piston from the water in the barrel, causing a vacuum into which the air will find its way. Self's suction chamber is an arrangement calculated to remedy the defect, and save the labour accumulated in the water. Professor Mosely, in his report, says of this machine;—"It is immaterial in what proportions the work is distributed over the stroke, or under what varying degrees of pressure it is generated, provided that the pressure never exceeds that of the atmosphere on the surface of the piston. If this pressure be exceeded, the piston may separate itself from the water beneath it in the barrel, the pump drawing air; and this is more likely to occur at the commencement than at any other period of the stroke, the motion of the water at that point being necessarily slow.

To communicate a finite velocity to the water at the commencement of the stroke, or while the space described by the piston is still exceedingly small, requires a much greater pressure than afterwards; and the greater, as the section of the suction pipe is less as compared with that of the barrel, and as the lift is greater. Thus, at the commencement of the stroke, a finite velocity of the piston can only be obtained by an extraordinary effort of the motive power associated with the chance of drawing air and of a shock, if the pressure be suddenly applied. A remedy for some of these evils in the working of a pump has been sought in the application to it of a second air vessel, communicating with the suction pipe immediately below the barrel, or with the top of the suction pipe and the bottom of the barrel. The commencement of each stroke is eased by a supply of water from this air chamber to the space beneath it. The influx of the water into that space is aided by the pressure of the condensed air in the air chamber, and when the stroke is completed, the state of the condensation of this air is, by the momentum of the water in the suction pipe, restored, causing it to rush through the passage by which that pipe communicates with the air chamber. Thus, by this contrivance, the surplus work which remains in the water of the suction pipe at the conclusion of each stroke, is stored up in the compressed air of the air-chamber, and helps to begin the next stroke of the piston.

The nature of this action will be best understood from that of the *hydraulic ram* (505). The contrivance constitutes, indeed, in some respects, a union of the action of the ram with that of the pump; and, besides accomplishing the object for which it was applied, appears to have the effect of considerably economizing the power employed in working pumps.[1]

3. *The Lifting Pump.*

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512. The object of the lifting pump is to raise water to a greater height than the common sucking pump can do. It is therefore nothing else than the common pump a little modified. ACDB (fig. 94) is the working barrel of the pump, with a side pipe AEGHF flanged, and terminating in a main or rising pipe IK, with a valve L. The top of the barrel is now shut by a strong plate MN; the piston rod Q works through the water-tight part OP. The piston valve is R; the barrel and suction pipe are firmly bolted at D, C, and XV is the level of the water. The water first of all passes through the sucking valve T, opens the piston valve R, and fills the barrel BC; then when the piston-rod is drawn up, the water is necessarily *lifted* and driven through the forcing valve L into the escape pipe IK.

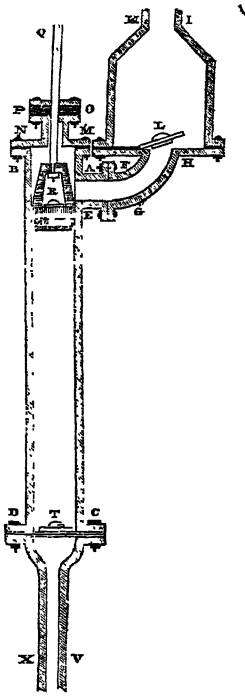


Fig. 94.

The action of the lifting pump is very simple. Suppose that the piston R is at T, that all the valves are shut, and that the air in the barrel and suction pipe is highly rarified, then immediately on the piston rod Q rising, the suction valve T will be forced open by the upward pressure of the water, and the piston valve R will necessarily be closed, for it drives out the remaining air from the barrel; consequently the valve L will keep open. When the piston R has reached NM, the water has entirely filled the barrel, and the valve L is shut by the atmospheric pressure. Again, when the piston rod descends, the valve R opens and T shuts; and when R is again at T, having completed one stroke, all the water will be above the piston and fill the barrel. Hence, on R being a second time pulled up, it has now to lift a weight equal to a fluid column BC, together with the atmospheric column in pipe IK, for the valve L is pushed open; on R reaching AB, a volume of water has been sent into the pipe IK equal to that which filled the barrel. But the barrel BC is again filled, and when the piston R descends, the fluid column in IK shuts L, the piston valve R opens and T shuts. When the piston R rises a third time, it has now to lift the water in the barrel, together with that in the pipe IK; and hence it is clear that water may be raised to any height, provided only that the barrel be strong enough to sustain the weight of the superincumbent column in IK,—which must be raised before the valve L can open,—and the force necessary to work the common suction pump.

The distance of DC from XV must not exceed 32 feet, but IK may be of any length. The piston rod is always drawn upwards, and consequently the rod Q is subjected to a longitudinal strain. A slim rod will suffice for this purpose, since there is no compressing force. The whole force which has to be overcome by the working lever or handle of the machine is,—1st, the weight of a fluid column extending from the level XV to the level of water in pipe IK, the base being that of the piston, a weight which acts at the piston rod where it joins the short arm of the handle; and, 2d, the passive resistances caused by the motion of the water and of the solid walls of the pump.

Sometimes a small pipe (furnished with a cock) projects from the side of IK. When the pump is in action, and if

[1] Mosely's *Report*.

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the cock be turned, the water will escape by the small pipe, so that in this condition the lifting pump becomes a common pump.

(b.) 1. *The Forcing Pump.*

513. The *Forcing pump* consists of a working barrel, ABCD (fig. 95), a suction pipe CDEF, and an ascension pipe, ONML. The part GHKI may be said to belong to the barrel; the second part IKLM is united to it, and the part LMNO is properly the ascension pipe. The clack or forcing valve is S, and RN is the suction valve. The object of the forcing pump is to raise water to a greater elevation than can be obtained by either of the former pumps. In the forcing pump the barrel AB is open to the atmosphere, the piston QVT is solid, and Q is a strong rod of iron. Suppose that the piston is being pushed down to R, then the valve S opens, and a volume of air equal to the capacity of the barrel is expelled by ON; let VT now rise, and R, which before was kept shut by the pressure, opens; S also shuts, and a volume of air from the suction pipe enters, and, expanding, fills the barrel. As the rarified air is more and more expelled, the water gradually rises in the suction pipe. Suppose that the piston VT and the water are at R, then, on VT rising, the water enters, and when VT reaches AB, the whole barrel is filled; the water has thus been sucked into the barrel. When VT begins to move down, R closes, and S opens; but it requires a forcing down of the piston to make it pass through the valve S into the pipe OL; the whole will be forced into this pipe as soon as VT is at R. A new volume will enter by R on the rising of VT, and S will be shut by the weight of the column in OL; an additional force, therefore, will be required to expel this second volume, owing to the column in OL.

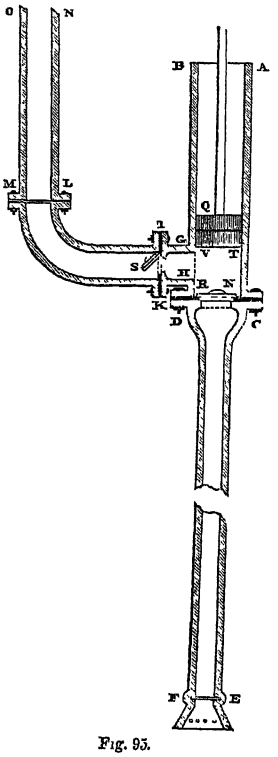


Fig. 95.

A small force is required to lift the piston-rod, but the force requisite to overcome the resistance in pushing it down, is that which would balance a column of water of a height equal to the distance between the level of water in pipe OL and the bottom of the piston, the sectional area being that of the piston. Since a great pressure is necessary to force the water into the pipe OL, the rod Q must be strong to resist the compression.

514. In the case of the *forcing pump*, let h' be the vertical height of the nozzle by which the water is discharged from the bottom of the barrel, then work produced by downward stroke $= Alw\,(h' - \frac{1}{2}l)$, where the quantities are the same, as in the former pump;

$$\therefore \text{Total work} = Alw\,(h + \tfrac{1}{2}l) + Alw\,(h' - \tfrac{1}{2}l)$$

$$= Alw\,(h + h') = \mathrm{P}; \text{ or } m\mathrm{P}; \text{ and } l = \frac{m\mathrm{P}}{Aw(h + h')}$$

where m is the coefficient.

2. *The Plunger Pole Pump.*

515. It is very difficult at times to make the pistons move water-tight in their casings, especially where dirty water is to be pumped up, as in the drainage of mines, and in the case also of the Bramah press. If, therefore, pistons are to fit accurately, they must be solid, as in fig. 96, where O is a solid piston, nicely turned and polished, its diameter being a little less than that of the cylinder CAGD, and working through a water-tight collar or stuffing-box DC. The small cistern XY, around the head of the pump, is kept full of water, for the purpose of keeping moist the air-tight collar. The small pipe RSZ in this cistern, is that, when the plunger O is at M, water may be poured into it by the cock S, so that the barrel AD may just be full. The piston-rod works through four rings T, of soft leather; HIGA are bolts binding the parts together. Suppose, now, that the plunger-pole O is at M, that water has been admitted by RSZ, and that the cock S is shut, then, on the plunger being drawn up, the air from pipe B will force up M, expand, and fill the barrel, together with so much water, while N is kept shut by the pressure of the atmosphere. When O descends, it drives the water before it, forcing down M, opening N, and expels a volume of water and air by LK. But on O reaching M, then N closes. There is still so much air in the barrel, but a few strokes of the pump will *expel* it, so that afterwards water only fills the barrel.

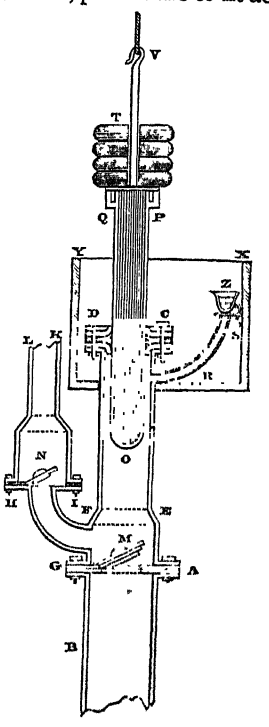


Fig. 96.

One great advantage which this pump has, is that it does away with the necessity of boring and polishing large cylinders accurately true, which of itself was a task of extreme difficulty; and even though it be done, yet the constant rubbing of the piston on the sides of the cylinder would soon reduce the diameter of the piston, necessitating therefore its frequent removal and renewal. The only wear, however, in the case of the *Plunger-pole pump*, so called because it plunges into the barrel, is the rubbing of the pole on the leather casing, and also the piston-rod Y through T; but these collars can be replaced at little expense.

Although the air may generally be said to be expelled shortly after the pump has made several strokes, yet to secure the utmost effect of the machine, a small right-angular channel is cut in the pole, one end communicating with the cylinder, and the other at the top of the pole, where there is a cock. If any air should accumulate at the top of the barrel, the cock is opened, and it is forced out.

3. *The Mining or Draining Pump.*

516. In draining the water from a mine with a single forcing pump, it is clear that there would be a column of several hundred feet, and a piston-rod of the same length. The working of such a pump would evidently require to fulfil conditions which would be impossible. In order, therefore, to drain mines, the method sometimes adopted is to divide the whole length of the shaft into several equal parts, at each of which a pump is established. The *principal rod* extends from the top to the bottom of the mine, carrying at equable distances heavy plunger-pole pistons, which work up and down in the cylinders of their respective pumps, guided all at the same time by the upward and downward movement given to the principal rod by the steam-engine at the mouth of the mine. There are ascen-

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sion pipes of equal length on each side of the main rod; the lower end of each dips into its respective open reservoir, the upper end of each empties its water into the reservoir immediately over the former. Each of these pipes has two valves opening upwards, the one below, the other above its communication with the body of the pump. When the pistons rise, the upper valves close and the lower open; the atmospheric pressure now acting on the surface of the several reservoirs, forces the water up into the side pipes by *suction*, so that on the pistons descending, the upper valves are driven open by the ascending water which is emptied into a reservoir, and the lower shut. In this way all the pumps of a *Mining pump* act.

(c.) 1. *The Fire Engine.*

517. The pump used for extinguishing fires is a double forcing pump, and is called the *Fire engine*. The pipe by which the water is thrown upon the fire is very flexible, so that it may be directed at pleasure to any part of the conflagration, whilst the pump is acting. The height of the jet will thus be variable, and if the pipe be held in a horizontal position it will be nothing. But the object required in the working of the machine is not so much to send the water to the extremity of the flexible pipe, as to give the water a considerable velocity when the jet issues from it. A jet is thus produced of great range, which can easily be directed to distant parts, where the fire is to be arrested. In order to effect this, the jet which issues from the pipe should escape with a uniform velocity. Hence, for this purpose, we have on both sides of the machine a forcing pump, each moving alternately during the same time, and by their united action constituting a pump of double effect. The pistons S, R, of the pumps WX, TU (fig. 97), move at the same time, but in contrary directions; when one is up the other is down, and *vice versa*. The water introduces itself into the interior of the pumps by the valves O, G; when a

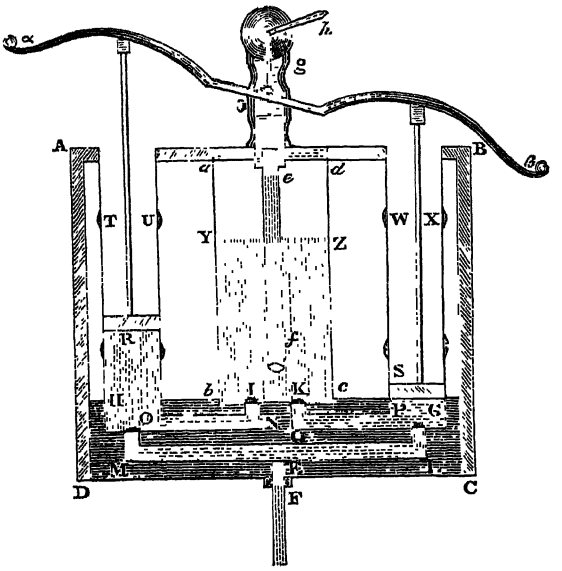


Fig. 97.

pump is full, the piston descending, shuts G and opens K, and the same with the other; the water is thus thrown into the reservoir *abcd*, into which is plunged the ascension pipe *fe*, forming part of the flexible pipe. Although there are two forcing pumps employed for throwing water into the reservoir, yet this arrangement does not ensure that regularity of velocity of escape which might be expected, since a marked irregularity or a retardation of the water takes place every time that each piston changes the direction of its motion. The velocity of the water, however, is regulated by a volume of air lodged above YZ in the top of the air reservoir *ac*. This air is completely inclosed; it puts itself in equilibrium with the pressure of water under it; and its elastic force, acting on the surface of the water YZ, forces the water up the pipe *fe* to the stop-cock *eg*, whence it passes to tube *h* attached to the leathern tube or *hose*. By means of the air vessel, then, the irregularities which the volume of water entering by I, K presents, are mainly felt in the reservoir *ac* into which they open, and are removed by the oscillations of the water which rise and fall alternately. It results from this, that the variations are very small, yet sensible in the velocity with which the water spouts out at the extremity of the hose. The long pipe or hose is of considerable transverse dimensions, but contracted to a narrow point at its nozzle. The water passes gently from *f* along the hose, and it is only on entering the narrow portion that it receives a considerable velocity of escape. The height, then, to which the water will be thrown depends on the condensation of the air in the air vessel, and on the elevation of the extremity of the pipe above the level of the water in *f*.

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The fire-engine is made long and narrow; a section of its breadth is ABCD in fig. 97; the principal use of the length, is to support a frame-work which is balanced on a horizontal axis, of which *g* is the projection, parallel to the length, and right over the reservoir *ac*. At each end of this axis is a lever $\alpha\beta$, united at α and β by two long handles, of which the projections are α and β. Several men, standing on both sides of the engine, gripe the handles so as to work the pump's pistons R, S, to which they are united by vertical rods. The long body of the engine serves likewise as a cistern into which pails of water may be poured, if there be not a convenient supply from a pipe F communicating with the cistern of the engine and the town mains.

2. *Delahire's Pump.*

518. *Delahire's pump* consists of a working barrel AB, shut at both ends A and B (fig. 98). C is the piston, and its rod O passes through a leather collar A. Communicating with the barrel, by the passages *m* and *n* which are near the top and bottom of the barrel, are two pipes H and K. The valves F and G open upward, D and E are similarly circumstanced. The action of the pump is evident. Suppose that the air has been withdrawn, that the water is at D, and the piston C close to *n*, when the piston-rod O is drawn up, all the valves will be shut except F and D, the latter of which must open first by the pressure of the water; the barrel, therefore, will be full when C is at A. If C descends, a volume of water must be expelled by E, which immediately opens on the descent of C, while D shuts. But as C is forced down to expel the water under it, the valve F instantly opens by the force of the water, and fills up the vacant space above C, the valve G falling by the pressure of the atmosphere. Now, the first volume of water was expelled by the pipe H, and it is just rising in that pipe while C has reached *n*; but as soon as C begins to rise again, the valve G is forced open by the water above C, and F shuts; the valve E is also closed by the fluid column above it, and D opens to fill the barrel under C. Hence we see that two barrels of water are expelled by the common pipe L at each stroke of the pump, so that the stream is continuous, or nearly so. There is, however, an awkward jar or shock at each change of the action; but this is entirely removed by

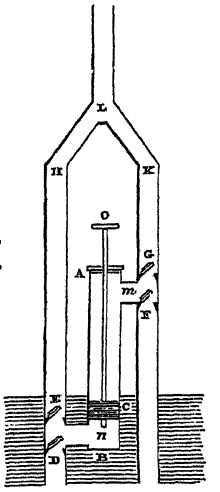


Fig. 98.

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using an air vessel similar to that of the hydraulic ram. This pump is extensively used for supplying air to furnaces, and it is then called the *double-acting air-pump*. (See *Hist. et Mem. de l'Acad.*, 1716; Belidor's *Architecture Hydraulique;* and Leupold's *Theatrum Machinarum Hydraulicarum.*

3. *The Bramah Press.*

519. The principle on which the *Bramah press* depends for its efficiency, is the equable distribution of pressure in fluids. Fig. 99 represents the machine, while fig. 100 is a

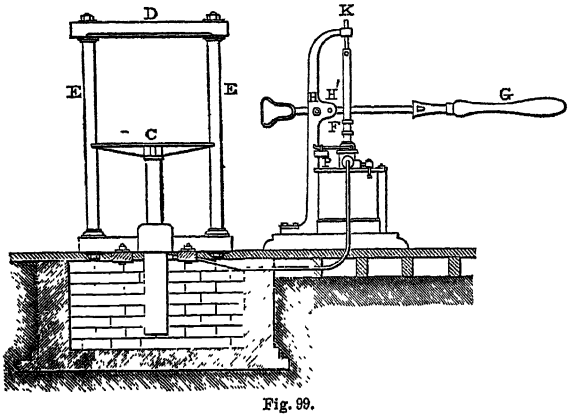


Fig. 99.

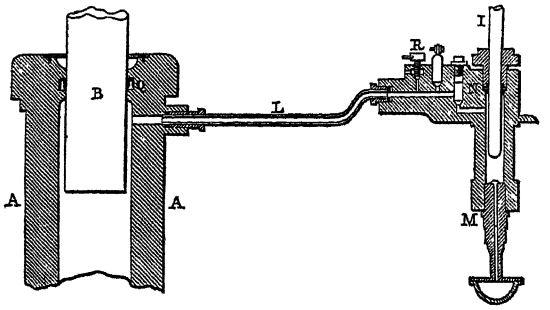


Fig. 100.

section of it. AA is a very strong cylinder inclosing a plunger piston B, having on its top a plate C. The piston, wrought by means of water, rises with its plate, and presses with great force any substance upon it against the roof plate D firmly bound to the pillars EE. The water is introduced into the cylinder A by means of the injecting pump F. This injecting or plunger pump is worked by a lever GH, of the second kind, moving round H, the power being applied at the handle G. As the handle receives an upward and downward movement, the plunger piston I ascends and descends, and transmits pressure against the bottom of the piston B by means of the water. The movement of the piston I is guided by the circular hole K, in which the free end of the piston-rod moves; the piston-rod of I is connected with the lever GH. At every stroke, then, of this piston, water is sucked up by the valve M from a reservoir placed under this pump, and is driven into the pipe L communicating with the cylinder A. M and N are two valves, which establish and intercept alternately the communication of the body of the pump A with the sucking pipe at M, and the connecting pipe L. The forcing valve is N, and the sucker valve M.

It is of the utmost importance that the surface of the pistons with the walls of the respective cylinders should be as close as possible, especially at the tops of the cylinder, and that the packing between them should be perfectly water-tight; for if there be the smallest leakage, a volume of water would inevitably escape. A leak, however, near or about I, is of less moment than at some part of A. For were the motion of the injecting piston I somewhat rapid, all the water would not have time to pass out by the leak at A, and therefore a portion of the water would always be effective. Special attention is always paid by engineers to the secure packing of the collars of the piston A, so that the pressure may be transmitted from one cylinder to another unchanged. On every descent of the piston I, a volume of water is forced through the valve at N. This valve closes the instant the piston has made its complete downward motion, and prevents the water from returning. The water thus thrown in, must be either compressed or must occupy a larger space. Practically speaking, water may be regarded as incompressible, and thus the water forced into the cylinder A must increase at every stroke, and the cylinder being too strong to yield, the piston B with its loaded plate must ascend. The piston will thus rise through a small space for every additional volume of water thrown in. As soon as the required effect has been produced, the pressure is immediately relieved by opening the discharge valve R, when the water returns to the cistern; and the piston B descends by its own gravity.

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The packing of the piston B is too ingenious and important a matter to be passed over without notice. Let fig. 101 be a section of part of the main cylinder and piston, where A is the cylinder, KB the piston. KB is about 9 inches, DE is a recess in the former, about one-half inch deep; the collar FG is a double leather turned over a metal ring H, placed in this recess. Bramah, in order to prepare the collar, took an annular piece of leather and steeped it in a solution for some time. Having softened the leather, he next placed it over the top of the metal ring H. Now, when the water is pumped into the cylinder, it enters the narrow space between the walls of the cylinder A and piston B, then into the recess DE, and acting on the under surfaces of the turned-over leather on both sides of the ring H, forces the faces on the sides of the piston and on the back of the recess. The more water then that is pumped in, and as the piston begins to rise, the pressure on the inner leather face is increased, so that the piston and cylinder being perfectly air-tight by means of the firmly pressed leather, no water can insinuate itself between the edges F, G, and escape. The greater the pressure on the leather, the tighter will the packing become, provided only that the leathers be sound. When the machine is begun to be worked, the leather gradually rises up to the top of the recess by the mere pressure of the water, and even before the piston has commenced rising. The leather packing will thus assume the form as in fig. 102. As soon as the discharge valve R is open, so that the pressure may be removed, the leather is free and no longer pressed, and both it and the ring will slide down to the bottom of the recess. The edges of the leather are not so low as the lower edge of the ring H, in order to prevent the leather edge at F from coming between the cylinder and piston.

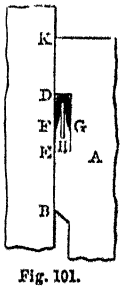


Fig. 101.

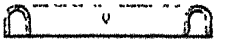


Fig. 102.

520. A similar contrivance renders the injecting pump water-tight. Fig. 103 represents the barrel *mm*, and *n* the plunger piston; *aa* is a copper ring lying horizontally between leather packing, which are the dark pieces. The ring has its upper and under surface scored, so that on the plunger being put in, and the piece *bb* screwed down, having a hole pierced in its mass to allow the working of the cylinder, the ring and the leather are in close contact, and the pressure squeezes out the leather on the side next the piston, and on the side next the barrel, thus preventing the water from escaping. The barrel is slightly curved as at *cc*, so that the water may get behind the leather,

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press it against the side of the piston, and allow no escape between the piston and the leather. When the pressure is more than three tons on the circular inch, the leathers wear very fast, and new ones must be put in.

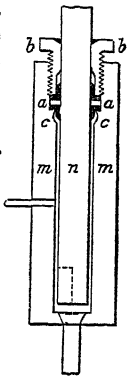


Fig. 103.

When the machine begins to act, so as to compress a body between the roof and the plate, the pressure exercised is feeble; but as the body is more and more pressed, the resistance becomes so great, that a large power is required to overcome it. In such a case we remove the fulcrum of the lever GH from H to H′, by the insertion of a pin, the bolt at H being afterwards removed. If HH′ be half the former arm, then the former power will press the body with a greater force than before, and hence, also, a greater force will be transmitted through the water.

In order that the pressure transmitted by the water may not be too severe for the several parts of the machine, a *safety valve* P (fig. 104), is introduced near the pump F. A conical valve O intercepts a channel, by which the water may pass out with a force sufficient to overcome the weight P at the extremity of the lever of the valve, when the pressure becomes too great, *i.e.*, when the pressure exceeds the limit beyond which we do not want it to pass.

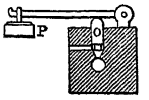


Fig. 104.

A screw R, the lower extremity of which forms a valve, closes effectually another channel, by which the interior water might be prevented from communicating with the water cistern, during the working of the machine. When the action of the press is to be stopped, the screw R is turned in a convenient direction, and a communication is opened with the water cistern, into which the water flows from the cylinder AA, the piston of which, now no longer subject to pressure, gradually falls within its cylinder. This valve, connected with R, is called the discharge valve.

521. Given the force applied at the injecting pump-handle, to determine the pressure on the base of the working cylinder.

Let S be the area of the working piston's base, s that of the plunger pump, P the force applied at the injecting pump-handle, L the arm by which P acts at G, and l that by which acts Q, the resistance to be overcome by the injecting piston. Then, as the lever is one of the second kind, $Q \cdot l = P \cdot L$; $\therefore Q = \frac{P \cdot L}{l}$ = resistance to be overcome. But the pressure exerted is proportional to the area pressed; and whatever be the pressure on a unit of surface of the injecting piston's base, the same pressure is transmitted to every other such area on the bottom of the working piston. Hence, action on base of B : action on base of I = base surface of B : base surface of I = S : s;

$$\therefore \text{Action on base of B} = \frac{S}{s} \times \text{action on base of I}$$

$$= \frac{S}{s} \cdot \frac{P \cdot L}{l}.$$

This expression is equivalent to the pressure to which any substance placed between the plates C and D is subject; it is the same also as the weight raised, which call W;

$$\therefore W = P \cdot \frac{L}{l} \cdot \frac{S}{s}.$$

But the areas of circles are as the squares of their radii, hence $\frac{S}{s} = \frac{R^2}{r^2}$, where R and r are radii of the base of tne pistons B and I respectively;

$$\therefore W = P \cdot \frac{L}{l} \cdot \frac{R^2}{r^2}.$$

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Wherefore, the efficiency of the press will be increased, by increasing either of the quantities P, $\frac{L}{l}$, or $\frac{R}{r}$.

Since the value of the ratio $\frac{R}{r}$ may be increased to an almost indefinite extent, it is clear that the press may be said to have no limit to the pressure exerted, except the strength of the materials. But, in a practical point of view, the indefinite value of $\frac{R}{r}$ may be said to be inapplicable; for when $\frac{R}{r}$ is in value very large, the volume of water introduced at every stroke of the pump would be so small that the piston would ascend too slow for all practical purposes.

As it is desirable to save time in working with this press, and as one workman can easily work the instrument at the commencement, there are generally two injecting pumps, a large and a small one, standing side by side, and both communicating with the forcing valve. If the diameter of the piston of the large injecting pump be double that of the smaller, and their barrels of the same length, then the volume of water forced in at every stroke by the former will be four times greater than that of the latter. Hence the first pump will raise, at each stroke, the working piston through any space quicker by four times than that of the second piston. Again, since the pressure is proportional to the area, a man at the large injecting pump would only require to exert a force one-fourth that which he would require to employ at the small injecting pump, supposing their levers to be of the same length. Wherefore, for the sake of speed, the large pump is worked first; and, when the effort required becomes too great, the small one. The effect evidently is the same as the shifting of the fulcrum point of the lever.

Further, in order to guard against accident, as, *e.g.*, if the forcing valve N should be prevented from working by the intervention of dirt sucked up by M when the plunger I has made its descent, a hole is drilled in the bottom of the piston I, and communicating with another on the side at a small distance above, as represented by the dotted line (fig. 103). Now when the pump is worked properly, the horizontal orifice never rises above the leathers; but, if the plunger be raised a little higher, then the water will find its way between the metal surfaces of the plunger and barrel, and immediately the pressure on the base of the working piston will be diminished.

522. The Bramah press is perhaps the most perfect hydraulic machine with which we are acquainted. It is subject to little or no friction, nor to the rapid wear of its metal surfaces in contact; the only repairs that it may require are the renovation of the leathers, and yet these, under ordinary pressures, will last several years. This hydraulic press is used in almost every department of industry. It is used for throwing light articles into small bulk; for extracting oil from hides previous to tanning; for pressing cloth; for extracting moisture from paper. It is used in the manufacture of gunpowder, sugar, wax-candles, vermicelli, &c. It is peculiarly adapted for testing the strength of cables and masses of metal; for extracting old piles, and uprooting trees; for raising or sustaining a building that has sunk a little; and also for quarrying purposes. The printer and chemist know its value; and recently the engineer successfully accomplished, by means of the Bramah press, the elevation of the Menai Tubular Bridge.

4. *The Centrifugal Pump.*

523. Mechanicians have endeavoured to replace the up-

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ward and downward action of the piston in machines for raising water into a rotatory, or a motion always in the same direction. Bramah, in England, and Dietz in France, attempted to produce a machine which would work in this manner. That which the latter invented is represented in fig. 105.

Machines of this description are known as *Centrifugal pumps:* attention has been directed within these few years past to these engines on account of their great efficiency. The principle of their action will be understood from the following description. A cylinder AA (fig. 105), revolves within a fixed one PQ, in the annular space BB, each having the same axis. In the rotating cylinder are four plates or pieces C, C, C, C, which extend nearly, but not quite to the fixed cylinder; these plates are inserted in corresponding openings on the exterior surface of the rotating cylinder, and the space BB is divided into four compartments, each separated from the other. The exterior and interior edges of the plates are not parts of the exterior and interior surface of AA, although they move with it; these edges, which are equidistant from each other, approach when towards the right the centre O of the ring AA, such that the exterior edge of each plate in turn comes to form part of the outer surface of AA, while in other parts they form part of its inner surface. It is the form of the space BB which causes the plates C, C to glide into the slits of AA, and to near and go from alternately the axis of rotation. Hence, the four compartments are not always of the same capacity; their magnitude increases as the plates are distant from, but decreases as they approach, the axis of rotation. There are two openings in the fixed cylinder, each protected by a bent surface or opening valve, attached at one end to the fixed cylinder, while the other end is free; the one communicates with the suction pipe M, the other with the forcing pipe N. As the cylinder AA turns, one compartment is presented to M; it increases its capacity, sucks in water from that pipe, and becomes filled at the moment of its greatest dimension. This space diminishes on whirling round to the opening of the forcing pipe N, and a centrifugal force being imparted to it, drives the water forward, and compels it to discharge its contents into that pipe, and so on with all the others. We see, then, that this centrifugal pump acts at once as a sucking and a forcing pump; and fulfils, moreover, the conditions of a pump of double effect, since the movement given to the water in both pipes is continuous.

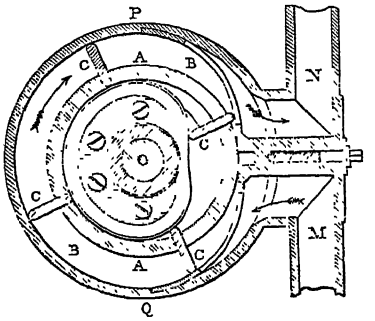


Fig. 105.

When the pump is set in motion the air from M is sucked out, and being carried round empties itself into N, so that the machine acts also as an air pump.

524. Mr Appold exhibited at the Crystal Palace in 1851 the form of a centrifugal pump, for which he was adjudicated the council medal. In Appold's pump the water enters by a circular opening, 6 inches wide, surrounding the axis with which the fan is connected. The fan-blades are 3 inches wide, and revolve within a fixed cylinder 12 inches diameter. The fan-blades consist of six curved arms. These curved fins are so disposed that the extremities at the fixed cylinder move tangentially, while the other extremities are fixed on to the rotating cylinder; the blades themselves pass through a stuffing-box in the side of the casing, working between two circular cheeks, and running close to them, but without actual contact. The outer revolving surfaces are thus shielded from the water, to which a free ingress is given, and a large space is left all round the circumference of the fan, to facilitate the escape of the discharged water.

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Mr Appold showed the decided advantage of curved fins over straight ones. When the curved fins were used, the jury found, from the experiments, that with a lift of 19½ feet, and a velocity of 788 revolutions a minute, and a circumferential velocity of 2476 feet per minute, the discharge was 1236 gallons a minute, and the useful effect was 0·68 of the power. With nearly the same lift, a fan having straight inclined arms, and rotating at the rate of 690 revolutions a minute, and a circumferential velocity of 2168 feet in the same time, the discharge was 736 gallons; the useful effect was only 0·43 of the power. With straight radial arms, and nearly the same velocity, the discharge was 474 gallons, and the useful effect only 0·24 of the power.

But Appold's machine is supposed to have a useful effect of 0·72 of the power, with a circumferential velocity of 1627 feet a minute, precautions being adopted which could not be employed in the experiments made at the Great Exhibition. The largest pump of this kind as yet constructed, is that at Whittlesea Mere for draining purposes. The wheel is 4·5 feet in diameter, and its average velocity is 90 revolutions, or 1250 feet per minute; it is driven by steam with 40 lb. on the square inch, and raises 15,000 gallons to a height of 4 or 5 feet in one minute. The centrifugal pump is most advantageous for low lifts, especially for those below 20 feet. Its best application is as a tidal pump, where the height of the lift is continually varying.

525. In the *Centrifugal pump* we have the same principle as will be seen in Barker's mill; the object of each, however, is different. In the latter, a fall of water through a hollow upright cylinder, with an axis passing through it, gives a rotatory motion to that vertical axis; while in the former, a rotatory motion is given to a vertical axis, in order to raise a column of water. Let P = the work in one second, applied in giving motion to the vertical axis; h = height to which the machine raises a column; v' = absolute velocity of water after discharge; V = velocity due to height; P′ = useful work per second; then, as in the reaction wheel, work done at efflux = work due to the centrifugal force, less the work spent in raising the water; hence $v = \sqrt{V^2 - 2gh}$ = velocity of water due to the pressure in the vertical pipe, as well as that which is due to the centrifugal force; w = the weight of a volume discharged in one second; $\therefore v' = \sqrt{V^2 - 2gh} - V$. So also the work applied = work in raising the water + work in water after efflux;

$$\therefore P = wh + \frac{v'^2 w}{2g} = \frac{w}{g}(V - \sqrt{V^2 - 2gh})V,$$

which, by expansion, gives, when V is infinitely increased, $P' = wh$. The effective nature of the machine will be expressed by

$$Q = \frac{P'}{P} = \frac{gh}{(V - \sqrt{V^2 - 2gh})}V.$$

The maximum effect of the machine, or Q, will take place when V = infinity.

Professor Mosely, in his *Report*, observes, respecting Mr Appold's centrifugal pump, that if the vanes be straight, it is evident that whatever may be the velocity of the water in the direction of a radius, when it leaves the wheel, its velocity in the direction of a tangent will be that of the circumference of the wheel, so that the greater the velocity of the wheel, the greater will be the amount of vis viva remaining in the water when discharged, and the greater the amount of power uselessly expended to create that vis viva.

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If, however, the vanes be curved backwards as regards the motion of the wheel, so as to have nearly the direction of a tangent to the circumference of the wheel at the points where they intersect it, then the velocity due to the centrifugal force of the water carrying it over the surface of the vein in the opposite direction to that in which the wheel is moving, and nearly in the direction of a tangent to the circumference, will, if this velocity of the water over the vane in the one direction be equal to that in which the vane is itself moving in the other, produce a state of absolute rest in the water, and entire exhaustion of vis viva. And in whatever degree the equality of these two motions—of the water in one direction over the vane, and of the vane itself in the opposite direction—is attained, in that same degree will the water be delivered in a state approaching to one of rest. The expedient of curved vanes is adopted in Mr Appold's pump.

With regard to the admission of water to the wheel, it is obvious that it should pass directly from the suction-pipe into the wheel without the intervention of any reservoir in which the vis viva of the influent stream—communicated in the act of rising through the pipe—may expend itself; and that such space should be allowed at the centre as not to alter the dimensions of the influent stream. It would further seem expedient, by means of properly constructed channels, to divide the water into separate streams, and to give to these divergent streams such curvatures as would facilitate their entrance upon the channels formed by the vanes, as in the Turbine or Reaction Wheels.

It is obvious that the tendency of the centrifugal force continually to increase the velocity of the water *over the vanes* as it recedes from the centre, cannot take effect in respect to all the particles of water in the same section, unless the sections of the channels diminish. If they do not, some of the particles of water in each section must be continually retarded, and power be uselessly expended in producing this retardation; whilst the current cannot but suffer from it a disturbance destructive of its vis viva.

This diminution of the sections of the channels might probably best be effected by giving to the sides of the wheel the forms of conical disks; an expedient which is adopted in Mr Lloyd's blowing machines, and in Mr Bessemer's centrifugal pump.

The communication of motion to the water of the reservoir in which the wheel revolves, and into which the water is discharged, should by every practicable expedient be avoided; and for this object the water should be kept as much as possible from the sides of the wheel. This is effected in Mr Appold's pump by fixing the wheel between two cheeks which project from opposite sides of the reservoir. The velocity with which the wheel must be driven depends upon the height to which the water is to be raised. Beyond a certain height this velocity is practically unattainable. But long before this limit is reached, it becomes inconsistent with an economical application of the power which drives the pump. It is probably therefore only in comparatively small lifts, where a large quantity of water is to be discharged, that the centrifugal pump will be found useful.[1]

The Screw-Engine of Archimedes.

526. The screw-engine invented by Archimedes is represented in fig. 106, where AB is a cylinder with a flexible pipe, CEHOGF, wrapped round its circumference like a screw. The cylinder is inclined to the horizon, and supported at one extremity by the bent pillar IR, while its other extremity, furnished with a pivot, is immersed in the water. When, by means of the handle K, the cylinder is made to revolve upon its axis, the water which enters the

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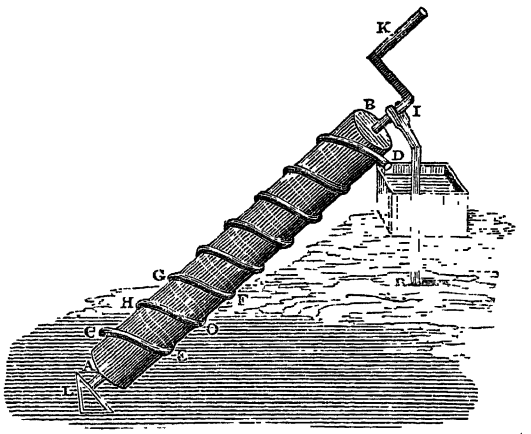


Fig. 106.

lower orifice of the flexible pipe is raised to the top, and discharged at D. On some occasions, when the water to be raised moves with a considerable velocity, the engine is put in motion by a number of float-boards fixed at L, and impelled by the current; and if the water is to be raised to a great height, another cylinder is immersed in the vessel D, which receives the water from the first cylinder, and is driven by a pinion fixed at I. In this way, by having a succession of screw-engines, and a succession of reservoirs, water may be raised to any altitude. An engine of this kind is described in Ferguson's *Lectures*, vol. ii., p. 113.

527. In order to explain the reason why the water rises in the spiral tube, let AB (fig. 107) be a section of the engine, BC*d*DE the spiral tube, BF a horizontal line or the surface of the stagnant water which is to be raised, and ABF the angle which the axis of the cylinder makes with the horizon. Then, the water which enters the extremity B of the spiral tube will descend to C, and remain there as long as the cylinder is at rest. But if a motion of rotation be communicated to the cylinder, so that the lowest part C of the spiral BCD moves towards B, and the points *d*, D, E towards C, and become successively the lowest parts of the spiral, the water must occupy successively the points *d*, D, E, and therefore rise in the tube; or, which is the same thing, when the point C moves to *c*, the point *d* will be at C; and as the water at C cannot rise along with the point C to *c*, on account of the inclination of C*c* to the horizon, it must occupy the point *d* of the spiral, when C has moved to *c*; that is, the water has a tendency to occupy the lower parts of the spiral, and the rotatory motion withdraws this part of the spiral from the water, and causes it to ascend to the top of the tube. By wrapping a cord round a cylinder, and inclining it to the horizon, so that the angle ABC may be greater than the angle ABF, and then making it revolve upon its axis, the preceding remarks will be clearly illustrated.—If the direction of the spiral BC should be horizontal, that is, if it should coincide with the line BF, the water will have no tendency to move towards C, and therefore cannot be raised in the tube. For a similar reason, it will not rise when the point C is above

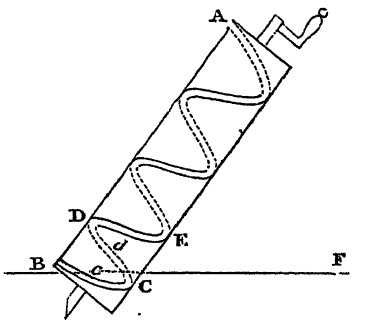


Fig. 107.

[1] Mosely's *Report*.

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the horizontal line BF. Consequently, in the construction of this engine, the angle ABC, which the spiral forms with the side of the cylinder, must always be greater than the angle ABF, at which the cylinder is inclined to the horizon. In practice, the angle of inclination ABF should generally be about 50°, and the angle ABC about 65°.

528. The screw of Archimedes is now generally constructed as shown in the annexed figure, where AB is the axis of the screw, having a flat plate of wood or thin iron coiled,

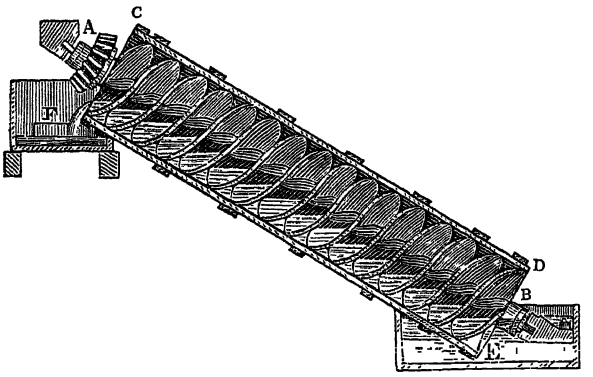


Fig. 108.

as it were, round the axis, like a spiral, or the threads of a screw. The plane of this plate is perpendicular to the surface of the cylindrical axis AB, but is inclined to the direction of the axis at an angle which must always be greater than the angle which the axis AB forms with the horizon when in use. This spiral plate, which is nothing more than a wooden screw with a very deep and narrow thread, is fixed in a cylindrical box CDEF, so as to form a spiral groove, as it were running up the tube from B to A, which is exactly the same thing as if a pipe of lead or leather had been wrapped round the cylindrical axis, as in fig. 108. If the outer case CDEF is fixed so that the screw revolves within it, the engine is called a *water screw-engine.* In the common screw-engine, Eytelwein has shown that the screw should be placed in such a manner that only *one-half* of a convolution may be filled at each revolution. When this condition, however, cannot be fulfilled, from the height of the water being variable, he gives a preference to the *water* screw, notwithstanding that in this case one-third of the water generally runs back, and the screw is apt to become clogged by impurities or weeds.

529. In a screw-engine erected at the Hurlet Alum Works, for raising the alum liquor, the length of the screw is 127 feet, its inclination to the horizon 37° 36′; the height to which it raises the liquor 76 feet 9 inches, the octagonal axis of the screw 8 inches in diameter, the diameter of the spiral 22 inches, the thickness of the covering 2 inches, the distance of the threads 9 inches, the number of the threads 168, the thickness of the spiral 2 inches, the width and depth of the spiral tube 7 inches each. The screw is sustained upon five sets of pivots or rollers, each set consisting of two rollers. The engine is driven by a water-wheel, which performs *one* revolution while the screw performs *two.* The quantity of liquor raised is 70 wine gallons; and as its specific gravity is 1·065, the quantity discharged in an hour is 17 tons. The screw is built wholly of wood, as the alum liquor acts upon iron.

530. The theory of this engine is treated at great length by Hennert, in his *Dissertation sur la vis d'Archimede,* Berlin, 1767; by Pitot, in the *Memoirs of the French Academy*; and by Euler, in the *Nov. Comment. Petrop.*, tom. v. An account of Pitot's investigations may be seen in Gregory's *Mechanics*, vol. ii., p. 348. See also Eytelwein's *Handbuch der Mechanick*, ch. xxi.; and *Journal des Mines*, tom. xxxviii., p. 321.

The Spiral Pump, or Zurich Machine.

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531. The Zurich machine consists of a cylindrical or spiral pipe, having one extremity dipping into the water to be elevated, and its other end communicating with an ascension pipe, whereby the water is discharged. This machine was devised, in 1746, by an ingenious pewterer of Zurich, named Wirtz, and its theory has been investigated by Bernouilli, Eytelwein, Robison, and others. When the machine was first erected, and its capabilities tested, it was used successfully at Florence and in Russia. It is now scarcely to be found out of Holland, where a considerable number are to be seen driven by means of *windmills.* Fig. 109 will give us an idea of this machine and its manner

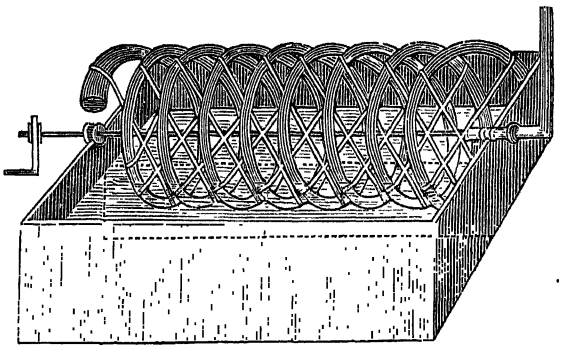


Fig. 109.

of working. The dipping extremity of the pipe is scooped like a spoon or horn, and capable of taking in a volume of water which will fill half a coil.

532. After the scoop has emerged, the water passes along the spiral by the motion of it round the axis, and drives the air before it into the rising-pipe, where it escapes. In the meantime, air comes in at the mouth of the scoop; and when the scoop again dips into the water, it again takes in a similar quantity. Thus there is now a part filled with water and a part filled with air. Continuing this motion, we shall receive a second round of water and another of air. The water in any turn of the spiral will have its two ends on a level; and the air between the successive columns of water will be in its natural state; for since the passage into the rising pipe or *main* is open, there is nothing to force the water and air into any other position. But since the spires gradually diminish in their length, it is plain that the column of water will gradually occupy more and more of the circumference of each. At last it will occupy a complete turn of some spiral that is near the centre; and when sent farther in, by the continuance of the motion, some of it will run back over the top of the succeeding spiral. Therefore it will push the water backwards, and raise its other end, so that it also will run over backwards *before* the next turn be completed. And this change of disposition will at last reach the first or outermost spiral, and some water will run over into the horn and scoop, and finally into the cistern.

533. But as soon as water gets into the rising pipe, and rises a little in it, it stops the escape of the air when the next scoop of water is taken in. Here are now two columns of water acting against each other by hydrostatic pressure and the intervening column of air. They must compress the air between them, and the water and air columns will now be unequal. This will have a general tendency to keep the whole water back, and cause it to be higher on the left or rising side of each spire than on the right descending side. The excess of height will be just such as produces the compression of the air between that and the preceding column of water. This will go on increasing as the water

Machines for Raising Water. Blowing Machine.

mounts in the rising pipe; for the air next to the rising pipe is compressed at its inner end with the weight of the whole column in the main. It must be as much compressed at its outer end. This must be done by the water column without it; and this column exerts this pressure partly by reason that *its* outer end is higher than its inner end, and partly by the transmission of the pressure on its outer end by air, which is similarly compressed from without. And thus it will happen that each column of water, being higher at its outer than at its inner end, compresses the air on the water column beyond or within it, which transmits this pressure to the air beyond it, adding to it the pressure arising from its own want of level at the ends. Therefore, the greatest compression, viz., that of the air next the main, is produced by *the sum of all the transmitted pressures;* and these are the sum of all the differences between the elevations of the inner ends of the water columns above their outer ends; and the height to which the water will rise in the main will be just equal to this sum.

(α.) *The Chapelet;* (β.) *The Chain Pump;* (γ.) *The Noria;* (δ.) *The Elevating Palette Wheel;* (ε.) *The Elevating Bucket Wheel;* (ζ.) *The Tympanum.*

534. (α.) The *Chapelet* consists of an endless chain or rope, on which, at equal distances, are flat disks of wood or iron fixed perpendicularly to the rope which passes through the centres of the flat disks. This chain passes over an upper and an under wheel, both of the same diameter. The lower is below the surface of the water to be raised; and these disks, in rising, pass through the interior of a hollow pipe, the breadth and length of which are the same as that of the disk. Every time, therefore, that a disk passes through this pipe, it isolates a volume of water, and empties it into the reservoir at a certain height above the water to be raised.

Again, this chain may be laid obliquely to the horizon, and water may be raised to a less elevation, but in less quantity, as when it is working vertically.

535. (β.) If in the chapelet we remove the disks, and for the upper radiating wheel substitute a solid circular disk, and for the lower a small pulley, and let a piece of loose tow or hair chain work up and down, then the rope in passing through the water will carry up so much with it; and as it passes over, the upper wheel will be compressed, and therefore force the water out of it into a reservoir. This machine is known as the *Chain Pump.*

536. (γ.) If instead of disks in the chapelet we substitute buckets or pails, each connected with an endless rope, then water may be raised to any elevation. Every time that a bucket enters the water it emerges full, and when it has reached its highest turning point, the bucket is emptied into the reservoir. This is the Noria or *Bucket Machine.* These machines are commonly used for draining and irrigating purposes.

Machines for Raising Water. Blowing Machine.

537. (δ.) If we conceive the wheel of art. 466 to be close to the circular course and turning in the opposite direction, and if we suppose the lower water-course the current of supply, then we shall have water raised to a height not exceeding half the diameter of the wheel. The machine is driven by a windmill or by steam, through the intervention of a toothed wheel acting on the teeth of the inner circumference of the wheel. By this arrangement the axis of the palette wheel is not much charged by the weight of water elevated, and consequently the friction of the wheel is much reduced. This is the *Elevating Palette Wheel.*

It is evident that this wheel is nothing else than an undershot or breast wheel, acting opposite to their mode of working.

538. (ε.) The *Elevating Bucket Wheel* may be regarded as an overshot wheel working in the opposite direction. The buckets, or water compartments, begin to empty themselves by holes in the inner circumference of the wheel when near their highest turning point. All the water is received ere the wheel has passed its highest point.

539. (ζ.) The *Tympanum* is also an elevating wheel, but much more efficient than either of the two former. It consists of a hollow circular drum, in which are four or more curved or spiral partitions, united to as many rectangular beams of a small height, of the same breadth as the drum, and proceeding from a revolving axis; the outer ends of these partitions are tangents to the drum. A crown wheel passes round the external circumference of the wheel, while a small crown wheel, turned by an engine, works into the teeth of the former wheel, and sets the whole apparatus in motion. Hence, as the mouths of the passages dip into the water a volume enters, which is carried by the motion of the wheel to seek the lowest point of the passage, which is at the axis of the wheel, where, finding a small opening, it empties itself into the reservoir. The friction of this wheel is inconsiderable.

These three last machines are much used in France for irrigating purposes.

CHAPTER IV.—ON THE BLOWING MACHINE OR WATER-BELLOWS.

The Trompe, or Water-Bellows.

540. Professor Magnus, at the close of his experiments on the motion of fluids, already detailed, gives an account of this piece of mechanism, the principle of which he thinks is to be referred to the penetration of a fluid by air. It is the so-called *trompe*, or water-bellows, which, according to Grignon,[1] was discovered in Italy about the year 1640. The instrument is represented in fig. 109, drawn from the description given by Richard in his *Etudes sur l'Art d'extraire immédiatement le Fer de ses Minerais*, p. 169.

B is a water-holder, kept always full by means of the canal Z. A, A are two tubes or hollowed beams about thirteen feet long, one of which is shown in the section. CC is a wooden cistern or barrel rendered air-tight; the tubes A, A widen toward the top; two boards *p*, *p*, inclined towards each other, are introduced above into each tube, thus forming a funnel-shaped narrowing of the orifice; the boards are kept asunder by the pieces of wood *t*, *t*. Below these pieces a number of apertures *e*, *e*, are made in the tube, through which air can enter. Similar apertures *e'*, *e'* were made in Richard's instrument about half way up the tubes; from these water sometimes escapes, as Richard himself has found, and for this reason it would be better to omit them altogether. When the conical stopper of the funnel-shaped orifice *p*, *p* is drawn upwards, the water falls through the tube, and at the same time air is sucked in at the orifices *e*, *e*; as this is carried downwards by the water into the cistern, the air in the latter increases, and passing into the tube H, streams out of the opening *b*. At *q*, in the bottom of CC, an opening is made through which the descending water can escape; the magnitude of the opening is so arranged that the water can never sink down to it. A second trough is generally placed before the opening, in which the water must first ascend to escape over the edge.

Instead of air being sucked in by *ee*, we may have, in place of the boards *p*, *p*, two wooden funnels high enough to reach over the surface of the water. The water flows through the space between the funnels; this causes the fluid within them to sink and the air to enter.

[1] *Memoires de Physique*, p. 196.

Blowing Machine.

541. The water-bellows is used in some departments of the south of France, and more immediately in the extraction of iron from its ores. In the year 1838 it was employed, with one or two exceptions, in the Department de l'Ariège.

542. Much has been written about the water-bellows; but the real cause of the descent of the air into the machine has never been properly explained, and it is yet totally unknown. Justi asserted last century that the water is changed by the violent motion into air.[1] Venturi again[2] referred the origin of the bubbles to the lateral motion imparted to the air by the moving stream. This would imply that a force of attraction exists between the air and water, sufficient to carry the former far beneath the surface, which is scarcely conceivable. One of Professor Magnus' experiments refutes this notion (422).

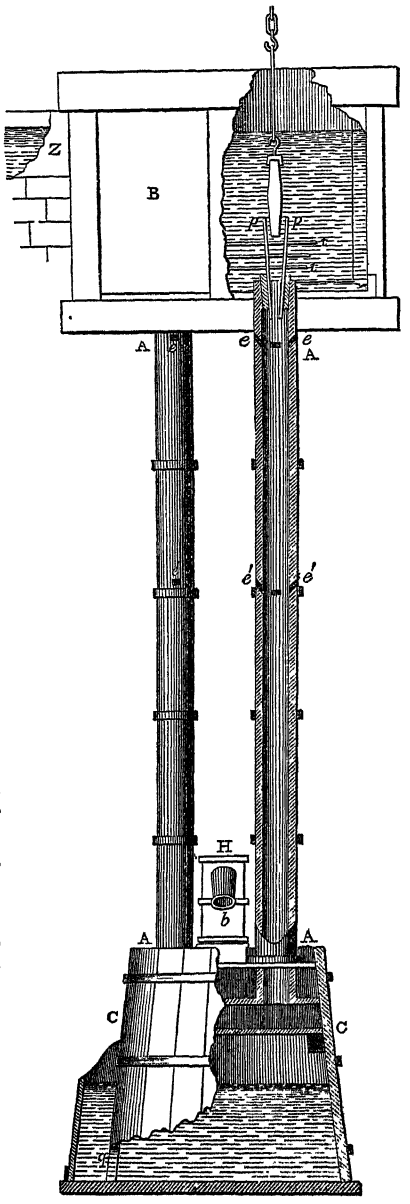


Fig. 110.

543. In order that the phenomena might be observed with the utmost accuracy, Professor Magnus constructed a model glass water-bellows (fig. 111), where N is the water-holder, in which, by means of a cork, the tube *ab*, 6 inches long, is fastened. The lower end of *ab* dips above into the tube *cd*, which is 6·5 feet long, and has an inner diameter of $\frac{3}{4}$ths of an inch; at *d* it pierces a cork which closes the bottle AB, and it ends at *g* about two inches above the bottom of the bottle. Through the cork *d* two other tubes are introduced—*de* which can be closed by the cock *e*, and *hik* which serves as a manometer, and is filled with mercury to *k*.

544. When the tube *ab* had an opening at its lower end of 0·4 of an inch in diameter, as the water flowed through it downwards, a considerable portion of air was carried along with it into the bottle AB. The pressure increased, and as the mercury ascended in *k* the water rose in the tube *cdg*. By means of the cocks *e* and D, the escape of the air and water was so regulated that the water height in *cdg* remained constant. When this height was about three feet over the surface of water in the bottle, the opening being 0·4 of an inch, a multitude of small bubbles were seen to descend with the water through the entire breadth of the tube. When the diameter was greater, the motion was quicker, so that the course of the bubbles could not be exactly followed. When, on the contrary, the opening *b* was smaller, *e.g.*, 0·2 of an inch in diameter, the air bubbles were observed at *f*, but they could not penetrate to the lower end of the tube; as soon as they had attained a certain depth, they rose again in consequence of their small specific gravity. Small isolated bubbles only were able to penetrate to a depth of 24 inches.

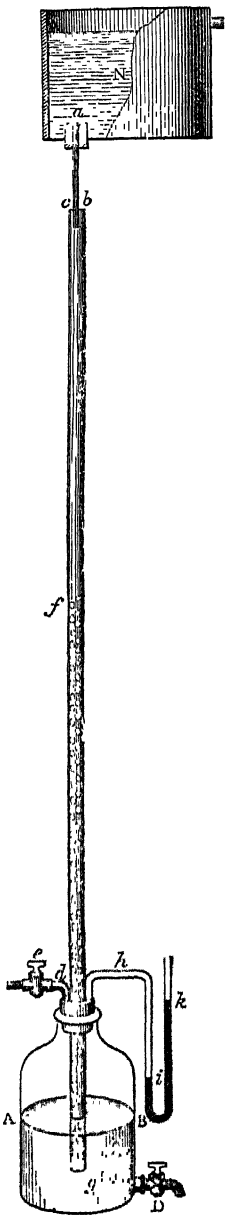


Fig. 111.

545. It is evident that the bubbles are formed at the point where the falling water meets the surface *f*; here they are quite inclosed by the water, and carried with it downwards. If the force which causes this motion be so great that the bubbles descend more quickly than they would arise in consequence of their small specific gravity; then they will reach the bottle AB. This, however, can only take place when the water falls from a sufficient height, and when the opening *b* bears a sensible ratio to the diameter of the tube *cdg*. If this ratio be small, the motion of the water in the latter is feeble, and the bubbles move more quickly upwards than downwards. If the opening be not much smaller than the tube *cdg*, the falling water closes up the latter, even when the tube, instead of reaching to *g*, ends immediately under the cork *d*. The water then stands at a height within the tube corresponding to the air-pressure in the bottle underneath; and, in general, exactly the same effects are observed as when the tube *cd* penetrates the surface of the water. Hence, in the case of the water-bellows it is unnecessary that the tubes A, A (fig. 110), should reach under the surface of water in the drum CC.

546. It will be observed that the action which takes place here is similar to that which is observed when water is poured into a glass, in which case also bubbles are carried downwards. The phenomena are so far explained by Prof. Magnus in his experiments on the motion of fluids (416).

547. We have an example of a trompe on a large scale in the method sometimes pursued after an explosion in a mine. The nearest rivulet being allowed to flow down the shaft, a considerable volume of fresh air enters with the water, and renders practicable a descent into the mine to succour the injured miners. (See *Commerce of Arts*; Wolfii *Opera Mathematica*; *Richesse Minérale*, tom. iii.; *Manuel de la Métallurgie du Fer*, by M. Karsten, tom. ii.; *Annales des Mines*, tom. ix., 1824; xi., 1825; Nicholson's *Journal*, vols. ii. and xii.) (D. B.)

[1] *Exhibition of Arts and Manufactures*, vol. ii., p. 97.

[2] Gilbert's *Annalen*, vol. iii., p. 125.

Hydrometer ‖ Hydrophobia.

HYDROMETER, an instrument for measuring the gravity, &c., of fluids. See HYDRODYNAMICS.

HYDROPHOBIA, dread of water (from ὕδωρ, *water*, and φόβος, *fear*), though a symptom occurring in several diseases of the nervous system, is now very generally restricted to that disease which results from the bite of a mad dog, wolf, or cat. This disease has been known from the earliest antiquity, and was styled by the Greeks λύσσα, by the Latins *rabies*, and the French *rage*. The disease is essentially a convulsive one, resembling tetanus, but is characterized by the inability to swallow fluids, the very sight of which induces convulsive spasms of the muscles of the mouth and pharynx, which extend more or less to the whole body.

This disease in man is invariably caused by the bite of some animal of the dog or cat kind, though it has been asserted, without proof, that the bites of other animals have induced the malady. The disease seems to originate in the different species of the genera *canis* (dog), and *felis* (cat), and is capable of being transmitted to man and all animals by the saliva of these animals being introduced into the system by means of a wound or bite. It has been lately endeavoured to be proved that only those animals in whom the disease originates can communicate it to others, and that the saliva of the animal which has had the disease communicated to it through means of a bite is incapable of communicating hydrophobia to the person or animal it bites.

Many lives are lost annually through hydrophobia. In France 48 persons died from this malady in 1852, 25 in England during 1851, 15 in 1852, and 11 in 1853—the last year of which the causes of death are published. From recent investigations in France, it appears that of 136 cases of hydrophobia in the human subject (the particulars of which were investigated by a commission appointed in 1852 by government), 105 followed the bite of a dog, 20 the bite of a wolf, 8 the bite of a cat, while of 5 the particular animal whose bite caused the malady was not ascertained. The persons were of all ages, from the infant at the breast to the old man of ninety. The period of the year when the bite which caused the disease was received was ascertained in 90 cases. In 25 of the persons the bite was received during the months of March, April, and May; in 42 cases, during June, July, and August; in 13 cases, during September, October, and November; and in 17 cases, during December, January, and February. The disease does not appear in man till some time after the receipt of the bite. Thus, in 69 cases where the exact date of the appearance of hydrophobia after the bite was ascertained, it appeared that in 14 cases the disease appeared within the month after the bite; in 41 cases, from the end of one month to the end of the third month; in 8 cases, from the beginning of the fourth to the end of the sixth month; and in 6 cases, from the seventh to the twelfth month. No case occurred in which the disease had appeared after more than one year elapsed from the date of the bite. The exact duration of the disease from its first appearance to its termination in death was ascertained in 78 cases. Of these 3 died the first day of the disease, 8 the second day, 28 the third day, 21 the fourth day, 4 the fifth day, 4 the sixth day, and the remaining 10 from the seventh to the twentieth day. This shows the frightful rapidity of the disease. The disease, when once it manifests itself, is quite incurable. Every means must therefore be taken to prevent the disease originating in the person bitten, and many means of cure have been recommended for this purpose; only, as it is known that but a very few of those bitten by a rabid animal take the disease (supposed not to exceed 1 in 20), it is not certainly known whether the subsequent freedom from the disease is to be ascribed to the means resorted to, or to natural causes. The bitten part should be instantly washed, and fluid caustic, or nitric acid, or probably still better, caustic ammonia solution, freely applied to the wounded surface, care being taken that the caustic reaches the bottom of the tooth-wounds. Many recommend, in addition, to dress the wounds till they heal with red precipitate of mercury ointment, and to take internally sufficient mercury slightly to affect the system. Decoction of sarsaparilla and guaiac internally, and occasional hot or vapour baths, have, in addition to these remedies, been highly recommended. (J. S—K.)

Hydrostatics ‖ Hyginus.

HYDROSTATICS. See HYDRODYNAMICS.

HYDRUNTUM, or HYDRUS, now OTRANTO, in *Ancient Geography*, a sea-coast town of Calabria, at the mouth of the Adriatic, and the most easterly point of the *heel* of Italy. Of its early history little is known; but it seems to have been either a Greek city, or to have been at one time inhabited chiefly by Greeks. Till the rise of Brundusium, it was a place of considerable importance. The great Roman highway, the Via Appia, terminated there, pouring into the town all the traffic between Rome and Greece, to which it was the nearest Italian port. Passengers, however, afterwards came to prefer the Brundusian route as safer, though somewhat longer. In the time of Strabo, Hydruntum had dwindled down into an insignificant spot; but in the fourth century it once more became the favourite route to Greece, retaining its importance till the final overthrow of the Western Empire. The modern Otranto, though the see of a bishop, is a small decayed town, and seems never to have recovered from its siege and capture by the Turks in 1480. The antique remains recovered from its ruins are too trifling to require special notice. Under the French empire it gave the title of duke to Fouché, Napoleon's famous minister of police. Its present population is rather above 5000.

HYERES, or HIERES (anciently *Arcæ* and *Hieros*), a town of France, department of Var, and arrondissement of Toulon, on the S. declivity of a hill, 3 miles from the Mediterranean, and 10 miles E. of Toulon. The town itself, which is ill-built and dirty, commands a fine prospect of the surrounding district. The streets are steep, narrow, winding, and badly paved. In the principal square there is a column surmounted by a fine marble bust of Massillon, who was born here, June 24, 1663. Pop. 9000.

HYERES, *Isles of* (anciently *Stœchades*), a group of small islands in the Mediterranean, about 10 miles S.E. of Hyeres. They are rocky and almost bare, but are strongly fortified. Porquerolles is 5 miles in length by 2 in breadth.

HYGINUS, CAIUS JULIUS, a celebrated Roman grammarian, was a native of Spain, or, according to others, of Alexandria, in Egypt. He seems to have been at one time a slave, and to have been manumitted by Augustus, who made him keeper of the Palatine library. His master was the famous Alexander, surnamed Polyhistor, whom he is said to have imitated closely in his writings. Suetonius mentions that in his old age he fell into poverty, and was supported chiefly by the generosity of a rich consular named Licinius, who, with the poet Ovid, had been his most intimate friend in early life. The dates of his birth and death are alike unknown. Hyginus is frequently mentioned by Pliny and Aulus Gellius, and always with respect. Not one of his works has come down to us, and even of the titles only the following are known:—*De Urbibus Italicis; De Proprietatibus Deorum; De Virgilio Liber; De Familiis Trojanis; De Agricultura.* Another Hyginus, who has been quite unwarrantably identified with this one, has transmitted to us two works, entitled respectively, *Fabularum Liber*, and *Poeticon Astronomicon, libri iv.* The first of these is a collection of legends from the old mythology, some of which are presented under new forms; the title of the second sufficiently explains its purport. Both of these works are written in a style so impure as to savour of the iron age; but who their author was, or when he flourished, has been very much disputed. Some critics even declare that they are merely translated from the Greek. To this Hyginus also are attributed treatises *De Castrametatione*, and *De Limitibus Constituendis*, which have been several times reprinted.

HYGROMETRY.

Hygrometry.

A VAST number of substances, such as sugar, flour, bread, &c., possess the property of absorbing moisture, the amount of which varies according to the circumstances in which they are placed. Atmospheric air also, and most gases, absorb and retain aqueous vapour, so that in all experiments regarding the composition of bodies it is necessary to ascertain their state as to dampness. The values of many commodities are greatly influenced by the quantity of moisture which they hold, and hence the utility of having some means of ascertaining this quantity.

The word hygrometry (from ὑγρος, moist, and μετρον, a measure) signifies the measurement of dampness, and therefore serves to denote the assemblage of processes, by help of which we attempt to measure the humidity of bodies. But the word is commonly restricted to atmospheric hygrometry; and, indeed, is the only department which has received adequate attention from natural philosophers.

When a substance capable of absorbing moisture is placed in damp air, it becomes gradually more and more humid, until a kind of equilibrium be established; that is, until the affinity of the air be so augmented, and that of the substance be so reduced, that no farther action goes on; and, conversely, when a moist body is placed in dry air, the air abstracts the moisture until a hygrometric equilibrium result. The humidity of the substance becomes thus an index to the dampness of the air in which it is placed.

By taking advantage of this circumstance, and of the changes which certain substances undergo when moistened, several experimenters have attempted to construct hygrometers; but, as yet, no instrument of this kind has been contrived which deserves a higher appellation than *hygroscope*, or indicator of dampness, and very few of them deserve even this name.

Humidity, while it augments the weights of bodies, is observed also to change their volumes and forms. Thus, a sheet of paper expands very considerably on being moistened, and contracts again on being dried. Hence, in order to stretch a sheet of paper, we first moisten it thoroughly, and then paste it down, or glue down its edges, in order that when dry it may become tense. The varying length of a slip of paper would thus serve to indicate the dampness of the adjacent air, were it not that paper undergoes a permanent change when much moistened, and that there is reason to think that the dust which penetrates its pores tends to alter its hygrometric properties.

The variability of paper renders it very unfit for accurate plans; but no substitute has been found for it. The variation in length from extreme dryness to extreme dampness is about 1 in 42, but is different in papers of different makes.

Every species of wood is liable to hygrometric changes, a circumstance which gives great trouble in carpentry. The change length-ways is small; but across the grain of the wood the expansion caused by moisture is very great. Generally, the change in the breadth of planks cut radially from the tree is much less than that of planks cut tangentially. This is shown by the manner in which the trunks of trees rend on being dried; the radial fibres contracting much more than the circular ones, and hence producing only radial rents.

On account of this great lateral contraction the pannels of doors are fitted into grooves so as to allow of some shrink; for if secured at the edges they would be liable to split.

All organic substances contain pores expressly for the conveyance of their juices, and are influenced by the accession of moisture, some of them very remarkably; and attempts have been made to render the changes which they undergo subservient to the measurement of humidity; but, unfortunately, these changes are very precarious as to their amounts, while repeated fluctuations are found gradually to impair the sensibility of the materials.

Hygrometry.

The hygrometer of Saussure is formed of a hair from which the oily matter has been removed by a gentle boiling in water containing one per cent. of the sulphate of soda. One end of the hair is fixed by pincers to an adjusting screw, and the other end to the periphery of a small pulley carrying an index, so that a minute change in the length of the hair may produce a perceptible motion in the index: a counterpoise is appended for the purpose of keeping the hair gently stretched.

The whalebone hygrometer of Deluc is constructed on the same principle, but the substance employed is a slip of whalebone cut across the fibres. The instrument is shown in fig. 1. A slender spring keeps the whalebone stretched.

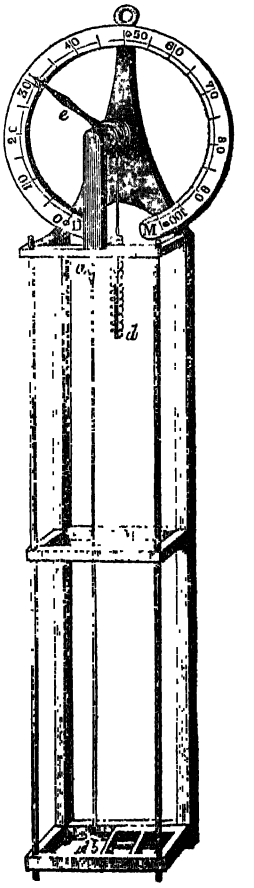


Fig. 1.

Captain Kater used the twisted Indian grass called *Oobeena Hooloo*, which possesses the remarkable property of twining and untwining according to the dampness of the air.

The manner of graduating these, and all hygrometers of this class, is to expose them for some time to air thoroughly dried, and then to air thoroughly humid, and to mark the two extremes of the scale, which is usually divided into 100 degrees. For the zero of the scale the air may be dried by means of concentrated sulphuric acid, fused chloride of lime, or any substance having a great affinity for moisture; and for the other extreme it may be moistened by suspending linen rags well soaked in water inside of the receiver, taking the precaution to wet its sides, and to place a saucer of water in it.

None of these instruments, however, give consistent results; so that the whole of them have fallen into disuse as accurate measurers, although they do serve to give a rough idea of the state of the air in regard to moisture.

It is well known that the temperature of a wet body is lower than that of a dry one exposed to the influence of the same air. Leslie applied this depression of temperature to measure the dryness of the air; for this purpose he placed two delicate thermometers near each other, the bulb of the one being covered with moistened linen or paper, and that of the other being dry; the difference between the two was an index to the drying power of the air. The original instrument which he used was composed of two thermometers jointed together, and provided with three slender feet; it is in the possession of the writer of this article. Afterwards Leslie applied the far more delicate

Hygrometry.

differential thermometer (fig. 2) to the same purpose; and his hygrometer is, perhaps, the most delicate instrument which we possess for indicating the humidity of the air. This instrument is formed by uniting two tubes having a ball blown on the end of each, and having a little tinged sulphuric acid previously introduced. The united tube is then recurved, as shown in the figure, and by a little management the end of the column of acid is brought near to the upper end of one of the tubes. When both balls are at one temperature the instrument indicates zero; and when one of them is covered with wet paper the instrument indicates the depression of temperature. Leslie graduated his hygrometers to show tenths of a centigrade degree.

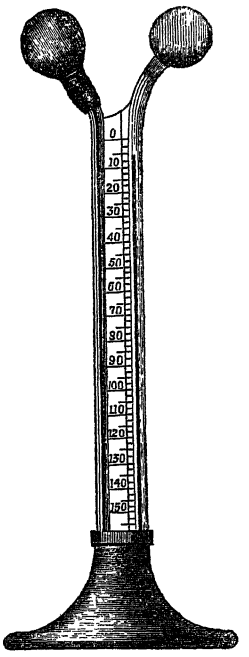


Fig. 2.

The indications of this instrument are very precise, and give definite information as to the state of the air; but it is evident that as it merely shows the amount of cold produced by evaporation, it is not strictly a hygrometer. The readings of the thermometer and barometer must also be taken before the quantity of moisture contained in the air can be computed.

It has been proposed, as an improvement on Leslie's hygrometer, to place two thermometers side by side, the bulb of one of them being kept moist by capillary action; this is only a return to the ruder and less delicate form of the instrument.

Warm air is capable of holding in solution more moisture than cold air can, and hence, in order to ascertain the quantity of moisture corresponding to the reading of a Leslie's hygrometer, we must observe the temperature of the air, and deduct from the total quantity of moisture which air at that temperature is capable of holding, the deficiency made apparent by the degree of cooling.

If, then, warm damp air be cooled sufficiently, it may be made to deposit its moisture: as soon as the air reaches that temperature, the moisture which it contains begins to be deposited on the surfaces of surrounding bodies, and *dew* is formed. Of this we have a familiar example in the dew which is formed on the surface of a jar containing cold water when it is brought into a warm apartment, particularly if the air of the room have been moistened by the breaths of a numerous company; and also in the water which trickles down the insides of our window-panes during a cold night.

Advantage is taken of this circumstance in the construction of Daniell's hygrometer or dew-point instrument. In its first form this hygrometer consisted of a widish tube expanded into a ball at each end; a quantity of ether was introduced previous to the closing of the tube, which was so bent that the whole of the ether might rest in either ball; a small thermometer also was previously inserted, having its bulb half immersed in the ether when in one of the balls. The liquid was then made to boil, so as to expel all the air, and in this state the tube was closed. By this means a Wollaston's cryophorous, on the small scale, was formed.

On bringing all the ether into the one ball, and cooling, by any means, the other ball, the temperature of the ether could be reduced; and if the cooling were carried sufficiently far, dew was formed on the outer surface of the glass. The indication of the inclosed thermometer then gave the dew-point.

Hygrometry.

The general principle of this hygrometer is excellent; but some little defects in the detail of the operations rendered it somewhat uncertain. In order to produce a sufficient degree of cold, the empty ball was covered with a piece of linen or silk, on which was poured a quantity of ether, and the observer had to watch the instant when the dew began to be deposited on the glass. In this way time could not be allowed for the glass, ether, and thermometer bulb to come all to one temperature, and the indication of the thermometer was therefore influenced by the rapidity or slowness of the cooling.

Dr Cumming, Professor Connell, and M. Regnault severally made contrivances for remedying this inconvenience; these are all founded on the same principle, and as that of M. Regnault seems best to accomplish the desired effect, we shall confine our observations to it.

M. Regnault's *condenser hygrometer* (fig. 3), as it is called, consists of a cylinder or thimble, made of very thin silver, and highly polished, 2 inches deep and $\frac{8}{10}$ths of an inch in diameter. This is fitted tightly on a glass tube, *cd*, open at both ends. The tube has a small lateral tubulure, *t*, near the upper end. The upper end of the tube is closed by a cork, through the centre of which the stem of a very sensible thermometer is passed. The bulb of the thermometer is in the centre of the silver thimble. A very thin glass tube, *fg*, open at both ends, passes through the cork, and descends almost to the bottom of the thimble.

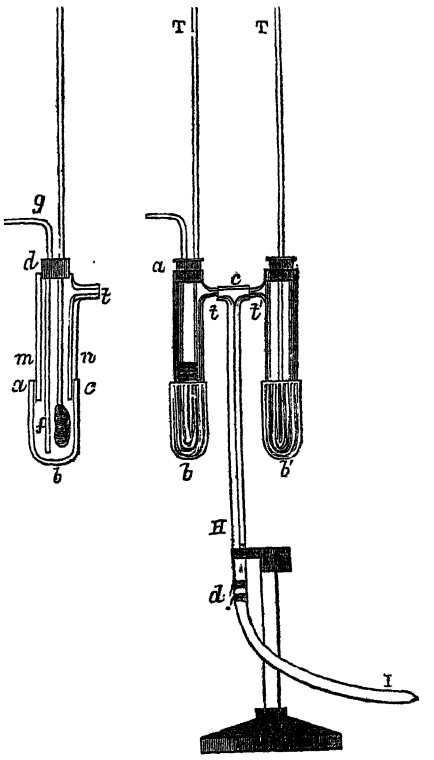


Fig. 3.

Ether is poured into the tube *cd* as high as to *mm*, and the tubulure *t* is placed in communication with an aspirator jar, six or eight pints in capacity, or with a small circular exhausting bellows, by means of the upright supporting pillar *H* and the flexible tube *I*, which is furnished with a stop-cock.

On allowing water to run from the aspirator jar, or on opening the bellows, air passes down the tube *gf*, and rises in bubbles through the ether, which is cooled by the induced evaporation. The refrigeration is the more rapid the more freely the air is made to pass, and the whole mass of ether is of a uniform temperature as it is briskly agitated by the passage of the bubbles of air. The temperature is sufficiently lowered, in less than a minute, to cause an abundant deposition of dew.

By regulating the supply of air, the thermometer may be kept readily at any required temperature less than that of the external air. Now the object of the observer is to discover at what exact temperature the dew begins just to be formed. When, therefore, he has obtained a copious deposition on the bright surface of the silver, he reduces the supply of air so as to allow the thimble to be warmed and the dew to disappear; he then augments the supply of air

again to cool the silver cautiously till the dew reappear. In this way he can ascertain the dew-point true to the tenth part of a degree of Fahrenheit's thermometer. The observer must remain at a distance from the apparatus, in order that the warmth of his body, and the humidity of perspiration, may not derange the results; a small telescope or opera-glass may be used to read off the degrees.

Less ether is needed with this instrument than with the original form of Daniell's hygrometer, and, unless when the air is very dry, the ether may be replaced by alcohol.

In order to measure the temperature of the air, another apparatus exactly similar, but containing no ether, is placed under the influence of the aspirator.

These two, the wet-bulb and the dew-point hygrometers, are the only instruments which have yet been contrived for giving definite information as to the humidity of the atmosphere; but neither of them indicates *per se* the quantity of moisture contained in a given volume of air; that quantity can only be ascertained by help of carefully conducted experiments.

Our knowledge of this branch of the subject is extremely limited, and the attention of scientific men is at present directed to the law which connects the indications of the dew-point and wet-bulb hygrometers.

For this purpose the simultaneous readings of the two instruments, of the thermometer and barometer, are all observed under as great a variety of circumstances as possible. It is to be regretted, however, that in making these comparisons an attempt is made to discover the ratio between the depressions of the dew-point and of the wet-bulb below the temperature of the air; a formula of the form

$$T-t=f(T-t')$$

being used, in which T is the temperature of the air, t that of the dew-point, and t' that of the wet-bulb; f being a coefficient, the values of which corresponding to different values of T are sought to be ascertained. Now one may easily see that when the air is nearly saturated with moisture both of the depressions $T-t$ and $T-t'$ must be small; but it does not follow that they are proportional to each other; for if we imagine the air to be nearly dry, the wet-bulb hygrometer will be nearly at its maximum reading, while the dew-point instrument has, so to speak, no maximum, since, when the air is perfectly dry, no conceivable lowering of temperature can ever cause it to deposit moisture.

The discussion of these matters, however, belong to the subjects of METEOROLOGY and EVAPORATION, to which articles the reader is referred for further information. (E. S.)

HYMETTUS, a celebrated mountain, or rather a mountain range of Attica, forming the S.E. boundary of the Athenian plain. It consists of two separate parts, the northern or Greater Hymettus, now called *Telo-Vuni*, and the southern or Lesser Hymettus, described by the ancients as Anhydrus, or the Waterless, and now called *Mavro-Vuni*. The highest point of Hymettus is 3506 feet above the level of the sea. The honey of Hymettus was regarded by the ancients as only inferior to that of Hybla; and the classics abound in allusions to the excellence and beauty of its marble. (See ATTICA.)

HYMN, a sacred ode, adapted in its original design to religious services of a public character. The primary idea of the hymn was adoration; but its specific meaning and purpose have been gradually extended, till the name has come to be applied to all classes of devotional compositions treated in the shorter metrical forms. Hymns were an important feature in the religious festivals of the ancient world. The classic mythology, that wonderful product of the legends of an imaginative people, yielded rich materials for poetical treatment; and numerous specimens of the lyric ode, sung in temple and theatre amidst music and choral dances—the exulting pæan, and shrill, maddening dithyramb—are preserved in Greek and Roman literature.

These ancient hymns are of three kinds—The *theurgic* or *religious*, as the so-called hymns of Orpheus, which were chanted by the initiated in the mysteries; the *poetic* or *popular*, which celebrated the fabulous adventures of gods and heroes, as the hymns of Homer and Callimachus, Pindar and Horace; and the *philosophic*, in which the esoteric tenets of the schools were presented under religious symbols—the homage of speculative intellect to popular belief. The hymn of Cleanthes is a lofty theosophic prayer to Zeus for light and wisdom, in the style of Milton's invocation to Urania.

But it is in the sacred poetry of the Hebrews that we find the perfect development of the hymn. In the odes of Moses and Deborah, there is a higher and purer inspiration than that of Aonian mount and Castalian spring. Daily, in the temple of Jerusalem, bands of priests and Levites with alternate voices chanted psalms in which saintly genius had been consecrated to the noblest ends. These psalms, chiefly composed by David, continued to be employed in the more spiritual worship of the Christian Church. They formed the language of its earliest praise, as they found in its faith their clear and full interpretation; and on this ancient and sacred basis has the whole superstructure of Christian hymnology been raised.

At what period hymns distinctively Christian were introduced into evangelical worship cannot be exactly ascertained. The apostolic writings speak of "psalms and hymns and spiritual songs;" and the last of these expressions has been supposed to refer to the doxologies or fervent strains of thanksgiving uttered by those who possessed spiritual gifts. We learn from Philo (*De Vit. Contemplat.*) that hymns of their own composition were used by the Essenes or Therapeutæ, a sect of Jewish ascetics, in their religious assemblies. Michaelis and others think they discover fragments of apostolic hymns in such passages as Eph. v. 14; 1 Tim. iii. 1, 16; 2 Tim. ii. 11, which have a kind of rhythmical flow. We have the testimony of Pliny, in the famous letter to Trajan, early in the second century, that the Christians "repeated hymns among themselves to Christ, as to a god." An early Christian writer remarks, that "the praises of Christ, the Word of God, were set forth in psalms and hymns of the brethren, written at the beginning" (*Eusebius*, lib. vii. c. 28). Three ancient Greek hymns, transmitted to us in the *Apostolic Constitution*, are supposed by Bunsen, a competent authority, to be the sole authentic specimens we possess of the ante-Nicene psalmody and hymnology. The first of these, the *Gloria in Excelsis*, commonly termed the "Morning Hymn," forms part of the communion service of the Anglican Church. Another, a *Hymn at the Lighting of the Evening Lamp* (Ὕμνος τοῦ λυχνικοῦ), is an interesting relic of the simple devotion of the early Christian household. The first writer known to have composed hymns for the worship of the Western Church is Hilary, bishop of Poitiers, who died A.D. 368. About the same time Ambrose introduced choral singing into the church of Milan, and wrote the *Te Deum*—a magnificent composition, moving in the majestic cadences of the Hebrew psalm. But both hymns and choir-song had existed from a much earlier period in the Eastern Church. A specimen of the Greek hymn, the earliest known, is found in the writings of Clement of Alexandria, who flourished in the beginning of the third century (*Paedag.* lib. iii., *ad fin.*) Gregory of Nazianzus, towards the end of this century, acquired reputation as a writer of hymns. The general

Hymn. diffusion and influence of the earlier hymns may be inferred from the fact of the heretical sects availing themselves of the popular taste in order to disseminate error. Arius wrote songs "for the sea, and the mill, and the highway, and set them to music." These rude chants materially promoted the spread of his doctrine. Chrysostom found Arian canticles in great esteem at Constantinople, and combated their tendencies by counter-hymns in defence of the Catholic doctrine. The Gnostic Bardesanes imitated the *Psalms of David*, not only in style and structure, but in number. He composed 150 mystical hymns; in these pseudo-psalms "presenting to simple souls," says Ephraem Syrus "the cup of poison tempered with seductive sweetness." This false coinage shows the currency of the genuine metal; and Jerome tells us that in his day "you could not go into the fields, but you might hear the ploughman at his hallelujahs, the mower at his hymns, and the vine-dresser singing David's *Psalms*."

In the 4th Council of Toledo, A.D. 633, the use of hymns was formally sanctioned by the Western Church. Most of the hymns for the festivals of saints and martyrs had been written at a much earlier period by Prudentius. We find some great names of the Latin Church in the list of its sacred minstrels;—Popes Gelasius and Gregory, Paulinus, Venantius Fortunatus, Bernard, Anselme, Bede, &c. The famous hymn of Thomas Aquinas—*Pange, lingua, gloriosi*—fixes the epoch of transubstantiation, the point at which the rhetoric of the pulpits froze into the logic of the schools—

> "Verbum caro, panem verum
> Verbo carnem efficit;
> Fitque sanguis Christi merum,
> Et si sensus deficit
> Ad firmandum cor sincerum
> Sola fides sufficit."

The great harvest of hymns was produced from the eleventh to the thirteenth centuries in the Gallican and German cloisters. Many a monk employed himself, in the interval of inditing palimpsests and illuminating missals, with stringing together leonine triplets and sextains. The constant perusal of the Fathers strengthened this tendency. In the prose of Augustine we are struck by the frequent recurrence of rhythmical cadence and balanced antithesis. It was the delight of the monkish versifiers to compress hard theological formulæ into pithy epigrams, and set them to a rough jingling music. The learned Benedictines of the congregation of St Maur specially laboured in this vocation, and weeded the service-books of many puerile and barbarous ditties (vide *Leysser, Polycarp. Hist. Poet. et Poem. medii ævi*).

Some of the best Latin hymns are anonymous, as the *Coelestis urbs Jerusalem*, long a favourite in Scotland ("O mother dear Jerusalem"), though the original may be found in Augustine's *Meditations; In abysso Deitatis*, and *Veni Creator Spiritus*, translated by Dryden. The *Dies Iræ* was composed by Thomas von Celano, a Minorite friar, and the *Stabat Mater* is ascribed to Jacopone.

The Reformation was accompanied by an outburst of song on the part of the people throughout Christendom. The altar-screen which fenced the priestly caste from laic intrusion was broken down. Instead of canons or friars intoning drowsy antiphons in the choir at the hours of prime, sext, and compline, the Reformed congregations, young men and maidens, old men and children, were heard with loud voices praising God. Translations of the *Psalms* prepared the way for hymns which popularized the tenets of the Evangelical Confessions, and became to the religious life of the Protestant communities what the ballads of a nation, according to Fletcher's maxim, are to its political life. In Luther's hand "the thing became a trumpet." His hymn *Ein' feste Burg ist unser Gott*, has been called by Heine the *Marseillaise* of the Reformation.

In striking contrast with the number of hymns elicited by the great religious awakening on the Continent, is their comparative scarceness in the early Protestant literature of England and Scotland. We know that in both countries religious canticles were adapted to old and favourite tunes, and widely diffused, but they were never so thoroughly assimilated with the religious life of the people, and incorporated with its ritual, as in Germany. The sublime poetry of the Bible satisfied the popular heart, while it nourished the intellect and imagination; and the psalms of the Jewish temple were sung with clearer emphasis and fuller response in the Christian sanctuary. The hymnology of British Protestantism may be said to be the growth of the last century and a half, before which period Germany possessed a classic literature of sacred song. The rude English version of the *Psalms* by Sternhold and Hopkins was superseded by that of Brady and Tate—a sacrifice of rugged strength to insipid smoothness and inflated verbosity. Milton's attempts at translation only show that his strong arm could not bend the bow of Ulysses. The Scottish version, though in reality the work of an English Puritan, has, with all its roughness and dissonance, preserved more of the vital spirit, the rich and pure aroma of the Hebrew original. Hymn.

The sacred poems of Herbert, Quarles, Vaughan, and other writers of that period, cannot be accepted in the strict sense as hymns. A few written by Mason, who died in 1694, more justly deserve the name. They are often quaint and harsh in diction, but compact with thought, and luminous with imagery. The hymns we have from Addison's pen are marked by elegance and refinement, and devoutness of feeling, though his muse stands in the outer court of the temple. Tried by the test of popularity—here a true criterion of excellence—one of the highest places must be assigned to those of Watts. He is our most voluminous writer, and though his effusions are occasionally deformed by conceits and false ornament, they are often lofty, impassioned, and felicitous in expression, while, above all, the living spirit of devotion breathes in every line. More simple and spontaneous are the hymns of Doddridge, with the same sacred warmth and glow. The numerous hymns of Charles Wesley are distinguished by the predominance of the subjective and emotional elements. Everywhere they are stamped with a fervid individuality, which verges at times upon vagueness and mysticism of the Moravian type. The hymns of Toplady, the great antagonist of the Wesleyan theology, are often charged with dogmatic statement to a degree of prosaic stiffness and austerity; but some of them, in their simple energy and fulness, and a kindling ardour which reminds us of Wesley, have obtained general currency. One of the most popular collections is that known as the *Olney Hymns*, the joint production of Cowper and John Newton. Newton's hymns are sound, vigorous, and sensible presentations of Christian truth, penetrated and vivified by deep Christian experience; while those of Cowper, by their tenderness and truth, their touching personal allusions, solemn saintliness, and sweet imagery, have made their way to the universal Christian heart. Two of Logan's hymns in the Scottish *Paraphrases* take rank with the finest in the language. Among more recent writers may be mentioned the names of Beddom, Steele, Jane Taylor, and, above all, James Montgomery, who exhibits some of the highest excellencies of a sacred lyrist. His lines on prayer are household words. *The Christian Year*, by Keble, may be noticed as having contributed, equally with the *Tracts for the Times*, to the success of the Anglo-Catholic reaction in the Church of England. In these pensive, dreamy, soothing strains, we have the logic of the Oxford schools turned into rhetoric. The academic cloister and the Gothic aisle are the "haunt and main region" of his song. The white Levitical vestment is his singing-robe, and you listen in the dim religious light to a music like the lulling chime of church-bells.

Hymn.

The Lutheran Church may be proud of her hymnology. Those who wish to see the flexibility, compass, and affluence of the noble German speech may look for it there. Her singers have swept every string of the many-chorded lyre,—sounded the full diapason from heights of aërial rapture to depths of penitential sorrow. Most of her great writers have cast their shekel into the temple-treasury. Goethe in his last days regretted having made no contribution to her sacred song; but his was the loss, not hers. The Reformation period, and that immediately succeeding, are illustrated by the names of Luther, Justus Jonas, Nicolaus Decius, Herberger, Schalling, Nicolai, and many others. The Thirty Years' War gave birth to the *Kreuz- und Trost-Lieder*, songs of trial and comfort, by men like Neumark, Albinus, Joachim Neander, Paul Fleming, and Paul Gerhardt. Her later poets have not attained to the rank of the first, though names like those of Tersteegen, Zinzendorf, Gellert, and Klopstock, have inscribed themselves indelibly on her annals. During the period when Rationalism ruled in her schools and pulpits, an attempt was made to tone down the rich evangelic colouring of the *Gesangbuch* to the dead neutral tint of the dominant Neology. This process of dilution was known as "Gesangbuchs Verwässerung,"—hymn-book watering,—but it did not succeed, and the sound doctrine and fervid devotion of the old hymns remained to protest against, not seldom to counteract, the petrified theology of the pulpit. Among modern writers may be mentioned the names of Novalis, Arndt, Hiller, Spitta, Knapp, &c.

The comparative poverty of the classic literature of France in hymns is striking when contrasted with its richness and fecundity in other départments. The Gallican Church continues to intone its praises in the old sacred language of the Vulgate and the Breviary,—the Sanscrit of the Western ritual;—while the Reformed Church has for the most part remained faithful to its simple version of the Canonical *Psalms*. The first translation of the *Psalms* by Clément Marot in the earlier half of the sixteenth century marked an epoch in the religious history of France. The sacred words wedded to native melodies found an echo in the heart of the nation. The king hummed them as he rode to the chase. The burghers of Paris sung them in crowds in the Pré aux Clercs; and the sweet music was heard in the vineyards of Provence, and among the market-boats of the Loire and Rhone. This famous version, retouched and completed by Beza, made a way through France for the triumphal progress of the Reformed theology. The sacred compositions of Mad. Guyon are well known to English readers through Cowper's translation. Though a member of the Romish communion, her writings are singularly free from its peculiar tone and bias. We find in them deep Christian feeling, aspiring fervour, and chastened emotion; often a sweet and tender simplicity, illumined with a pure, still fire of contemplative devotion. It is the pious, but too introverted spirit of Thomas à Kempis flowing into the poetic mould, and, as in the *Imitation*, the thought often shines dimly through a soft warm haze of sentiment. The keen scent of the Jesuits (*odora canum vis*) soon detected in these effusions the taint of Quietism—that vague suspicion which threw a shadow on the reputation even of Fenelon. In later times, the Catholic missionaries have availed themselves of the influence of vernacular hymns among the common people, and combated Protestantism with one of its own weapons. Simple rhymes or *cantiques* in honour of the Virgin and the saints are a distinctive feature of these missions, and hold the same place in France as the *laudi spirituali* in Italy.

Among hymn writers of the Reformed Church the most voluminous and best known is Cæsar Malan of Geneva. To the higher qualities of the poet this writer makes no pretence, but his hymns are characterized by ardent utterance of devout feeling, and clearness of doctrinal statement, in fluent and unaffected verse. The list of her sacred lyrists, though small, includes the great name of Vinet. He has written little, but left on his hymns the stamp of his powerful intellect, genial heart, and all-pervasive spirituality. After all it may be doubted whether the genius of the French language, with all its grace and pliancy, lends itself with such facility as the sister tongues of Germany and England to the grave and simple measures of the hymn. (See Bunsen's *Versuch eines allgemeinen Gesang-und Gebetbuchs.*) A full collection of Latin mediæval hymns has been recently published at Freiburg, in Baden, by M. Mone, librarian at Carlsruhe. (J. D. B.)

Hypatia.

HYPATIA is one of those whose names are glorified rather by wrongs than by merits; and had she not died, few would now know, and fewer care, whether she ever lived.

The facts which remain concerning her are these, as far, at least, as we can trust an age in which historians, philosophers, and priests, were equally careless of facts.

In the year A.D. 415 (or more probably 413) there was at Alexandria a maiden, beautiful, eloquent, and a great mathematician, according to the standard of those times. She seems also to have been possessed of some political genius, for Orestes, the prefect of Alexandria, did nothing without consulting her. She was the reigning star of the then Alexandrian school of Neo-Platonism, and was possibly the instructress of Syrianus, who, after the victory of the Christians, migrated to Athens, and became the spiritual father of the famous Proclus.

Proclus, then, may be considered as the ultimate development of Hypatia's teaching: what it was in itself, we know not. As an orator, she seems to have been the outcome of that school of Neo-Platonism in which, under the Emperor Julian, Maximus, Libanius, and their contemporaries, tried without effect the force of preaching as an antidote to the popular and powerful sermons of the Christians. As a commentator on the geometry of Apollonius and Diophantus, she may have had leanings toward that earlier and finally victorious school, which attempted, under the teaching of Iamblichus, to discover in *a priori* physical science a symbolism which might express *a priori* spiritual truths. A similar movement among men of feminine minds arose in the seventeenth century, when Böhmen, Van Helmont, Eugenius Philalethes, and other theosophists, attempted at once to justify their mysticism (far purer and nobler than that of the Neo-Platonists) by proving its analogy with the supposed laws of the material universe, and to preserve the already decaying *a priori* science of the middle ages. In both cases the attempt was a sign of approaching and inevitable death to the systems of thought which it advocated, whether physical or spiritual. Doubtless there is an analogy between the physical and the spiritual worlds. The instincts of all ages and races, whether materialist or spiritualist, have assumed and acted on the postulate. It remains for some future age, if not to discover, at least to prove by experiment, that the analogy must be worked out by investigating the spiritual world, on the only method henceforward allowable in the physical one, namely, on the inductive method.

Whatsoever, therefore, Hypatia's opinions may have been, her work in the world must have been very insignificant, except in as far as a chaste and high-minded woman, however illogical, is certain to instil into her hearers something of her own purity and loftiness. To this influence of hers we should attribute the intense veneration which Synesius, bishop of Cyrene, evidently felt for her. In his most amusing letters, there are some six addressed to her. They are, for the most part stilted and artificial, as written to a person of artificial character, self-conscious herself (as were all her school), and demanding self-consciousness in others; despising simple nature, and requiring art as the token of supra-

Hypatia.

human education. But one or two really pathetic passages in them show that Hypatia was one to whom (if merely in virtue of her woman's heart) Synesius could pour out his most real and human sorrows, sure of sympathy, if not of comfort. These letters, indeed, with the tone of chivalrous admiration which they breathe, are among the most interesting documents of the age; and indicate, with the *Æthiopics* of Heliodorus, and even the *Pastorals* of Longus, that there were men here and there, among the ancient and dying races of the South, who were approaching, for good and evil, the mediæval form of thought as to the relation of the sexes. Hypatia herself, however (if we are to credit Suidas), carried to an extreme the Manichæan disgust of sex common to Neo-Platonists and to monks. Her method of ridding herself of a certain unfortunate lover is probable enough, but too gross to quote. Those who may read it in the original will do well to remark (unless the histories of Popish saints have already taught them) how near the limits of sentimental prudery are to those of shameless cynicism. The story of Hypatia's having been married to Isidorus seems an utter mistake of Suidas. He cannot mean Isidorus of Gaza; the man who became head of the Athenian school after Proclus and Marinus must have been born after Hypatia's death; for she died A.D. 413 or 415, according to Socrates; and Proclus (if Marinus, his pupil, may be trusted) was born A.D. 412. Photius merely says that Isidore surpassed Hypatia, "as a man a woman." The assertion that he was her husband is a mere note of the edition of 1620–30. But the chief argument against her marriage is to be found in Synesius' letters, in which he repeatedly begs to be remembered lovingly to her father Theotecnus (not Theon, as he is usually called), to her brother Athanasius, and to other friends; but makes no mention either of a husband, or of any Isidorus. And the known tendencies of the school make it most improbable that such a woman should have degraded herself in her own eyes so far as to become a wife.

Her tragedy is well known by the account of Gibbon, drawn from *Socrates*, bk. vii., § 15; and from Theodoret, who asserts Cyril's complicity. Theodoret knew Cyril well enough to suspect him of anything; at least, to say of him, after his death, that "the only fear was that hell would find him too unpleasant a guest, and send him back to earth." And certainly all we know of him justifies the sneer; at least, it seems certain that Cyril protected her murderers.

Hypatia's death seems to have happened thus:—The minds of the Nitrian monks, and of the Alexandrian populace, had been inflamed by her intimacy with Orestes, the prefect, who was at open war with Cyril. Hating her both as what she was, the championess of an eclectic Polytheism; and as what she was not, a profligate woman, they laid wait for her at the door of that lecture-room in the Mouseion, where (to the envy of Cyril) her admirers' chariots and slaves were wont to wait. She was seized, stript naked, dragged into the Kaisareion (then a Christian church), and torn piecemeal, with fragments of shells and pottery. The flesh was scraped from the bones, and what remained burned in the Kinaron.

Thus ended, or seems to have ended, the last noble woman whom Greek paganism produced. Her letter to Cyril, regretting Nestorius' banishment, must be considered as a forgery; for Nestorius was not banished till A.D. 436, and Socrates gives too detailed and honest an account of her death to be far wrong. But, indeed, Hypatia is at best but a myth and a shade; and two centuries more saw her transfigured into the famous Saint Catharine of Alexandria; the Christians whom she opposed into pagan philosophers confuted; Cyril into Maxentius the persecutor; the potsherds of the Kinaron into the toothed wheels miraculously broken by lightning from heaven; and Hypatia installed for a thousand years to come as one of the four virgin saints of Christendom. So does the whirligig of Time bring round its revenges; and every noble soul, even under a feigned name and circumstance, has its nobleness acknowledged, and does—not the work which it intended, but the work of which it was really capable. (C. K.)

Hyperbola ‖ Hyperbole.

HYPERBOLA, a curve formed by cutting a cone in a direction parallel to its axis. See CONIC SECTIONS.

HYPERBOLE, a figure of speech of very frequent occurrence both in written and oral discourse. As its etymon implies, it signifies a shooting or throwing beyond or over the mark. Popularly, it denotes an over-shooting of the truth in the description of anything by exaggerating qualities that really do exist in it without introducing new ones. Bolingbroke cleverly alludes to it as a figure that lies without deceiving. Hyperboles diminish as well as exaggerate; but though there are many good instances of diminishing hyperboles, most writers succeed better in those of the opposite kind. A good illustration of a diminishing hyperbole is that quoted by Longinus from a comic poet who describes a character in one of his plays as "possessing an estate smaller than a laconic despatch." Talking of a thin man, Shakspeare describes him as "so gaunt, the case of a flagellet was a mansion for him." Swift, describing a lion of more than ordinary fierceness, says of him:—

> "He roared so loud, and looked so very grim,
> That his own shadow durst not follow him!"

Hyperbole is a favourite figure with the poets of all times and nations. In the specimens of ancient Oriental prose that have reached us, we find numerous examples. In the *Talmud*, for instance, a man hewing wood beside the pool of the Jordan, is asked if the water is deep there. "So deep," he said, "that an axe-head of mine which slipped in there seven years ago has not yet reached the bottom." The poetry, and even the ordinary conversation of Oriental nations are, for the most part, mere tissues of hyperbole. To the less warm imaginations of the West, they sound bombastic and even absurd; and if taken literally, they undoubtedly are so. When analyzed, however, they are found to be hardly more extravagant than those that pass current among moderns without creating the least surprise. Our most ordinary compliments are, in this way, as truly hyperbolic as the highflown civilities of the East.

How far hyperbole may be carried cannot be fixed by any precise rule. Good sense, and a refined taste, will best determine beyond what point it becomes absurd. Longinus compares a hyperbole carried too far, to a bow-string which relaxes by overstraining, and produces an effect opposite to what is intended. Few English writers err so much in this respect, and seemingly in mere wantonness, as Shakspeare:—

> "Three times they breathed, and three times did they drink,
> Upon agreement, of swift Severn's flood;
> Who then affrighted with their bloody looks,
> Ran fearfully among the trembling reeds,
> And hid his crisp-head in the hollow bank,
> Blood-stained with these valiant combatants."

And again:—

> "His brandish'd sword did blind men with its beams;
> His arms spread wider than a dragon's wings;
> His sparkling eyes replete with awful fire,
> More dazzled, and drove back his enemies,
> Than mid-day sun fierce bent against their faces."

Milton is often as guilty of the same offence:—

> "Me miserable! which way shall I fly
> Infinite wrath, and infinite despair?
> Which way I fly is hell! myself am hell!
> And in the lowest deep a lower deep
> Still threatening to devour me opens wide,
> To which the hell I suffer seems a heaven."

Pope himself sometimes forgets his good taste:—

> ". . . . Swift Camilla scours the plain;
> Flies o'er the unbending corn, and skims along the main."

Hyperides.

Probably, however, there never was a writer who did not occasionally lapse into hyperbole. As a general rule, too, it may be said that every parable, proverb, epigram, or bon mot, to say nothing of the utterances that form what has been called the "small change" of books and social life, is a hyperbole.

HYPERIDES, a celebrated Athenian orator, one of the ten comprised in the Alexandrian Canon, was the contemporary, and sometimes the friend, sometimes the enemy of Demosthenes. The date of his birth is not accurately known; but it probably fell within the first decade of the fourth century B.C. After studying philosophy under Plato, and oratory under Isocrates, he began his public career as an advocate in the Athenian courts of justice. When it became necessary for him to choose a political creed he joined the patriotic party, at that time led by Demosthenes and Lycurgus. To this choice he clung through life, reckless of the hardships it entailed. In proof of his sincerity he fitted out two triremes at his own expense for the Eubœan expedition of B.C. 358. His whole public life, for the next twenty years, was spent in devising means of resistance to the growing power of Macedonia. In B.C. 338, when the disastrous fight of Chæronea laid Greece at the mercy of the victorious Philip, Hyperides proposed that the citizens should rise *en masse*, send their wives and children to places of security, and fight it out to the last.

Though this desperate advice was not taken, the genuine patriotism of the advice was appreciated and rewarded by his countrymen. When the death of Philip revived the hopes of the anti-Macedonian faction, Hyperides promoted the alliance with Thebes; and after the destruction of that city by Alexander, was one of the orators demanded of the Athenians by the young victor. Alexander, however, did not press his demand, and Hyperides continued to oppose the Macedonian influence as strongly as ever. The arrival in Athens of Harpalus, the run-away treasurer of Alexander, then absent on his eastern conquests, disturbed the friendly relations that had hitherto subsisted between Hyperides and Demosthenes. Harpalus had embezzled some 5000 talents of the public money, with which he endeavoured to organize a party for himself among the Athenians. It was believed, that among others, Demosthenes had yielded to his bribes and specious stories, and Hyperides, who had shown himself proof to these temptations, either voluntered, or (as is more likely) was selected to prosecute his ancient friend. This, as was natural, led to a rupture between them which was not healed for some time. In the Lamian War, which followed the death of Alexander, Hyperides took a leading part; and when it was brought to a close, spoke the funeral oration over his countrymen who had perished in battle. This oration, of which considerable fragments are preserved in Stobæus, was looked upon as a masterpiece by the ancients themselves. The following year (B.C. 322) saw the hopes of Athens finally crushed at the battle of Crannon. The chiefs of the patriotic party sought safety in flight. Hyperides was overtaken at Ægina by the minions of Antipater and cruelly put to death. Seventy-five orations were attributed to Hyperides; but a third of these were rejected as spurious by the ancients themselves. Westermann has preserved the titles of sixty-one of these in his *History of Greek Oratory*. Hopes have been entertained at comparatively recent periods of recovering the bulk of the authentic speeches. In the beginning of the seventeenth century, a German scholar professed to have seen a complete copy of Hyperides in the library of the Hungarian king Matthias Corvinus at Ofen. Taylor, the editor of *Demosthenes*, gave out that he had been similarly fortunate; but as neither of these scholars turned their good luck to account, it has been concluded that they were both mistaken. In 1847, however, the hopes of the learned were revived by the tidings that the famous speech against Demosthenes, or, at least, very considerable fragments of it, had been discovered. It turned out that Mr A. C. Harris, an English gentleman resident in Alexandria, when inquiring at Thebes, in Upper Egypt, in the spring of 1847, for Tahidic fragments, had been shown some broken Greek papyri by a dealer in antiquities, and had purchased them. The papyri themselves were of the better kind, and were pronounced by the able scholars to whom they were submitted, to date from a very remote antiquity. The evidence seemed complete that they could not be later than the third century of the Christian era, while there was a strong probability in favour of a still greater age. The Cambridge editor, Mr C. Babington, inclines to the belief that they may be referred to the age of the Ptolemies. What the value of the oration itself may be, it is possibly somewhat premature to pronounce. It certainly contains the bulk of the evidence on which Demosthenes was banished from his country, but the question of the great orator's guilt is one on which Droysen and Niebuhr, Mitford and Thirlwall, have come to opposite conclusions; and though the recovered oration is a valuable contribution to the history of the time, as well as to Greek philology, it is still too mutilated to be finally decisive. How the MS. came to be found in Thebes, is itself, at first sight, somewhat of a mystery. It is believed that its Arab discoverer found it among the tombs in that city, and that it had been buried there with a mummy. Mr Harris, however, states that the MS. "is unique among the contents of the tombs of Thebes;" but endeavours to account for its existence there by saying, that "when we reflect on the numbers of rhetoricians, philosophers, and literary men, who used to flock from Greece as well as Rome to the banks of the Nile, and notice a practice that prevailed in that country of burying writings with the dead, our wonder ceases; and we begin to entertain legitimate hopes that the discovery of this oration may be followed by that of portions, at least, of many of the lost works of antiquity." These hopes, however, have not, in the meantime, been realized. (See *The Oration of Hyperides against Demosthenes respecting the Treasure of Harpalus*, by Churchill Babington, M.A., London, 1850. There is also a good German edition of the oration by Schneidewin, Gottingen, 1853.)

Hyphasis ‖ Hysteria.

HYPHASIS, now the SUTLEDGE, one of the five rivers of the Punjab. See PUNJAB.

HYPOCHONDRIASIS, may be described as an extreme sensibility of the nervous system, usually attended with symptoms of dyspepsia, as flatulence, eructation, a sense of uneasiness in the region of the stomach, and hypochondria, and almost always with lowness of spirits, which makes the patient believe himself to be much worse than he really is. The morbid feelings of the hypochondriac are real, depending on physical disturbances of the system; but the nervous apprehension of the patient causes him to dwell on them, and magnify them into undue importance. Attention to diet and exercise is the most important part of the treatment of hypochondriasis, together with withdrawal from those studies, pursuits, or habits, which appear to have led to the formation and development of the disease. Occasional gentle laxatives and tonics may also be required, but these should only be taken under medical advice.

HYSTERIA, from ὑστέρα, the womb, though commonly applied to those violent fits which attack women, and which are attended with convulsions, a sense of choking, and involuntary laughing and crying, is strictly applicable to a large proportion of those chronic, so-called *nervous*, disorders to which females are subject. Of these the fit or convulsion is but the occasional and prominent symptom. The fit itself is usually preceded by a general uneasiness and feeling of oppression, a tight sensation about the throat, headache, cramps, and the sensation of a ball rising from the stomach

Hypostasis. to the throat (*globus hystericus*). A temporary loss of sense and consciousness, with general convulsions, screaming, tearing the hair, beating the breast, or otherwise attempting to injure the person, follows this, and the paroxysm passes off in a fit of laughter, or alternate laughter and crying, or a flood of tears. It is of great consequence to distinguish this disease from epilepsy, with which it may be confounded. In epilepsy there is no premonitory symptom, as a sensation of ball rising to the throat; a sharp cry or shriek always immediately precedes the convulsions, and on the convulsions passing off the patient falls into a deep sleep of shorter or longer duration. Uterine and gastro-intestinal irritation or irregularity are the principal causes of hysterical affections. They are consequently almost alone met with in females; but one or two well authenticated cases have been seen in males of highly susceptible nervous temperament. During the fit the attendants should take care that the patient does not injure herself, but further than this they should exert no restraint upon the person. To prevent her injuring herself with her teeth, several folds of a towel or napkin may be put between the jaws. If there be much determination of blood to the head, the applying cold wetted cloths to the head, and sprinkling cold water on the face and throat, are recommended as useful; and in slighter cases, cold water sprinkled over the face, and applying smelling-salts to the nose, are thought to shorten the fit. Between the paroxysms means should be used to remove the cause of the disorder; and tonics, particularly preparations of iron and quinine, regulation of the bowels and the secretions, and attention to diet and exercise, are the measures most likely to restore health when the complaint, as it usually is, is attended with various degrees of debility. Assafœtida, valerian, ammonia, and other antispasmodics are also useful in preventing the recurrence of the convulsions.

HYPOSTASIS, in *Theology*, a word employed to denote the personality of the Second Person of the Trinity. The word employed by the Greek fathers to denote the Godhead, without reference to the distinction of persons, was οὐσια (*essentia*). *Substantia* was, by the Latins, used in the same way, though Hilary makes it equivalent to *hypostasis*, when he speaks of three *substantiæ* in the Godhead. But there was still another term, the ambiguity of which produced continual controversies in the early church. This was the word *subsistentia*, which was at times used synonymously with οὐσια, and at other times synonymously with *hypostasis*. Hence the Roman and African churches, in 347, at the synod of Sardes, pronounced the belief of three *hypostases* in the Godhead to be heresy. Athanasius expressly declares that *hypostasis* is exactly the same thing as οὐσια (*essentia*). Yet it had been determined against the *Sabellians* at the synod held at Alexandria in 319, that there was one οὐσια (*essentia*), and three *hypostases* in the Godhead. The confusion was in a great measure remedied by the discussion at Alexandria, A.D. 362, at which Athanasius presided. To his discretion the favourable result was mainly owing. It was now agreed that *hypostasis* should be taken in the stricter sense, so that, while there was one οὐσια (*essentia*) in the Godhead, there were three *hypostases*, or persons. Hypothesis ‖ Hythe.

HYPOTHESIS, a temporary principle put forth in order to help in reducing our knowledge to system. A hypothesis, as such, is a temporary explanation of a phenomenon, and is subject to certain conditions;—1. The fact for the explanation of which the hypothesis is framed must be known to be a fact. 2. Before any one hypothesis be resorted to, it must be ascertained that no other hypothesis will answer equally well with the one chosen. The value of a hypothesis depends—1*st*, on its internal consistency, and external accordance with things known to be true; 2*d*, on the completeness with which it explains the phenomena in question; and 3*d*, on the extent to which it is independent of other hypotheses.

HYRCANIA, in *Ancient Geography*, a district of Asia, of which the limits appear to have been very different at different times. In its most limited sense it corresponded very nearly to the modern province of Mazaunderan. In its more extended application it comprised, besides that province, those of Khorassan, Dahistan, and Dabistan, and was bounded on the N. by the Caspian or Hyrcanian Sea, W. by the Charindas, which separated it from Media, S. by the Labuta range, which separated it from Parthia, and W. by the Charindas, which separated it from Media. The champaign country of Hyrcania was marshy, but in many places produced considerable quantities of corn and wine. Its mountain districts were densely wooded, and famous for their countless swarms of bees. The capital of the country was indifferently called Carta or Zadra-carta. Very little was known by the ancients about Hyrcania or its inhabitants. When its name occurs it is generally used as a synonym for anything more than ordinarily wild and inhospitable.

HYTHE, a municipal and parliamentary borough, and market-town of England, county of Kent, 15 miles S. of Canterbury. It stands at the foot of a steep hill or cliff, near the E. extremity of Romney Marsh, and consists chiefly of one long street, running parallel to the coast, from which it is about half a mile distant. The church, on the slope of the hill above the town, is an elegant cruciform structure in the early English style. Hythe is much frequented during the bathing season. The municipal borough is governed by a mayor, four aldermen, and twelve councillors; and contained, in 1851, 2857 inhabitants. The parliamentary borough includes Folkestone and several smaller places, and contained, in 1851, 13,164 inhabitants. It returns one member to parliament.

I.

I || Iamblichus.

I, or *i*, the ninth letter and third vowel of the alphabet, is pronounced by throwing the breath suddenly against the palate, as it comes out of the larynx, with a small hollowing of the tongue, and nearly the same opening of the lips as in pronouncing *a* or *e*. Its sound varies; in some words it is long, as *high, mind;* in others short, as *bid, hid, sin;* in others, again, it is pronounced like *y*, as in *collier, onion;* and in a few it sounds like *ee*, as in *machine, magazine*, and the like. No English word ends in *i*, *e* being either added to it, or else the *i* turned into *y*. But, besides the vowel, there is the *jod* consonant, which, because of its different pronunciation, has likewise a different form, thus, J, j. In English it has the soft sound of *g;* nor is it used excepting when *g* soft is required before vowels, where *g* is usually hard. Thus we say *jack, jet, join*, instead of *gack, get, goin*, which would be contrary to the genius of the English language.

I, used as a numeral, signifies *one*, and stands for as many units as it is times repeated; thus I. one, II. two, III. three; and when put before a higher numeral it subtracts itself, as IV. four, IX. nine, and so on. But when placed after it, as many are added to the higher numeral as there are I's added. Thus, VI. is 5+1, or six; VII. 5+2, or seven; VIII. 5+3, or eight. The ancient Romans likewise used IↃ for 500, CIↃ for 1000, IↃↃ for 5000, CCIↃↃ for 10,000. Further than this they did not go in their notation, but, when necessary, repeated the last number, as CCCIↃↃ,CCCIↃↃ, for 200,000; CCCIↃↃ,CCCIↃↃ,CCCIↃↃ, for 300,000; and so on. The ancients sometimes changed *i* into *u;* as *decumus* for *decimus*, *maxumus* for *maximus*, and so on. According to Plato, the vowel *i* is proper to express delicate but humble things, as in the verse of Virgil:—

"Accipiunt inimicum imbrem, rimisque fatiscunt."

I, used as an abbreviature, is often substituted for the word Iesus, of which it is the first letter.

IAMBLICHUS, the Syrian Neo-Platonist, enjoyed considerable fame during his lifetime, which ended somewhere in the first half of the fourth century; and he rose again into high repute at the restoration of Greek literature, Ficinus having edited and translated his most important work, *De Mysteriis*, as early as 1483. Gale, in 1678, published at Oxford an edition, which may be considered as our standard one, and should be known to every student of human thought. The prolix biography of Eunapius gives us very little valuable information as to Iamblichus. He seems to have been, like the majority of the Neo-Platonists, an aristocrat, of an illustrious and powerful family of Chalchis, in Cœle-Syria. He assembled round him a school of disciples, whom we find with him sometimes at Alexandria, and sometimes at his favourite haunt, the baths of Gadara. We may regret the less, however, that so few facts have been preserved by them, when we look at those which remain. We can dispense with the testimony of men who assure us (and in one case, says Eunapius, as actual eye-witnesses) that he evoked the two genii of the fountains of Eros and Anteros, who came as two cupids to embrace him in their arms; that he worked miracles and prodigies; was surrounded at times by a golden glory; and in one case was raised nine feet off the ground by an ecstasy of prayer. Some of these latter tales he denied, but in a tone (if Eunapius is to be believed) which shows that he would not have been sorry had they been true. "He who deceived you," says he, "was 'ὄυκ ἄχαρις'—not without elegance of imagination."

Iamblichus.

These few hints, combined with the works of his which remain, give us a key to his thoughts, of which something has already been said in the article on Hypatia. Under Plotinus, and Porphyry (the tutor and afterwards the opponent of Iamblichus), the object of the Neo-Platonist mystic had been the same as that of the middle-age mystic, viz., to raise himself to communion with, and ultimately to absorption into, Deity, by that strongest exercise of the rational will which results in its self-annihilation, and in a state of absolute passivity. Plotinus and Porphyry were said to have succeeded in this effort several times during their lives: but, on the whole, the majority of those who tried the experiment must have failed; and in proportion as it was found difficult for man to rise directly to God, the desire was reawakened of bringing the gods down to men, and so filling the dark void of secret unbelief. Iamblichus, as a native of Syria, the especial home of conjurors and gross superstitions, as well as of Gnostic mysticism, was a fit man to make this attempt; and from him dates a series of efforts to adapt to the mystic philosophy of the East as many of the old polytheistic forms of worship as were not absolutely impure. For this purpose it was necessary to explain the relation between the physical and the spiritual, not merely (as with Plotinus) in the case of Deity and of man, but in the case of Deity and all nature. Hence Iamblichus was especially attracted by the symbolic nature-worship of the Egyptians and Chaldeans, which he (or some disciple of his) defends against the cavils of Porphyry in the famous letter of Abamnon the priest. Hence, too, he was attracted by the Pythagorean dreams as to the sacredness of numbers. We find among his works (or rather his compilations from early Pythagoreans) explanations of the symbols of that school; and the title of one lost work (*The Theological Principles of Arithmetic*) sufficiently explains both itself and the cast of its writer's mind.

Connected with this habit of mind is, it would seem, his denial of Plotinus's dogma, that reason in the human soul is without passivity. He requires a theory which will enable him to explain how the spiritual (whether human or divine) can be affected by incantations, ceremonies, suffumigations, sacrifices; and, above all, how the Deity adjured shall not only appear to, but inspire and possess the soul of the initiated or priestly man, independently of any human will; and he has therefore to assume (perhaps not wrongly), a capability in the soul of being influenced passively and involuntarily *ab extra*. If this be the true explanation, the question between Plotinus and Iamblichus is none other but the insoluble one between the advocates of grace *de congruo* and those of grace *prævenient*. But Iamblichus fell into that degraded form of the latter belief which tempts to an altogether magical view of the efficacy of symbols and of ceremonies, and which tempts likewise to a modified polytheism, in his case taking the form of a host of demons, heroes, and gods, besides angels, principalities, and souls; each rank of which depended mysteriously on the one above it (some remnant, probably, of the old notion of successive emanations, borrowed from the earlier Syrian Gnosis). These beings confer on man gifts corresponding with their own natures; and they appear in forms, and with accompaniments, symbolic of their rank and power. In sketching these various apparitions, Iamblichus shows a clumsy turn for symbolic fancy, contrasting strongly with the great acuteness with which he specially pleads in behalf of these follies. His greatest difficulty is, of course, Porphyry's objection, that the incantations, and even threats and insults, used by the priests to make the gods appear, were at once

immoral and unphilosophical. The gods could not be the passive puppets of men, of herbs, of incense, of talismans. Iamblichus answers, with much ingenuity, that the threatening words are only anthropomorphic adaptations, as are all assertions that the gods are angry or alienated; and that the ceremonies used do not act by altering the will of the Deity, but by virtue of secret affinities which run through all natural and spiritual beings, linking each heavenly being to some earthly one,—as Phoibos to the laurel, and Asclepios to the cock; so that "immaterial things are immaterially present in material things." Nay, there is even a "pure and divine matter" in sacred objects underlying the gross appearance, and akin to the Deity, to which it is consecrate; which, if it be employed in the making of statues or of temples, or in holy rites, attracts and calls out the gods, by mystic sympathy, to show themselves to the worshipper.

It may be easily seen from these few hints what a door to superstition of the lowest kind Iamblichus was re-opening, by thus justifying to the educated classes that materialist idolatry which still lingered among the lower. From his time forth, Neo-Platonism followed, if not smoothly, still surely, the downhill path which he had pointed out; and which, perhaps, was the only one possible for it, and for the old mythologies which it tried to rehabilitate. But his book (if it be his) is most worthy of careful study, alike to the theologian and the philosopher, who will find it full of significance for us and to every age. Iamblichus may be considered to have said all which can be said on behalf of the magical theory of ceremonial and sacramentary worship; and the metaphysic by which he justified the old polytheism was virtually that which the more mystic section of the Eastern Church justified in after ages their own idolatry. The Latin mediæval church, forming itself among nations of a more practical and objective habit of mind, adopted the results of such a form of thought, dogmatically, in a coarse and literal shape, without asking for a philosophic justification of them; and the mystic developments of mediæval Germany were rather of the Platonist than of the Iamblichan school,—protests against surrounding idolatry, and not excuses for it. But there are now signs of a desire to connect the Roman popular belief with the spiritualist philosophy of Germany; which, though tokens of old age and decay, may yet give a new galvanic life, for centuries to come, to the mediæval Pantheon. In such a case Iamblichus may regain the honour in which he was held by the Neo-Platonists of the sixteenth century, and even be once more (as he was by his contemporaries) preferred to Plato himself. In any case, all which can be said in favour of such a movement lies virtually and half developed in the Letter of Abamnon; the spiritual want is the same as that of his day; the method of patching the rent, and of putting new wine into old bottles, will probably be the same also. "The thing which has been, it is that which shall be; and there is no new thing under the sun." (C. K.)

IAMBUS, one of the commonest feet in Greek and Latin prosody. It consists of two syllables, of which the first is short, and the second long, as Horace says,—

> "Syllaba longa brevi subjecta vocatur iambus
> Pes citus."

The iambic metre was originally employed in satirical poetry called *iambi*, of which the laws were first fixed by Archilochus. Before his time, the trochaic tetrameter had been the popular measure in poetry of this class; but when the rapidity of dialogue and theatrical action came to be duly studied, nature herself pointed out the iambic as the most suitable metre; for, as Aristotle remarks, it is the most colloquial of metres, as may be seen by one who chooses to remark that ordinary conversation often falls into iambic verse, and never into any of the more formal metres' —the hexameter, for instance.

The most common form of iambic verse is that known as the Iambic Trimeter Acatalectic, or Tragic Senarius, as it is called, from being the favourite metre of the Greek tragedians. It consists of three measures of two feet each, and has no catalectic syllable. The feet admissible in the various places are given in the subjoined table:—

1.	2.	3.	4.	5.	6.
⏑ –	⏑ –	⏑ –	⏑ –	⏑ –	⏑ –
⏑⏑⏑	⏑⏑⏑	⏑⏑⏑	⏑⏑⏑	⏑⏑⏑	
– –		– –		– –	
– ⏑⏑		– ⏑⏑			
⏑⏑ –					

In the case of proper names, an anapæst may be admitted into any place except the sixth, which must always be an iambus. But for the anapæst to be thus admitted, it is necessary that it be completed within one word, and leave no syllable or syllables over to be carried on to the next place. In the comic trimeter a dactyl may be used in the fifth place, and an anapæst in any of the first five.

Great care was bestowed by the Greek tragedians on the cæsural pauses, on the proper distribution of which depends much of the beauty of the iambic metre. The two principal cæsuras are the penthemimeral and the hephthemimeral; the first falling (as its name denotes) on the fifth half-foot, and the other on the seventh half-foot. The penthemimeral is by far the most common of these two.

> *Penth.* ὦ τέκνα Κάδμου τοῦ πάλαι νέα τροφή
> *Hepth.* ἱκτηρίοις κλάδοισιν ἐξεστεμμένοι.

In certain cases the seventh syllable is a word so intimately connected in sense with that which goes before it, as practically to form part of it. Enclitics, or particles which cannot themselves begin a verse, are the class of words that come under this rule. Sometimes this seventh syllable belongs to the succeeding words, as in the line—

> ἀλλ' ὃν πόλις στυγεῖ, σὺ τιμήσεις τάφῳ.

In such cases it would be better to consider the stop which occurs after the sixth syllable as equivalent to the cæsura. Porson, and after him most grammarians, have called this the *quasi-cæsura*.

Sometimes, when the poet desired to produce a particular effect, he violated all these laws; and the instances are numerous in which the cæsura is neglected altogether, and that without any division in the verse as an equivalent, and even without an elision. In the iambic trimeter the third and fourth feet seem to have been seldom comprised in the same word; instances of it are very rare.

Iambic verses are not connected; each is complete in itself, and independent both of that which goes before and of that which follows it. Cases sometimes occur, though rarely, in which one verse is connected with another, either by elision, or by a close union between the final word of the first, and the first word of the succeeding verse. (Hermann's *Elem. Doctr. Metr;* Tate's *Introduction to the Principal Gr. Tragic and Comic Metres;* Linwood's *Treatise on Greek Tragic Metres*, Lond., 1855.

IAPODES, or IAPYDES, a tribe of Illyria. See ILLYRIA.

IBERUS (now the EBRO), in *Ancient Geography*, a great river of Spain, rising in the Cantabrian Pyrenees, in the country of the Autricones. Flowing in a S.E. direction, it drains the N.E. corner of the peninsula, and falls into the Mediterranean after a course of about 350 miles. On its left bank it receives the Cinga, the Sicoris (Segre), and the Gallicus or Gallego; and on its right the Salo (Xalono). It is a much disputed point whether the Iberus gave its name to the Iberi, or took its name from them. That people appear to have occupied, at a very remote period, the whole south of Europe from the Rhone westwards. When the Celts crossed the Pyrenees, they amalgamated to some ex-

Ibis ‖ Ice-Trade.

tent with the holders of the soil, and the result was a race known in history as the Celtiberi. W. von Humboldt, maintaining that the people gave name to the river, asserts that remains of their language are to be found in the Basque still spoken in the Biscayan provinces of Spain, and proves, by philological affinities, the identity between many of their proper names and those of the islands of the western Mediterranean, and many parts of Spain and Southern France. The name of Iberia was also applied to a district of Asia, corresponding to part of modern Georgia. It was first invaded by the Romans under Lucullus, and seems to have paid a kind of homage to some of the emperors, though it was never fairly incorporated with the Roman dominions. An incidental notice of Strabo describes the country as tolerably well cultivated, and its inhabitants as more civilized than most of the surrounding tribes.

IBIS. See ORNITHOLOGY.

IBRAHIM or IBRAHEEM PASHA. See EGYPT, end of Section II.

IBRAIL. See BRAHILOW.

IBYCUS, a Greek lyric poet of the sixth century B.C., was a native of Rhegium, in Italy. Almost nothing is known of his personal history beyond the fact that he spent the greater part of his life at the court of Polycrates, the tyrant of Samos. A curious legend is told of the manner of his death. Travelling through Greece, he was waylaid by robbers in the neighbourhood of Corinth, and barbarously murdered. As he lay mortally wounded on the ground he looked up, and seeing a flock of cranes flying overhead, he called upon them to avenge his death. The murderers betook themselves to Corinth, and while sitting in the theatre there saw the cranes hovering about. One of them, in a paroxysm of fear, cried out "Behold the avengers of Ibycus," and thus gave the clue to the detection of the crime. The "Cranes of Ibycus" became a favourite proverb with the Greeks ever after. Only a few fragments of Ibycus have come down to us, but these afford sufficient traces of the passionate nature for which Ibycus was famed beyond nearly all the erotic poets of Greece. He also attempted heroic and mythical subjects, but with less success. The best edition of the fragments of Ibycus is that of Schneidewin, Gottingen, 1835.

ICE, is the name applied to water which has been converted into a solid state by the action of cold. For the different ways in which this may be effected, see § *Congelation*, under art. COLD.

ICE-*House*. For small quantities of ice a wrapper of straw is sufficient, provided it be kept above the ground, and in a place free of moisture. But when vast quantities have to be kept for a considerable time, and in a hot climate, *ice-houses* become indispensable. In this case the ice is placed in a cellar, surrounded with thick walls, and either arched over or supplied with a conical wooden roof. What thaws may either be removed by means of a drain beneath the cellar, or may be drawn off by a pump. For very hot climates the roof of the cellar may be covered with earth to any required extent. Air should be excluded from the cellar. The best soil for an ice-house is chalk, as it lets the thaw and moisture ooze through. The immense erections used in America in the ice trade are above ground, and resemble huge barns, 200 feet long. About fifty of these great structures surround Frest Pond, in Massachusetts.

ICE-*Trade*. It is only within the last five and twenty years that the ice-trade has become so important, and every year it is rapidly increasing. Ice was used as an article of export for the first time in 1806 by Mr Tudor of Boston, the persevering originator of the trade. For a quarter of a century he continued to devote his attention to the trade; and, after numerous misfortunes, he has established it as one of the most lucrative and promising in the United States. The following table will show how rapidly the trade has arisen. It refers to the *exports* from Boston alone:

Icebergs.

Years.	Tons.	Years.	Tons.
1832.....	4,352	1853.....	100,000
1845.....	48,422	1854.....	156,540

The quantity thus stored was distributed as follows:—

	Tons.		Tons.
Southern States	110,000	East Indies	14,284
Consumed at home	60,000	England	895
Brazil and West Indies...	31,361	Total.....	216,540

The small quantity shipped for Britain is owing to competitors nearer hand, viz., from Norway, perhaps the only other country which carries on an ice trade.

The amount stored up in New York during 1855, was 305,000 tons, of which 20,000 were for exportation.

The process of cutting and storing up the ice may be thus described:—During the time that the ice is forming in December and January, it is kept as free of snow as possible. Occasionally holes are pierced in the forming ice, to enable the water to overflow, as thus the formation of ice is accelerated. Before cutting the ice, its surface is systematically cleared of snow with wooden scrapers. An iron scraper then removes the snow-ice, and the field is ready for being marked off into squares of about 5 feet each by an iron plough. Next follow the *cutters* in the tracks marked off by the preceding instrument, cutter, plough, and scrapers being each drawn by a horse. By hand-saws the square pieces are now disengaged, and are ready for being floated to the shore. Thence they may be carted to ice-houses;—400 tons can be cut and stowed away by forty men and twelve horses in a single day. The wooden store-house of the Wenham Lake Company has room for 20,000 tons of ice. Steam has been applied for the purpose of elevating, lowering, and stowing away the ice. The ice thus stored is to be taken to all parts of the world, to be used for cooling wines and all kinds of beverages, preserving meat, in ice-creams, confections, &c.

The ice-trade is highly important in opening up an extensive field of labour for the working classes at a period of the year when all ordinary avocations are suspended, and during which poverty entails distress. About 2500 persons are employed in the Boston district alone, and throughout the States of the Union, about 9000. The cost of transit by railway in the Boston trade is estimated at nearly L.20,000, and by sea at about L.100,000. The number of vessels employed was 520. The value of the ice farms of New York and Massachusetts is considered equal to that of the rice crop of Georgia. The whole capital invested in the trade is about a million and a half sterling. (Hunt's *Merchants' Magazine*, for August 1855; Knight's *Industry of all Nations*, &c.)

ICEBERGS. The accumulation upon elevated situations of frozen snow, produces those moving masses of ice called *glaciers*. (See GLACIER.) In the Alps, and in Norway, these glaciers coming down to a mild region melt away; but in the arctic regions, they often flow into the sea and produce icebergs. While floating about, these masses may increase indefinitely in size, from receiving fresh accessions of snow, or by the freezing of the water continually splashed against them, as well as by the sudden freezing of the water which falls as rain. They are of all sizes, from mere fragments to upwards of half a mile in diameter, and of all weights, from a few pounds to a hundred thousand tons. They rise sometimes 150 feet above the water, and this is but an eighth of the whole mass. They float about in hundreds, and are often driven by winds far into the ocean, and become exceedingly dangerous to navigation. Icebergs from each pole have approached nearer the equator than 40°. N. and S. Lat.; they have been met with in the neighbourhood of the Cape of Good Hope. Many of these icebergs, originating on land, present the same phenomena

Iceland. as glaciers. Hence, upon near inspection, they are found to be loaded with the debris which, as glaciers, they scraped off the mountain sides, past which they flowed to the sea. This debris contains masses of greenstone, clay-slate, gneiss, granite, &c. In the polar circle, where the floating masses reach to many hundreds of miles in length, they are called *ice islands*. When two of these approach each other, any vessel which happens to be between them is almost certain to be crushed to pieces. The larger of the two, by its greater momentum, urges itself beneath the smaller, which is thus tilted up on the shoulders of the larger, whose mass it goes to increase. The *iceblink* is an appearance produced on the horizon by these ice islands when stationary, and which indicates the existence of an ice island before it is itself visible.

ICELAND, one of the largest islands in Europe (being little inferior, in point of superficial extent, to Ireland), is situated in the north part of the Atlantic Ocean, between N. Lat. 63. 23. 30., and 66. 32.; and W. Long. 13. 32. 14., and 24. 34. 14.; the N. point being thus very near to the arctic circle, but not passing beyond it, as all maps but a recent authoritative one have represented it. Its extreme length from E. to W. is about 280 miles, and its breadth from N. to S. varies from 180 to 200.

History. The precise period at which this island was discovered and first colonized is unknown; but, from the Landnamabok, an ancient Icelandic chronicle, and a work generally relied upon as authentic, we learn that the Norwegians were the first settlers upon its coasts. Naddodr, a famous pirate of that adventurous nation, was, on his return to the Faroe Islands from a predatory excursion, about the year 860, driven by a tempest upon the coast of Iceland. He ascended to the summit of a mountain, but observing around him neither the vestige of a human residence, nor aught else than vast and tractless fields of snow, he immediately abandoned it. Probably aware of this discovery, Gardar Svarfarson, a Swede, followed the same tract a few years afterwards, and succeeding in circumnavigating the country, discovered it to be an island. He there spent the winter, but finding little inducement to make it a permanent residence, he in the following spring returned to Norway. The third adventurer on this coast was one Floki, another celebrated Norwegian pirate, who, during two seasons, explored a considerable portion of the southern and western coasts. His attempt at forming a permanent settlement proved, however, like that of his predecessor, a failure; his cattle died, his expected crops were ruined, and, after experiencing numerous distresses and hardships from the inclemency of the weather, he determined to repair to a warmer region, and gave to the island at his departure the name by which it has ever since been known. That this name, and the report which he spread on his return of the inhospitable nature of the island, were principally the effect of prejudice and disappointment, is evident from the contradictory account given of it by his companions, one of whom thought he could only convey an adequate idea of its richness and fertility by declaring that butter dropped from every plant.

These expeditions, though affording a slight knowledge of the country, would probably not have led to its colonization, had not disturbances in Norway induced some of the inhabitants of that country to quit their native soil. Harold Harfagra having subdued most of the petty princes of that country, put an end to the system of liberty and independence which the inhabitants of Norway had hitherto enjoyed; and thus drove many, even of its nobility, with their families and dependents, from their homes. A body of these voluntary exiles, under the conduct of Ingolf, one of the discontented subjects, sailed from Norway, A.D. 874, from which year the Icelanders date the occupation of their island. When Ingolf approached the coast of Iceland, we are informed that he threw into the sea the wooden door of his former habitation in Norway; and finding it some time afterwards cast upon the shore at Reikiavik, he fixed his abode on the spot where the capital of the island now stands. He was followed by several others, and in a short time considerable portions of the southern and eastern districts of the island were taken possession of. Harold, it appears, did not at first oppose the emigration of his subjects; but afterwards finding it carried on to a great extent, he imposed a fine of four ounces of fine silver upon every person who should leave Norway to settle in Iceland. The Landnamabok already mentioned, whose object was to afford a picture of the colonization of the island, describes with singular minuteness the arrival and spreading of the different settlers, and records, together with those of the Norwegians, the names of many Danes and Swedes, and even some Scotch and Irish, who at this period selected Iceland as their place of residence. The natural consequence of progressive colonization under the feudal tenure which was thus produced, was frequent contention between the new comers and those who had already settled in the country. To obviate these, a chief was named, under whose guidance and direction the concerns, interests, and feelings of the yet separate communities might be regulated and assimilated. This beneficial change was effected A.D. 928, and a republican form of government was thus established, well calculated to provide for the emergencies which gave it birth. We say a republican form of government; because, though there was only one supreme magistrate, who decided all disputes, and presided at the *allthing*, or great general assembly of the nation, still he was elected to this office by the free choice of the people, and retained it no longer than while he preserved their confidence. This state of liberty the Icelanders enjoyed with uninterrupted harmony for the space of nearly 400 years. During this period, education, literature, and even the refinements of poetical fancy, flourished amongst them; and the well-known *sagas* or tales of the country, the most remarkable literary productions of that dark age, were principally penned prior to the fourteenth century.

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The ancient Icelanders possessed, as is still the case with their posterity, few of the luxuries or refinements of life; and were occasionally exposed to severe privations, from the nature of their soil, and the climate under which they lived. There is reason, however, to believe, though the fact cannot with perfect accuracy be ascertained, that the climate of Iceland was once less austere than it now is, and that only trees and shrubs, but even corn, were grown upon the island. Of the ancient existence of the former the trunks occasionally discovered in the bogs afford pretty satisfactory evidence. Corn of any description is not now a native of the island; and a few birches, not rising much more than a yard in height, afford the only approach towards timber. Like the present inhabitants, the ancient Icelanders were much dispersed over the country, their habitations being seldom grouped together, but placed wherever the situation and nature of the soil appeared suitable. Their occupations and modes of life appear also to have borne much similitude. The produce of the farm, and the capture of fish, afforded them, as they do the present inhabitants, the principal means of subsistence; and their traffic with foreign countries made a valuable addition to their domestic comforts. The moral habits of the people were good, though prior to the introduction of Christianity, in the year 1000, they were blended with superstition and some unnatural customs, such as the exposure of their infants. The putting down of heathenism is not the least remarkable event in the early history of Iceland. Frederic, a bishop of Saxony, was the first who preached Christian doctrines in this distant land. The propagation of his

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tenets, however, met with every species of opposition; but the numbers who adopted them gradually increased so considerably, that the national assembly which met at Thingvalla, in the year 1000, took the matter into consideration. Whilst the question was warmly debated, the story told is, that a messenger hurried into the assembly and announced that fire had burst from the earth in a southern part of the country, and was carrying destruction before it. The heathen party instantly exclaimed that this was the vengeance of the gods against the presumption of their opponents. But Snorro, who was a zealous advocate for the Christian cause, immediately demanded, "For what reason was the anger of your gods kindled, when the very rock was burning on which we stand?"—Thingvalla being in the midst of a volcanic country, and precipitous cliffs of lava surrounding the place of public assembly. The prompitude of the reply had the desired effect, and ultimately procured a decision in favour of the Christians. On the promulgation of Christianity, religious contests were at an end; the whole people espoused the new faith; and a church establishment was soon afterwards formed. The Icelanders appear to have equalled the blindest of their fellow Catholics in their attachment to the hierarchy; and it was not till 1551 that the Reformation, under Christian III. of Denmark, found its way into the island. Since that period the form and ceremonies of the Icelandic church have been strictly Lutheran, though, from the poverty of the country, their churches are in general extremely wretched, and the pittances allotted to their clergy still more so.

But to return to earlier periods. We are indebted to the enterprise of the ancient inhabitants of Iceland for the discovery both of Greenland and Newfoundland. A mariner named Eric accidentally approached the former of these countries about the year 972, and was so delighted with his discovery, that he gave it the name which it still bears. His flattering accounts of the country had the desired effect of alluring his countrymen to its shores; and in this he so far succeeded, as in a short time to form an extensive and thriving settlement. The colonists maintained a constant commercial intercourse with Iceland and Norway; and the records of the settlement come down uninterruptedly to the beginning of the fifteenth century, when at once every trace and vestige of it was lost. The causes of this singular fact have never yet been fully ascertained, although the most probable supposition is, that an accumulation of ice took place about this time on the Greenland coast, which prevented the access to it by sea. The breadth of the sea between the two countries does not exceed 100 miles; and yet the fate of this ancient colony, commonly called by distinction Old Greenland, is quite unknown. The northern shores of America were first known from Biono Heriolforn, a native of Iceland, who was driven upon them during a voyage to Greenland in 1001. Attracted by the account of this discovery, Leif, another enterprising navigator, pursued the same route considerably farther southwards, and finding an agreeable and pleasant country, he wintered there, giving it, from the circumstance of wild vines growing on it, the appellation of Vinland. This was subsequently, to a partial extent, colonized by the Icelanders; but few particulars are known of their progress, and what ultimately became of the colony is now a mere matter of speculation.

The independent and happy state of Iceland was not destined to be uninterrupted. About the year 1250, party disputes and internal feuds arose, which the ambition of the mother country enabled Haco, the then king of Norway, to foment. In 1261 a formal proposal was consequently made in the national council, to submit to that sceptre; but in doing so, the Icelanders stipulated that they should be allowed to retain their ancient laws and privileges, that they should be exempt from taxes, and that the annual importation of the most necessary articles of foreign produce should be secured to them. For upwards of a century Iceland was under the dominion of Norway, without any occurrence taking place of the slightest importance; and when in 1380 that country became subject to Denmark, the island was transferred to the same power, without tumult or opposition. The change in the constitution of the island, from its annexation to a European monarchy, naturally produced a corresponding change in the character and habits of the people. Not that the foreign yoke was a tyrannical one, otherwise a portion at least of the ancient vigour and activity of the inhabitants would have displayed itself in occasional acts of insurrection. On the contrary, the Danish monarchs not only exercised their sway with a lenient and forbearing hand, but paid much attention to the welfare and the wants of this remote part of their dominions; and thus repose and security succeeding to internal broils, produced a state of comparative apathy and indolence. Rank and property became more nearly equalized, and the trade of the country was gradually transferred to the natives of other kingdoms. A plague which devastated the island in 1402, and carried off, it is said, nearly two-thirds of the whole population, tended still further to depress the spirit of the people, and destroy the strength and prosperity of the country. The reformation of religion, which, as above stated, took place in Iceland in the year 1551, was the first dawn of an improvement amongst the natives, which the introduction of printing and the establishment of a press about the same period aided greatly in extending. The recent history of Iceland is principally characterized as a record of physical calamities, which from 1707, when the ravages of the small pox carried off sixteen thousand of its inhabitants, down to 1753 and 1759, when the inclemency of the seasons created the most dreadful and distressing famines, and lastly, the memorable year 1783, when the great eruption from the Skaptaa Yokull took place, have rarely ceased in one form or another to devastate the island. The scene of this last-mentioned eruption is amongst lofty mountains in the interior of the island, known only to the natives by the remote view of their snow-clad summits. From this desolate and unfrequented region, Sir George Mackenzie remarks, vast torrents of lava issued forth, overwhelming all before them, and filling up the beds of great rivers in their progress towards the sea. For more than a year, a dense cloud of smoke and volcanic ashes covered the whole of Iceland, extending its effects even to the northern parts of continental Europe; the cattle, sheep, and horses of the country were destroyed; a famine, with its attendant distresses, broke out amongst the inhabitants; and the small-pox invaded the island at the same time, with its former virulent and fatal effects. From these combined causes, more than eleven thousand people perished during the period of a few years; an extent of calamity which can only be understood, by considering that this number forms nearly a fifth part of the whole population of the country. The destruction of the fishery upon the southern coasts of the island by these volcanic eruptions was another more permanent source of distress, and one which is not even now fully removed.

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Govern-ment, laws, &c.

The government of Iceland is committed to an officer appointed by the crown of Denmark, who is occasionally a native of the island, but more frequently a Dane by birth. This supreme magistrate has the title of Stiftamtman, and is intrusted with a general superintendence of every department. Under him are the amtmen or provincial governors, each of whom rules one of the four provinces of the island, and possesses a similar jurisdiction over his respective quarter, as his superior officer does over the whole island. Each province again is divided into syssels or shires, over which the sysselmen preside. This office is likewise in the appointment of the crown; and, on account of its importance,

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it is always given to one of the most respectable landed proprietors within the district. The rank of sysselman corresponds in some degree to that of sheriff in this country. The hreopstiore is a subordinate parochial officer, whose duty it is to attend to the condition of the poor, and to assist the sysselman in the preservation of the peace. He is usually chosen from among the farmers; whilst the forlik-unarmen are those appointed as arbiters for the decision of disputes among the parishioners. The laws of Iceland, like the general form of government as established nearly six hundred years ago, have undergone little important alteration; but the judicial changes have been more considerable, and the forms of justice in most respects now resemble those of Denmark. The residence of the governor is at Reikiavik, in the S.W. angle of the island, the only place approaching the character of a town in Iceland. There likewise the althing or parliament meets once in two years to make laws for the island, under correction of the Danish crown.

The revenue of the island, arising from crown property, commercial charges, a small tax on transference of property, &c., amounted in the year ending 31st March 1854, to 27,949 rix-dollars (L.3119), while the expenditure for officers' salaries, education, the clergy, and other items, was 56,743 rix-dollars, or more than double the income, the excess being supplied by the central government. The income, however, appears to be increasing in proportion.

Crimes are rare; the gentle and peaceable disposition of the natives, their moral and religious education and sober habits, act as preventives of such as are of a flagrant description. Small thefts, especially of sheep, are the most frequent; but the high court has seldom to decide more than six or eight cases annually. The whip is the only punishment applied in the country, excepting fines; those who are punished with hard labour or banishment being sent to Copenhagen.

There are about 194 parishes or livings on the island; but the clergy number at least 300, as many of the parishes have two churches, the great distance and the danger of travelling, particularly in winter, when the rugged fields of lava are covered with snow, making it frequently impossible for all the peasantry of the same parish to attend at one church. The clergy are partly supported by a species of tithes, which are mostly paid in kind. These stipends, however, are extremely miserable; the largest in the island not exceeding 185 dollars, and the average being little above 35 dollars, or L.6 sterling per annum. They must therefore depend almost entirely for subsistence on their glebe land and their stock of cattle, and a small pittance they are entitled to for the few baptisms, marriages, and funerals that occur among their parishioners. "The clergy," observes Mr Barrow, "almost universally submit to every species of drudgery from necessity. Their incomes are too small to allow them to hire and feed labourers; and nothing is more common than to find the parish priest in a coarse woollen jacket and trousers, or skin boots, digging peat, mowing grass, and assisting in all the operations of haymaking. They are all blacksmiths also from necessity, and the best shoers of horses on the island. The feet of an Iceland horse would be cut to pieces over the sharp rock and lava if not well shod. The great resort of the peasantry is the church; and should any of the numerous horses have lost a shoe, or be likely to do so, the priest puts on his apron, lights his little charcoal fire in his smithy (one of which is always attached to every parsonage), and sets the animal on his legs again." The bishop has a neat mansion in the neighbourhood of Reikiavik, and his cathedral within the town is a handsome structure, furnished with a good organ, and possessing a beautiful marble baptismal font, the work of Thorvaldsen, who sent it as a present, in consideration of his being of Icelandic descent.

The clergyman of the parish having to undergo the same toils and hardships as the most humble of his flock, and enjoying no superior comforts or refinements, must feel that it is by his intellectual attainments only he can retain that station, and command that respect from his parishioners, which it is so necessary for him to possess. Literary pursuits are therefore the principal occupation of the clergy during the long and dreary period of winter; and, considering the difficulties in their way, the progress most of them have made is astonishing. The history and literature of the more refined nations of Europe now form a part of their studies. The English language, in which they find so many words of their own, and so many borrowed from the Latin, is cultivated by many of the clergy. The German they find still more easy; the Danish or Norwegian language is only the modern form of their own; and many of the choicest works in these dialects have been translated into Icelandic. The present state of literature in Iceland thus appears to be of a different description from what it was in ancient times. Its supposed decline is the subject of general complaint, though in point of fact it has only changed its character from the heroic and romantic to the useful and intelligible. A traveller found in 1855 two monthly newspapers published at Reikiavik. In the printing office there the master was putting through the press a translation of the *Odyssey* into Icelandic, and he showed a considerable stock of smaller works. A public library of two or three thousand volumes, accessible at a moderate rate, serves to introduce the inhabitants to the best productions of continental and English talent.

There are no public hospitals or charitable institutions of that description on the island; the sick and the poor being almost wholly supported by their own families. Indeed a sort of disgrace attaches to those who send them away to be taken care of by strangers, even though maintained at their own expense. Owing to the dispersedness of the population, there are no juvenile schools in Iceland: the system of juvenile education may be described as traditional; that is, each father teaches his own children. Notwithstanding the imperfection of this system, there are few who cannot both read and write well. It is remarkable that even in Reikiavik, which has a population approaching 1000, there is not a single school for children. It possesses, however, a kind of gymnasium or inferior college, well endowed by the government, where the youth designed for professions are educated. This establishment occupies a large and goodly building, containing a suite of school-rooms, and accommodation for a portion of the scholars, who are usually in all about sixty. There are three masters, the one, professor of theology, instructs the pupils in Hebrew and Greek, as far as the Greek Testament and Xenophon; the second teaches Latin, history, mathematics, and arithmetic; and the third the Danish, Norwegian, German, and Icelandic languages. There is also a teacher of the English language. The attendance of the pupils is constant from October to May, the intermediate months being the period of vacation, when they go to their homes.

Property is held either of the crown or in fee simple; the crown lands and many others are let to farmers, on what may almost be called perpetual leases. The rent is paid in two parts; the land rent, fixed at an old valuation, which it has not been found necessary to alter, and a rent for the number of cattle which it is calculated the farm is able to support; and these are transferred from one tenant to another, each succeeding one taking them, and leaving a similar number on quitting the farm. This, however, does not prevent a farmer keeping as much stock as he can maintain, without paying an additional rent. The tenant is for life, provided he does not injure the farm; but he may quit whenever he pleases, on giving six months' notice. His rent is generally paid in produce; on the coast in fish; in the

Iceland. interior in wool, tallow, butter, sheep, &c., or, according to agreement, in money. Individuals who cultivate their own properties, and tenants who are in easy circumstances, generally employ one or more labourers, who, besides board and lodging, have from ten to twelve dollars of annual wages. In Iceland, as in Norway, there is no such thing as entailed property, and the law of descent excludes primogeniture. If an individual die intestate, his estate is sold or valued, and divided amongst the children, so as to give equal shares to the sons, and half shares to the daughters. If, however, any of the brothers can pay the shares to his brothers and sisters, it is generally arranged that the freehold estate be made over to him, in order to retain it in the family.

Population. The population of Iceland has undergone considerable vicissitudes through the operation of epidemics. At 50,444 in 1703, it had sunk in 1769 to 46,201, nor did it rise much above this point throughout the remainder of the century. In 1850, it was 59,157. This is small for an island whose surface is to that of Ireland as four to five; but that surface both from its own nature, and the character of the climate, is perhaps as unfavourable as any which exists between the limits of the two arctic circles. Deducting the areas of the numerous fiords with which it is intersected, the square contents of the land may be calculated at 37,388 statute miles; but as the centre of the island consists entirely of snowy and uninhabited mountains, the peopled portion cannot be considered more than 25,000 square miles; and the population therefore will not much exceed two persons on each square mile. At present the population must be increasing with greater rapidity, if we may judge from the proportion of births to deaths, the respective numbers in 1852 being 2435 (of which 333 illegitimate) and 1437. The whole population is employed either in farming, which occupies about three fourths of them, or in fishing. Other employments do not exist, nor is there any other class of people or townsmen, save the small number of merchants in Reikiavik and the other trading establishments. Every branch of industry is therefore domestic, and confined chiefly to articles of clothing, such as coarse cloth, gloves, mittens, and stockings. The peasantry are generally ingenious, and manufacture such simple pieces of furniture as their cottages require; some also aspire to make trinkets of silver, and articles from the walrus tusks. The trade of Iceland has never, till the present time, been managed in what modern science points out as the most advantageous way. The Danish government long had a monopoly of the business of this remote dependency. For many years, while this was abolished, Danish merchants had a preference in trading, by virtue of higher dues exacted from those of other countries. It was not till 1856 that the foreign merchant was encouraged to come to Iceland by a perfect equality of terms. The only place in the island entitled to be considered as a port is Reikiavik: only a few trading stations exist elsewhere. There is an annual export of from 1,000,000 to 1,200,000 pounds of raw wool, besides about 200,000 pairs of knitted stockings, and 300,000 mittens, or gloves without fingers. The Iceland sheep have remarkably fine fleeces of wool, which the farmers in the spring of the year take off whole; their weight being usually from four to five pounds. The other principal branch of industry in Iceland is fishing, which must be considered as in a thriving state. The fishing banks around the island abound in cod and other species, and the number of boats engaged in the business in 1853 amounted to 3506, being an advance of nearly 50 per cent. in 20 years. Fish-oil, whale-blubber, skins, eider-down, feathers, and the *Lichen Islandicus* for medicinal purposes, may also be included amongst their list of exports. These the natives dispose of to the Danish merchants in exchange for coffee, sugar, tobacco, snuff, a small quantity of brandy, rye and rye-bread, biscuit, wheaten flour, salt, soap, and such other small articles as are in constant use for domestic purposes. Those who can afford it purchase a supply of linens and cottons, which of late years have become of more common use, and which must tend greatly to cleanliness, and the prevention of those diseases which woollen clothing worn next the skin tends to engender. The traffic thus occasioned takes place in the early part of summer, and whilst it lasts creates a kind of fair, with no little bustle and business, in the capital. All the articles brought from the interior for sale at the sea-ports, and all those taken back for winter consumption, are transported on pack-horses. There is not, in fact, in all Iceland such a machine as a wheel-carriage; before any such can be used, there must be roads, of which up to the present time none exist. The lines of transit along the country are mere tracks, cut deep by use where the ground is soft, and encumbered by blocks where it is hard. Yet, full as these paths are of difficulties, it is surprising at what a pace the small hardy sure-footed horses of the country will proceed. For foot-travelling they are in general impracticable. Iceland.

The Icelanders are generally middle-sized and well made, though not very strong. Their manners are exceedingly simple, and they are very respectful as well as obliging to strangers. Though their poverty disables them from imitating the hospitality of their ancestors in all respects, yet they cheerfully give away the little they have to spare, and express the utmost satisfaction if the gift shall have proved acceptable. They possess but few peculiar customs, and those not of particular interest. Their sole occupation during summer is to provide means of subsistence for the winter season; and when confined during the dreariness of an arctic winter to their huts, their great source of amusement is the tales of olden times, when the learning of their country rendered it renowned in every quarter of Europe. "Being of quiet and harmless dispositions," says Sir George Mackenzie, "having nothing to rouse them into a state of activity, nothing to inspire emulation, no object of ambition, the Icelanders may be said merely to live. But they possess innate good qualities, which, independently of the consciousness of their former importance, have preserved their general character as an amiable community. They have indeed become negligent with respect to the cleanliness of their persons and dwellings, but they deserve a high place in the scale of morality and religion. To religious duties they are strictly attentive; and though the clergy are not generally raised above the level of the peasantry in any respect but in their sacred office, yet they have been able to preserve the regard due to those who are considered as peculiarly the servants of the Supreme Being." The poor Icelander, too, is strongly attached to his native soil, and, like the Swiss, has been known to throw up lucrative appointments which he held elsewhere, for the sake of rejoining his family and friends on the island, being never so happy as when he sees a prospect of returning to it.

Topography. Few countries in the world present a more forbidding aspect, or have less apparently to invite the approach either of the traveller or the merchant, than Iceland. The interior is composed, as already mentioned, of lofty mountains, many of them volcanoes, nearly the whole being a pathless wilderness of snow. The circle of lower ground round the coast, where alone there is any population, is generally bare, rocky, and desolate, with only an admixture of green spaces where man and the domestic animals may find a subsistence. Nowhere does a tree rise to vary or soften the rigorous landscape. A *bae* or farm-stead is usually a cluster of low semi-subterranean hovels, covered thick with sod, and with few apertures to admit the light; there, as much as possible, the whole family, parents, children, and servants, eat and sleep in one room for the sake of warmth. At the fishing villages on the coast there is often a merchant's house of somewhat more roomy and elegant accommodations. The town of Reikiavik is mainly a mercantile esta-

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blishment; and, accordingly, its few short regular streets contain a considerable number of roomy wooden buildings, resembling those of Norway, and furnished with many of the comforts of life; there the merchant usually has a large miscellaneous shop and stores for goods on the ground floor, and a tolerable suite of apartments for his family above. Standing a little apart, and in strong contrast, is the fishermen's village, consisting of a cluster of the veriest hovels; there, according to the description of a traveller, —"A window is a luxury; a cask or barrel, with the two ends knocked out, answers the purpose of a chimney; but the smoke is frequently allowed to escape through a hole in the roof."

The surface of the country is for the most part highly mountainous and rugged; some of the yokuls or snow-capped eminences, as the Snaefell, the Skaptaa, Kateja Torsa, and Hecla, rising to the height of from 4000 to 6000 feet above the sea. The centre of the island, however, is traversed by considerable plains, some of which are covered with tolerable pasture, whilst others form extensive wastes, morasses, and fields of lava. It is also watered by a number of large rivers, which, from the rapid melting of the snows in summer, present a turbid, and some of them so white an appearance, that they are denominated from that circumstance. The smaller streams which rise in the lower grounds are transparent, and are celebrated for the abundance and beauty of the salmon which frequent them. There are also a number of lakes, of which the principal are Thingvalla Vatn, an expanse of water from 10 to 15 miles in length, and 6 to 8 in width, on whose banks the great assemblies of the nation used to be held; Myvatn, in the north-eastern extremity of the island; and Fiskevatn, a lake so designated from the fine fish it affords to the inhabitants of the midland districts.

The coast, like that of Norway, is in every direction deeply indented with creeks and arms of the sea; few of them, however, afford safe anchorage; and along the southern coast, eastward from where the great river Elvas empties itself into the sea, there are extensive shoals, formed partly, no doubt, by the depositions of the rivers proceeding from the great range of yokuls to the eastward of Mount Hecla, but principally from the remains of volcanoes, which, like the Sabrina and Graham Islands, have at one period appeared above the surface, but from the action of the waves have subsequently sunk below it. No part of the globe presents such a number of volcanic mountains, so many boiling springs, or such immense tracts of lava. The frequent and long-continued eruptions of its volcanoes are all on record in the historical annals of the island; their number since the year 1004 is stated at sixty-five. Of Hecla no less than sixteen great eruptions are mentioned; but, with the exception of those in 1818 and 1846, this celebrated mountain has been in a quiescent state since the middle of last century. By far the most dreadful occurrence of this description was that already mentioned, which took place from the great range of the Skaptaafell Yokul in the year 1783,—an eruption which devastated the finest portion of the island, and produced famine and disease amongst its inhabitants to an extent scarcely credible.

The boiling springs of Iceland have long attracted the attention of scientific men, and they are assuredly amongst the most curious and most remarkable phenomena which it presents. These are very numerous in many quarters of the island. One group, called the Geysers of Haukadalr, situated at the distance of two days' ride (about 70 miles) from Reikiavik, has attracted special attention. It occupies a space of a quarter or third of a mile square, on the slope of a small hill of trap rock, overlooking a valley connected with that of the River Hvita, or White River. In the lower part, amidst grassy ground, are the various hot-water wells and openings now in activity, each surrounded by more or less of silicious incrustations; in the upper and steeper part, immediately under the cliffs forming the top of the hill, are great banks composed of the debris of the incrustations of ancient and now nearly extinct geysers. The district of the active springs is constantly covered with steam proceeding from the various openings, and a sulphureous smell pervades it. The springs are very various in size and action; many being small, and a few large; some being constantly full to the brim and at rest, while others are at full boil; and a few are subject to occasional water-eruptions. The most remarkable are the Great Geyser, the Great and Little Strokr; and two large but quiet wells, noted for the beautiful blue tint of the water.

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The Great Geyser presents itself, in its calm moments, as a circular pool, 72 feet in diameter, and 4 feet deep; placed on the summit of a mount wholly composed of silicious matter, and from 10 to 20 feet high, according to the side on which it is measured, the ground here making a rapid inclination. In the centre of the saucer-like basin containing the pool is a well, above 10 feet in diameter and 83 feet deep. Water at a high temperature is continually rising through this well, and filling and overflowing the basin, at the outer edge of which the writer found it to be at 188° Fahrenheit. Every few hours, however, a rumbling noise is heard underground, and the water heaves up in the centre a few feet above the general level, and overflows the basin in unusual quantity. Once a-day, at an average, an eruption takes place,—a spectacle of the utmost grandeur. "The prominent object before me," says a late tourist, "the ground of the spectacle, as an artist might call it, was the vast effusion of steam covering the place, and rolling away under a varying wind. It was only on coming pretty near and getting to windward, that I caught the sight of a multitude of jets of water darting in outward curves, as from a centre, through amidst this steam-cloud, glittering in the sunshine for a moment, and then falling in heavy plash all over the incrusted mount. It seemed to me, though the circumstances are certainly not favourable for an accurate estimate, that these jets rose about 60 or 70 feet above the basin." An eruption generally lasts a few minutes, and at its close the water is found to have shrunk a few feet down the well, leaving the basin dry. Sir George Mackenzie speculated on these outbursts being produced by pressure on the air contained in cavernous recesses under the ground; but Professor Bunsen has lately announced a chemical theory much more likely to be accepted. He points to the fact that water, after being long subjected to heat, loses much of the air contained in it, has the cohesion of its molecules much increased, and requires a higher temperature to bring it to the boil, at which moment, however, the production of vapour becomes so great and so instantaneous as to cause explosion. The bursting of furnace boilers is often attributable to this cause. Now, the water at the bottom of the well of the Great Geyser is found to be of a constantly increasing temperature up to the moment of an eruption, when on one occasion it was as high as 261° Fahrenheit. Professor Bunsen's idea is, that, on reaching some unknown point above that temperature, ebullition takes place, vapour is suddenly generated in enormous quantity, and an eruption of the superior column of water is the consequence.

The Great Strokr (*strokr* means a churn in Icelandic), situated about 100 yards from the Great Geyser, is a pit of silicious matter, of irregular form, but approaching the appearance of a well, and having only a tendency to the formation of a basin at the top. Usually, the water is heard fretting about a dozen feet down; but at intervals of half a day or so, eruptions take place, resembling those of the Great Geyser. The visitor can here command an eruption, by throwing in a barrowful of turf, or any similar stuff. The appearance and phenomena of the Little Strokr are precisely similar, only on a smaller scale. It appears that

Iceland. the blue holes above mentioned were once eruptive also, and were styled by an English traveller the Roaring Geyser, and that it was only on that geyser becoming tranquillized that the present Great Strokr began its outrageous practices.

The water of the Geysers is perfectly pure in appearance, and notwithstanding the sulphureous smell, may be used in cooking, or even to drink. In reality the infusion of foreign matter is extremely small, being little more than a thousandth part of the whole, as appears from the following statement of Dr Black regarding a quantity of 10,000 grains (about one-sixth of a gallon):—

Soda	0·95	Muriate of soda	2·46
Alumina	0·48	Dry sulphate of soda	1·46
Silica	5·40	Total	10·75

Small as is this proportion of silica, it has been enough in time to form the thick incrustations around the geysers, and even the mount on which the Great Geyser is situated. These incrustations are usually of a dull colour and great hardness, their surfaces being efflorescent, like the top of a cauliflower, wherever the water falls in a plash, in other places smooth.

Our space allows us only to glance at the geysers containing an infusion of fine clay. These have caused, in the superior part of the slope, several deposits of various colours, resembling the finest pigments.

The formation of this mud, and other products of the hot springs of Iceland, out of the materials presented by the rocks of the country, offers the most curious subjects of inquiry for the chemist. Of these products there is one of some commercial importance, and which calls for special attention, viz., sulphur. It is produced in large quantities at two places—Husivik, on the N. of the island, and Krusivik, within a day's ride of Reikiavik. In the latter instance, in a hollow at the bottom of a tuff hill, we find thick deposits of red and blue clays, mixed with iron pyrites, and of which the temperature, a few feet down, is nearly equal to that of ordinary boiling water. The hot springs gushing through these deposits form the sulphur in crystals and in layers, requiring very little refining to prepare it for use.

The mud volcano of Reykialid, near Myvatn, occupies the crater of Mount Krabla, one of the principal volcanoes of Iceland, and is thus described by Henderson, who made the circuit of the island during the year 1815. "At the bottom of a deep gully lay a circular pool of black liquid matter, at least three hundred feet in circumference, from the middle of which a vast column of the same black liquid was erupted with a loud thundering noise. This column is equal in diameter to that ejected by the Great Geyser at its strongest eruptions. The height of the jets varies greatly, rising on the first propulsions of the liquid to about twelve feet, and continuing to ascend, as it were, by leaps, till they gain the highest elevation, which is upwards of thirty feet, when they again abate much more rapidly than they rise; and after the spouting ceases, the situation of the aperture is rendered visible only by a gentle ebullition, which distinguishes it from the general surface of the pool; the eruptions take place every five minutes, and last about two minutes and a half." In the same vicinity are the hot springs of Husavik, which, though they bear no comparison in magnificence to those of Skalholt, are extremely interesting in many respects. The pipe of one of them, the Oxahver, which is said to have derived its name from the circumstance of an ox having fallen into it, is about eight feet in diameter, is surrounded with a strongly incrusted brim, and shortly below the surface trends to one side, and becomes quite irregular. Its jets rarely exceed twenty feet in height, but, according to Henderson's account, they are conducted with the utmost regularity in point of time. It was amongst the beautiful incrustations formed around the basin of this spring that Mr Rose of Edinburgh, during his mineralogical excursion a few years ago, observed that variety of apophyllite, to which the synonyme of Oxahverite was subsequently applied. Iceland.

Though it cannot be denied that these springs have some communication with the volcanoes which abound in the island, yet it is a remarkable fact that they are seldom found very near them, although dispersed throughout the whole country. When their situation suits, they are turned to good account by the inhabitants, both as bathing quarters, and for various culinary purposes, in boiling fish, evaporating sea-water, and the like. At Reikholt there is a celebrated bath of this description, which was constructed six hundred years ago by the famous Snorro Sturleson. It is fourteen feet in diameter and six feet deep, being supplied, by means of covered conduits, both with hot and cold water, from springs about a hundred yards distant, so that any desired temperature might be obtained.

Iceland is one mass of igneous rocks, of two classes—first, traps and tuffs arranged in beds generally little inclined, and presenting in some places sectional cliffs of from three to four thousand feet in height; second, trachytes in huge irregular masses, constituting the principal mountains of the interior. Different as they are in general appearance, a connection can be established between them by the clearest intermediate steps, exhibiting a progress in time from the formation of the traps under a superincumbent ocean, to the tremendous subaerial volcanic operations which produce the trachytes, and which cannot yet be said to be at an end. The traps are intersected by numerous veins, and curious appearances are presented where these have alone survived the disintegrating forces. The surfaces of some of the lavas which Sir George Mackenzie observed in Iceland he describes as not unlike coils of ropes or crumpled cloth; in other respects they appear to resemble the lavas of recent volcanoes elsewhere, being, like those of Ætna, thrown up into large flattened masses. These, it is well known, are produced by the formation of a crust on the lava during its course, which, as it accumulates, breaks through the hardened surface; and thus, when it cools, leaves a wide extended plain of the most rugged and impassable description. In some places the surface has swelled during the course of the lava into knobs, from a few feet in diameter to forty or fifty, many of which have burst, and disclose caverns lined with melted matter in the form of stalactites. Of these some remarkable instances are mentioned amongst the extremely rugged lava of Buderstad, in the vicinity of the Snaefell Yokul, where several of the caverns extend to the depth of forty yards. Stappen, in the same part of the island, presents, for the extent of about two miles, the most striking columnar appearances, both in the cliffs which form the shore, and in the numerous insulated rocks which appear at different distances from the land. Amygdaloid forms the larger portion of the eastern extremity of the island, and it is imbedded in this that those splendid specimens of calcareous spar *par excellence* denominated Iceland-spar are found. This rock is likewise the matrix of all the different varieties of the zeolite tribe, of the magnificent calcedonies, and in fact of most of the fine minerals which have long rendered Iceland so celebrated among collectors. Fossilized wood is found in several places; that variety termed Surturbrand is peculiar to the north-eastern volcanic district. It is remarkable that the specimens hitherto brought home of this last substance appear to be oak. It burns with flame, and can be cut and shaped like jet; but from its brittleness does not admit of being sliced into shavings. Pumice, obsidian, and other volcanic minerals appear in great beauty in many districts of the island, particularly near Hecla, and to the north of Krabla.

There is little rema ble in the zoology of Iceland.

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The only wild animals are foxes, which in some parts of it are very numerous, and do much damage to the farmers in destroying their lambs and other produce. Reindeer were introduced from Sweden about the middle of last century, and have since increased and run wild. The Iceland horse is small, but hardy, active, and capable of sustaining considerable fatigue. Dogs and cats they have in abundance, and rats and mice are proportionally numerous. The floating ice occasionally transports a polar bear or two from the Greenland coasts during spring, which, however, are no sooner heard of than the neighbouring country are up in arms to kill them, and they are consequently hunted down and destroyed without mercy. The skins of the foxes, particularly those of the blue species, are valued as an article of commerce.

Amongst the land birds of the island are the sea-eagle or erne, a very destructive bird among the eider-ducks; the falcon, which used formerly to be a valuable item in the exports of the island; and the raven, which is a larger and more powerful bird than those of Britain, frequently pouncing upon and carrying off young lambs, and destroying poultry; it is met with in great numbers, particularly on the cliffs near the sea-coast. The ptarmigan, snipe, golden plover, wagtail, and curlew, are well known. Water-fowl of every description, common to northern latitudes, are met with on the coasts and in the lakes. Of these the most valuable to the inhabitants is the eider-duck, which is strictly preserved, a penalty of half a dollar being exigible for shooting one of these birds. From this circumstance they become so remarkably tame, especially in the breeding season, that they frequently make their nests close to the houses, and in spots which have been prepared by ridges of stones artificially built up for them; and in such places, during the process of incubation, it is not unusual for the female to remain on the nest, and suffer herself to be fondled. The lining of their nests, being the downy substance plucked off their own breasts, is taken away, even a second and third time, until the poor bird has plucked herself nearly naked. Their eggs, too, are removed once or twice, and are eaten in the same manner as plovers' eggs. Swans are very numerous in some of the lakes of the central part of the island, where they remain unmolested until the ice sets in, when they betake themselves to the sea-shore. The eggs, the feathers, and the down of this fine bird, like those of the eider-duck, supply the peasantry with an article of food, and also of commerce.

The vegetable productions of the island, as already stated, are the reverse of luxuriant. With the exception of a few stunted birch, and some dwarf willows, in the southern and eastern districts, nothing in the shape of a tree occurs; and, even in the sheltered situations afforded by the gardens surrounding the merchants' houses near Reikiavik, all attempts to raise the most common culinary vegetables occasionally fail. Even in good years, Dr Hooker remarks that in many of these little inclosures the cabbages were so languid and small that a half-crown piece would have covered the whole of the plant. It is a curious fact, however, that timber has in former periods grown in more abundance, as is evident from the logs so frequently met with in the morasses and peat-bogs of the country. These the peasants are in the habit of extracting and using for firewood.

Iceland Moss || Ichneumon.

The scanty produce of the land is, however, to a great degree compensated for by the abundance of fine fish which occurs on the coast. In several parts of the island, particularly on the north and north-west, the shark fishery is a regular occupation. Strong hooks fastened to chains are baited and anchored a little way out to sea, and the fish when caught are thus towed to shore. Of the skin shoes are made, a considerable quantity of oil is extracted, and some parts of the flesh are occasionally smoked and used by the natives for food. The cod is very plentiful; the haddock grows to a large size; ling, skate, flounders, and halibut are likewise very common; the herring, too, frequents the fords in vast shoals, but this branch of the fishery has hitherto been little attended to. The salmon in the rivers are said to be very fine, and no country in the world produces them in greater quantity. Seals are particularly numerous on the shores of the Breide-fiord and the western coast.

Such is a rapid sketch of the most remarkable features of Iceland. The ardour, however, with which the sciences of natural history and geology are now pursued in Britain, coupled with the increasing facility every year afforded by means of steam navigation, will, no doubt, in the course of a very few summers, present us with more minute and more accurate information respecting the truly extraordinary natural productions of this wild but wonderful island.

(See *Letters on Iceland*, by Von Troil, in 1772; *Travels in Iceland*, by Sir George Mackenzie, in 1810; *Journal of a Residence in Iceland during the Years* 1814 *and* 1815, by Ebenezer Henderson; *Visit to Iceland in the Summer of* 1834, by John Barrow, Esq., jun.; and *Tracings of Iceland and the Faroe Islands*, by R. Chambers, 1856.

(T. A—L—N.) (R. CH—S.)

ICELAND MOSS. See BOTANY, Nat. Order 273.

ICENI, in *Ancient Geography*, a warlike tribe of Britain, inhabiting a part of the island nearly corresponding with the counties of Norfolk and Suffolk. The exact limits of their country are very difficult to settle, and as the point is one of some importance for rightly understanding the campaign of Ostorius, it has caused a good deal of controversy. The only way of escaping the difficulty is to believe that the Iceni occupied a considerably larger surface of country than is usually assigned to them, and extending their frontiers to the confines of Essex and Hertfordshire. The great event in the history of this tribe is their rebellion from the Roman yoke under their queen Boadicea. See BOADICEA

ICHNEUMON. See ENTOMOLOGY and MAMMALIA.

ICHTHYOLOGY.[1]

Introduction.

INTRODUCTORY CHAPTER.

SECTION I.—DEFINITION AND GENERAL OBSERVATIONS. THE PRINCIPAL EPOCHS IN THE SCIENCE OF ICHTHYOLOGY. VERTEBRALS.

FISHES may be technically defined as *vertebrated animals with red blood, breathing through the medium of water by means of branchiæ or gills.* This definition, as Baron Cuvier has remarked, is the result of observation; it is a product of analysis, or what is termed in physics an empirical formula; but its accuracy is demonstrable by the inverse method, for, when once duly perceived, we may, in a great measure, deduce from it a knowledge of the entire nature of the beings to which it is applied. Being vertebrated, they must be possessed of an internal skeleton; of a brain and spinal marrow, inclosed in a vertebral column; of muscles exterior to the bones; of four extremities only; and of the organs of the first four senses, situate in the cavities of the head; with other relations not necessary to be here named.

The greater portion of the surface of the earth is covered by the waters of the translucent sea; and wherever continents and the larger islands protrude their rocky bulk, we find them coursed by flowing rivers, or intersected by lakes and marshes. These present in their aggregate an enormous mass of waters, and afford protection and nourishment to myriads of living creatures, probably superior in number and in no way inferior in beauty, to those which inhabit the earth. On land, the matter susceptible of life is mainly employed in the construction and continuance of vegetable species; from these, herbivorous animals draw their nourishment; and this being animalized by assimilation, becomes an appropriate food for the carnivorous kinds, which scarcely amount to more than one-half of the terrestrial creatures of all classes. But in the liquid element, and more especially among the saline waters of the ocean, where the vegetable kingdom is so much more restricted, almost all organized substances are pervaded by animal life, and each lives at the expense of some smaller or feebler foe. There we meet not only with the greatest and most wonderful variety of forms, but also with the extremes in respect to size,—from the myriads of microscopic monads, which, but for artificial means, must have remained for ever invisible and unknown, to the ponderous whale, which surpasses, by twenty times, the bulk of the largest elephant. There, too, we may discover the majority of those magnificent combinations of organic structure, on the relations of which naturalists have established the distinction of classes, or great primary groups; in other words, the sea may be said to contain representatives of each; for, even among birds, those aerial creatures which usually inhabit so light an element, we find species so constructed as to dwell almost for ever on its waves. The mammiferous class is still more fully represented in the numerous tribes of seals, morses, manaties, and whales, all of which require a moist abode, and some of which immediately perish when deprived of it. Most reptiles are aquatic, many insects are so, more particularly in their larva state; and almost all the Mollusca, the Annelides, the Crustacea, and Zoophytes, four great classes, which on *terra firma* are few and far between, exist in countless numbers in the waters of the ocean. Hence that ancient dictum recorded by Pliny, "Quicquid nascatur in parte naturæ ulla, et in mari esse; præterque multa quæ nusquam alibi."

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But amongst all the teeming wonders which vivify the vast expanse and liquid depth of waters, none so predominate, or are so truly characteristic, as the subjects of our present treatise; nor are any more worthy of our careful consideration, whether we regard the beauty or eccentricity of their forms, the metallic splendour of their colours, or the innumerable benefits which, through the foresight of Providence, they confer upon the human race. We therefore deem it incumbent upon us to exhibit an ample view of the present condition of Systematic Ichthyology; but before doing so, we shall endeavour to add to the interest of the subject by a few general observations.

We may state, in the first place, that we here intentionally refrain from any bibliographical inquiry, or historical exposition of the progress of Ichthyology. If such were complete, or even ample, it would occupy too much of that space which we deem more usefully devoted to the actual condition of the science; and we more willingly set that department aside, when we consider how perfectly it has been presented by Baron Cuvier.[2] We shall, however, briefly allude to what may be regarded as the principal epoch in the progress of Ichthyology. During many remote ages it consisted, in common with all the kindred branches of human knowledge, of nothing more than a few partial and disjointed observations. Aristotle, about 350 years before the Christian era, made some progress towards connecting these together as a body of doctrine; but still it was a feeble body, reposing upon truths (perceived indeed with surprising skill when we consider the scanty data) as yet obscurely known and vaguely expressed, owing to the entire absence of all proper standards for the distinction of species. For more than eighteen hundred years ensuing, the writers on natural history can scarcely be regarded in any other light than as either copiers or commentators of Aristotle; but about the middle of the sixteenth century, Belon, Rondelet, and Salviani, the true founders of modern Ichthyology, made their appearance (we mean as authors), by a singular coincidence, almost precisely at the same time,—the first in 1553, the second from 1554 to 1555, and the third from 1554 to 1558. Differing from their compiling predecessors, they saw and examined for themselves, and made drawings from nature, if not with the elegant accuracy of modern days, at least with a recognisable exactness. Yet, true to the ge-

[1] From ἰχθύς, *a fish*, and λογος, *a discourse*.

[2] See the *Tableau Historique des Progrès de l'Ichtyologie, depuis son origine jusqu'à nos jours*, in the first volume of the great though unfortunately uncompleted work, the *Histoire Naturelle des Poissons*. We deem ourselves fortunate beyond our predecessors in encyclopædic labour, in having as a guide in so difficult a subject as that on which the reader is about to enter, the volumes of Baron Cuvier's and M. Valenciennes' signal publication. As far as this great work extends we have availed ourselves of the labours of its authors, and have endeavoured to present the general and miscellaneous information scattered through it, as amply as our limits would permit, and in a form and sequence the most advantageous to those unacquainted with the voluminous original. In the present revisal of this treatise we have also borrowed freely from the writings of our British Cuvier, whose work on the *Comparative Anatomy and Physiology of Fishes*, forming part of his Hunterian Lectures, gives the fullest and most accurate view of the animal economy of fishes, and most philosophical account of the skeleton, that have hitherto appeared. We beg also to repeat our acknowledgments to Mr Couch, the acute discoverer and describer of new species frequenting the Cornish coasts, and Mr Yarrell, whose work on *British Fishes* is *facile princeps* among works illustrative of local Ichthyology.

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nius of their time, they continued to attach much more importance to the ascertainment of the names which the species bore in the classical pages of antiquity, than to the composition of their history, as it were afresh, by the light of nature and their own knowledge. Nevertheless, they rectified as well as extended the observations of Aristotle, and laid a positive foundation of the subject, by figures and descriptions of a certain number of well-determined species. About the close of the seventeenth century, Willughby, and his illustrious friend John Ray, gave for the first time a history of fishes, in which the species were not only clearly described from nature, but distributed in accordance with characters drawn solely from their structure, and in which we are no longer unnecessarily burdened with inapplicable passages from either Greek or Roman writers. Finally, about the middle of the eighteenth century, Artedi and Linnæus completed what the others had commenced, by establishing well-defined generic groups, consisting of ascertained species precisely characterized. From that period it may be said that no radical defect existed, nor any obstacle in the way of a gradual perfecting of the system, which could not be overcome by zeal, accuracy, and perseverance. Nevertheless, it is to the genius of Baron Cuvier that we owe the gigantic stride which has been made in our own more immediate days.

It is only by a profound study of the whole animal structure that we can, to the extent of our limited intellect, correctly appreciate that part of the works of the great Creator, and get some insight into the branching and anastomosing affinities by which the almost numberless kinds of living beings are linked together. Many years spent in anatomical investigations gave Baron Cuvier such a knowledge of the mutual dependence of the various parts of the organism of each of the numerous species which came under his observation, that he was able, from the inspection of a single bone, to reconstruct, mentally as it were, the animal to which it had belonged, and to assign the species its place in the system of nature. This great step in the history of Zoology placed its discoverer in the first rank of the cultivators of the science. In none of the greater divisions of the animal kingdom were Cuvier's labours, in forming a natural arrangement of the species, of more value than in the class of Fishes, the lowest of the *vertebrata*, or of that division of animals whose proper character consists in the possession of *a central bony axis on which the soft parts are sustained, and from which the motive powers diverge*. The Latin word used above has been adopted into the English scientific language, though by many the more Anglicised term of "vertebrals" is used, and we call the internal chain of bone the vertebral column, while its several successive component joints are named "vertebræ." The German equivalent of vertebrata is "wirbelthiere."

We must remark, at the outset, that neither this term of Vertebrata, nor any other definition of a group which the ingenuity of man has hitherto devised, is logically correct. In Mammals, indeed, the highest class of the division, the internal bony frame is strong and massive, and fitted to support the limbs, by which, with the firm earth for a fulcrum, the animal moves through a medium greatly lighter than itself. In Birds, too, constituting the second class of the division, the bones of denser texture but more slender form and often hollow, are admirably fitted for sustaining the powerful muscles exercised in the maintenance of extended aerial flight; and in both classes, the turning joints of the vertebral column, and more especially of the cervical portion of it, are adapted to the various motions of the animal, and for enabling it to rotate its head from side to side, and survey whatever comes within its field of vision. As we descend to the less highly organized vertebrals, we come to other and remarkable modifications of the spinal column. In the third class, or the Reptiles, there is one order, namely, that of the *Ophidia*, or Serpents, whose locomotion is performed by creeping without external limbs, and solely by the flexibility of the vertebral column and the muscles attached to it, and to its appendages the ribs. The vertebræ are accordingly much more numerous in these animals than in any others, and their motions on each other more extensive. In another group of the same class the vertebræ of the body are soldered together by bone, and power of motion is preserved only in the neck and short tail. A third group, named Amphibians, are fishes in their embryo or tadpole condition, and undergo a kind of metamorphosis in becoming terrestrial and air-breathing creatures. A fourth remarkable group, of which only a few species have been hitherto detected, presents, with much of the piscine form, the peculiarity of the existence of both gills and lungs, and a residence in water during life. In the Fishes, the proper subjects of this treatise, and the lowest class of vertebrated animals, there is a large group named by some authors CARTILAGINEI, or CHONDROPTERYGII, because the internal skeleton remains in the state of cartilage, the bony structure being wholly absent in some species, and in others only very partially present; and thus the precision of one part of the character of the vertebrata given above is impaired. In certain of the Cartilaginei the joints of the column are obsolete, and flexibility is substituted for the turning motions indicated by the word *vertebræ*. These brief notices point at some of the difficulties which beset the zoologist when he endeavours to convey the knowledge he has acquired to others, by concise and definite phrases. Yet however difficult it may be to construct a correct definition, it is certain that the idea of the type of an animal group may be conceived in the mind, on the basis of exact observation and legitimate deduction, in proof whereof the reader is confidently referred to the works of Professor Richard Owen of the British Museum, and particularly to his treatise *On the Archetype and Homologies of the Vertebrate Skeleton.*[1]

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The vertebrated animals agree in having a spinal chord or elongated bundle of nervous filaments running along the body, and protected by bony arches composed of the neural apophyses, or processes which rise upwards from the body or centrum of each vertebra. The anterior expansion of the spinal chord, named the brain, is most fully developed in the higher classes of vertebrals, and is comparatively very small in fishes whose encephalon has the character of a series of ganglions, or knots of nervous matter, arranged in single succession or in pairs. In the lowest known form of fish, the Lancelet, the whole vertebral column is merely a pulpy nervous chord invested by a membranous sheath; and Pallas, the first describer of this animal, ranked it, in accordance with the progress that science had made in his time, among the Slugs. In all the vertebrals the vascular trunks and organs of digestion are protected by the inferior processes and diverging appendages of the vertebræ; and the type of this division of animated beings is essentially tetrapodal (fig. 1), though in some groups one or both pairs of limbs are either rudimental or absolutely wanting—examples of these deviations from the ordinary type being most frequent in the classes of Reptiles and Fishes. The four limbs are produced in lateral pairs; and in fishes the first pair are named pectoral fins, and the second pair, being situated on the ventral aspect of the fish, are called ventral

[1] *On the Archetype and Homologies of the Vertebrate Skeleton*, 8vo. London, 1849. Also *Report of the British Association*, 1846—*On the nature of Limbs*; Richard Owen, &c., 8vo. London, 1849.

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fins, even though their relative position, as is the case in some kinds of fish, should be in front of the pectorals when they

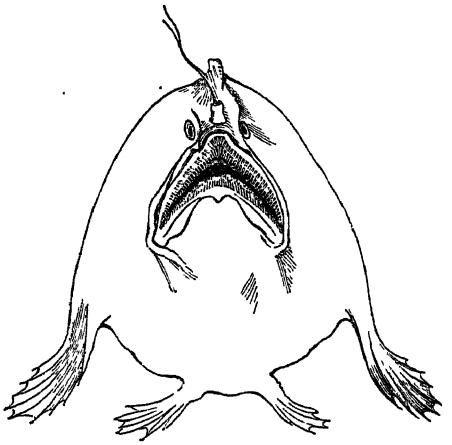


Fig. 1.

Cheironectes caudimaculatus of the family of *Lophiidæ*.

obtain technically the name of jugular fins. In the above woodcut we have a front view of *Cheironectes caudimaculatus*, belonging to a group of fish which actually *walk* at times on their four limbs. The vertical fins of fishes are of a different nature, and the rays which support them, whether jointed and soft, or hard and spinous, are not parts of the interior skeleton, but belong properly to the skin or dermal skeleton. The fins that rise vertically in the mesial plane of the back, whether one or more, are named "dorsal." Those from the opposite ventral aspect, situated in all cases posterior to the vent, and therefore appertaining truly to the tail, are termed "anals," and the solitary fin at the end of the tail is named the "caudal." Artedi denominated the fish which have spinous rays on the back, Acanthopterygians, and those which have only flexible and jointed rays, Malacopterygians—other groups having however been previously detached by the forms of their branchial apparatus, or the cartilaginous condition of the skeleton. Among the Reptiles there are species which have dermal crests on the back or tail, supported by rays, and analogous to the vertical fins of fishes.

In the great majority of vertebrals a lateral symmetry exists externally and in the skeleton; only one group of fishes, namely, the Flounder family, presents a remarkable dissimilarity in the two sides of the fish.

All the vertebrals also agree in the separation of the sexes, two individuals being required for the reproduction of the species.

SECTION II.—THE EXTERNAL FORM AND CHARACTER OF FISHES.

By using the comparative terms of highest and lowest class of vertebrals, we do not imply that there is any deficiency in the structure of fishes which constitute the fundamental group, for every creature was perfectly organized when called into existence by the fiat of the Creator for the functions he destined it to perform; but He, having designed the fishes to play a part in the scale of nature requiring less intelligence, has furnished them with a simpler nervous system and less sentient organs, a more obtuse sense of touch, restricted organs of smell and taste, and an acoustic apparatus shut up within the head, without any exterior ear or auditory canal for collecting and conveying the vibrations by which sound is produced and transmitted. Light being required to enable the fish to discover its prey or avoid its enemies, the eye is larger in many of them than in other vertebrals, and only in a very few diminutive or almost obsolete. Lubricated by the surrounding medium, it needs no lachrymal gland; and as the light is tempered greatly by a small increase of the depth at which a fish glides through the water, few species have anything like eyelids or nictitating membranes. The function of nutrition is very active, the appetite being very generally voracious, digestion remarkably rapid, and the growth, when suitable food is abundant, extremely rapid. The reproductive power, also, is exceedingly great. Destined to pass their whole lives in a medium whose variations of temperature are much more limited than that of the atmosphere which the other vertebrals breathe, but whose conducting power is greater, the temperature of fishes exceeds only by a few degrees that of the water in which they swim, and their blood is cold. A less vigorous respiration, therefore, suffices to keep up the animal heat, and the oxygenation of the blood is accomplished by the agency of the water on certain vascular organs named gills. Through these organs venous blood is propelled by a simple heart, consisting of one auricle and one ventricle. In these and various other parts of their organization, fish preserve permanently structures that exist in the higher vertebrals only in an early stage of their embryonic development. Palæontologists have ascertained, moreover, that fishes were the first of the vertebrals which appeared on the theatre of the earth's history, and at an epoch long antecedent to the deposits in which the remains of the higher animals are found. These primitive fish, however, were not types of the lower forms of the class, but, on the contrary, many of them were powerfully built, and resembled the saurian reptiles in parts of their structure, so that they were at least on par with the more highly organized fishes of the present day. We have not learned that the remains of fish having the embryonic vermiform shape, have been discovered in the oldest ichthygenous deposits.

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The Salmon is a familiar example of one of the more common forms of a fish, and one frequently quoted as being pre-eminently qualified for cleaving through the liquid element in which it lives; but there is a vast variety of shapes to be found in the class. The common Salmonoid form

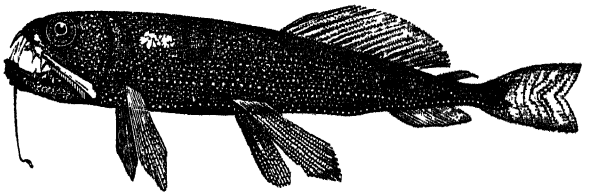


Fig. 2.

Astronesthes niger (*Chauliodus Fieldii*, Valenc.), one of the *Scopelinæ*, a group of the Salmon family.

(fig. 2) of the osseous fishes passes in different species, by compression and abbreviation, to the thin vertical disks

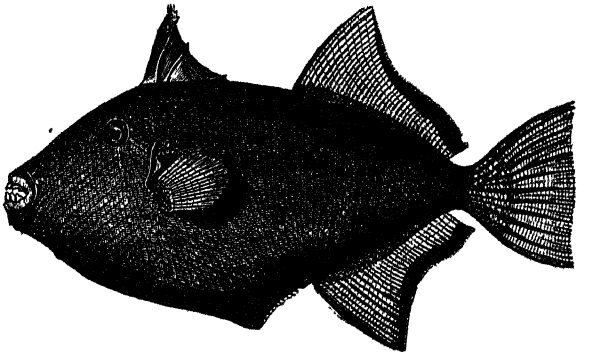


Fig. 3.

Melichthys vidua, one of the *Balistidæ*, discovered on Cook's first voyage.

of the Chætodons or Balistes (fig. 3), or, by compression and elongation, into the riband-form of the *Gymnetri* and

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Leptocephali (fig. 4). Totally opposed to these is the

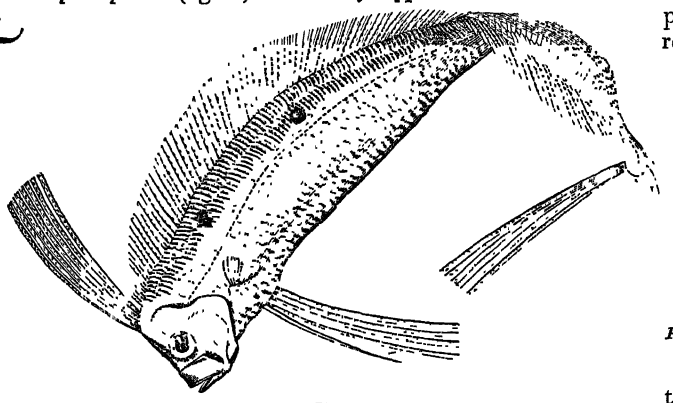


Fig. 4.
Trachypterus falx, an example of the thin elongated *Tœnioidei* or Riband-fish family—the *Gymnetridæ* of our table.

square box-like shape of the cubical Ostracions (fig. 5), the pyramidal form of others of that tribe, or the round bladder-like figure of the inflated Diodons or the hard-scaled spheroid *Monocentris*. We have examples of a slender elongated cylindrical form among the *Syngnathidæ* or Pipe fish, and among the Eels (fig. 6), Lampreys, and Sharks. Indeed, the vermiform type exhibited by embryos of vertebrals in their earliest stage, is persistent in many fishes, which by the assemblage of other points of their structure enter totally different groups. A depressed, dis-

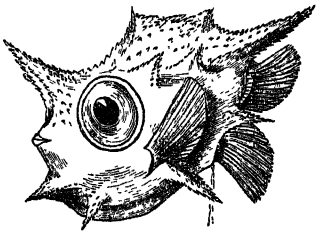


Fig. 5.
Centaurus boöps of the *Ostracionidæ* discovered on Sir James Clark Ross's memorable voyage to the Antarctic seas.

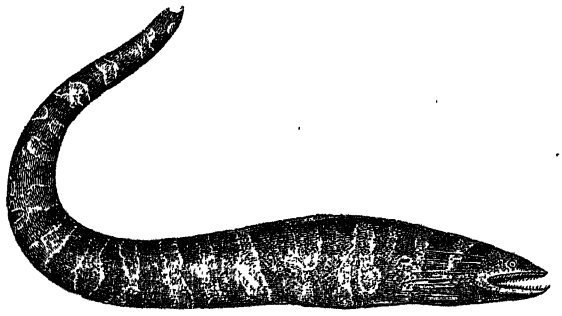


Fig. 6.
Channo-muræna vittata of the Murænoid family of *Apodals*. In this genus there are no fins, except a slight vestige of rudimentary rays at the end of the tail lying in the thick skin.

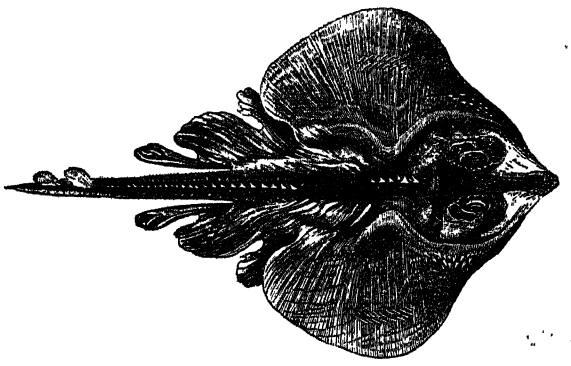


Fig. 7.
Raia Lemprieri, a Skate from Australia.

coid shape, with the appendage of a whip-like tail, is common among the Rays (fig. 7) and their allies; and in the Flounder family we have nearly the same external form produced by compression, and that lateral dissimilarity already alluded to. Other forms, curious from their gro-

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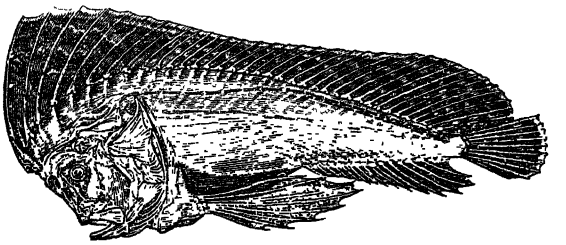


Fig. 8.
Patœcus fronto, one of the many singular forms which the *Lophiidæ* exhibit. It was discovered by Governor Sir George Grey in South Australia. The generic name has reference to the figure-head of an ancient ship.

tesqueness, or from the redundancy of certain parts, are not uncommon; and we need not adduce other examples than those which exist among the *Lophiidæ*, *Gobiidæ* (fig. 8),

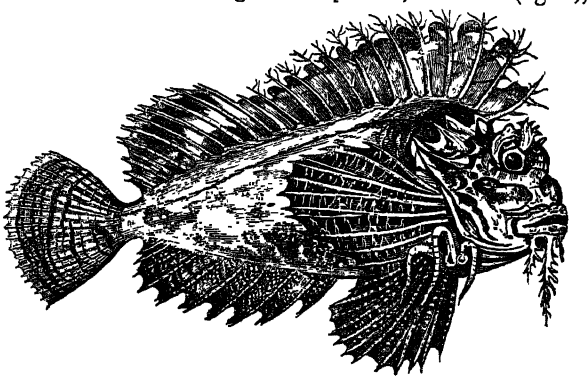


Fig. 9.
Choridactylus multibarbus, a member of the *Apistes* group among the *Sclerogenidæ*, and furnished like the other Apistes with a treacherous spine on the preorbitar scale bone. The free rays of the pectoral fin are organs of touch analogous to fingers, and similar to the free rays of the Gurnards, and many other fish that habitually frequent the bottom of the sea.

Pristidæ, *Sclerogenidæ* (fig. 9), *Siluridæ*, or *Acanthuridæ*. Some of the forms which we have thus noticed in general terms, and others which the woodcuts exhibit, are ill calculated for swift progression, and the small and delicate fins of the *Ostracions*, for instance, can serve little more than the office of rudders to the inflexible scaly case from which they protrude. The chief organs of locomotion in the rapid swimming fish is the tail, which, in a majority of such fish, equals or far exceeds the trunk in length. It sculls a fish along like an oar worked at the stern of a boat. In the vermiform apodal fishes, and in many Cartilaginei, swift motion is produced by lateral undulatory strokes of the entire body and tail. When the body is suspended in an element of the same or nearly the same specific gravity with itself, it is moveable by a slight impulse; and we find, accordingly, that if the limbs exist, they are more tender than the analogous members of the higher classes, and that the want of one or both pairs is more common than in other classes.

Before we enter on the consideration of the proper vertebral skeleton, it may be well to premise that the bones, or hard parts of fishes, are primarily divisible into those of the—1. *Neuro-skeleton* or endo-vertebral series; 2. The *Splanchno-skeleton*, for the special protection of certain organs; 3. *Dermo-skeleton*, parts, as the name denotes, of the cutaneous system, and analogous to the exterior skeletons of the lower divisions of animals.

SECTION III.—THE OSTEOLOGY OF FISHES.

The structure and growth of bone have been described elsewhere; and it is sufficient to say here that it consists of animal matter, with diffused earthy particles, chiefly of

phosphate of lime, which gives it its hardness. Of the vertebrals, birds have most earthy matter in their bones, and fishes the least; but there is great variety in this respect even in the same class, the bones of each species

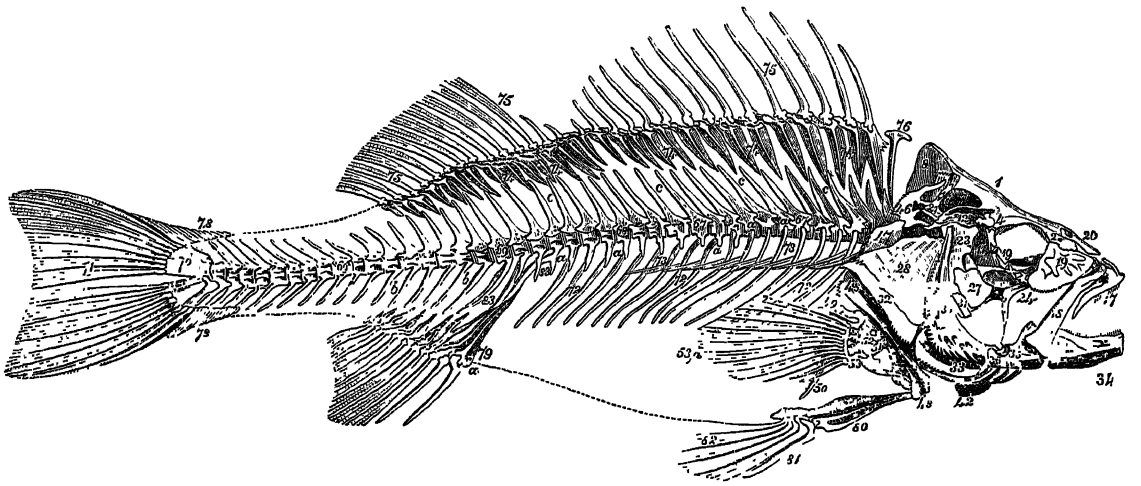


Fig. 10.
Skeleton of the Perch.

being adapted by their degrees of firmness and hardness for the shocks they have to sustain. The difference depends chiefly on the quantity of fluid matter in the cells and canals of the bone. In a note the composition of the bones of a cod, after the fluid portions had been evaporated, is given as analysed by Bibra.[1] The bones of fishes contain more evaporable fluid than those of the other classes of vertebrals, and also a larger portion of the salts of soda. The animal portion of a Shark's skeleton has much of the properties of mucus, yields no gelatine when dissolved in boiling water, and is not precipitated from the solution by infusion of galls, in which respect it differs from the cartilaginous foundation of the bones of beasts. The unossified skeleton of the Lamprey holds only $1\frac{1}{2}$ per cent. of earthy salts. In the vascular canals, which are permeated by the vessels that deposit the bone and carry on its circulation, there is usually some oil, which is composed chiefly of oleine, and is easily converted into soap, and then produces oleic acid, glycerine, and a minute portion of margaric acid. It has odour, and for the most part a yellow colour. In the Belone and Lepidosiren it imparts a deep green colour to the bones. The bones of fishes continue to grow in size almost throughout life.

The limits of this treatise do not admit of a detailed account of the skeleton and other parts of the structure of fishes, of all which, in connection with many admirable remarks on the homologies and analogies of the several parts of ichthyic structure with the corresponding parts of the other vertebrals, the student will find a full account in Professor Owen's *Lectures on the Comparative Anatomy and Physiology of the Vertebrate Animals*. So complete a work, so easy to be procured, renders it unnecessary to introduce more anatomical details here than are absolutely requisite for the understanding of the systematic review of the class which follows; and these we shall borrow from the work referred to, as being the best authority existing.

The first step in the knowledge of the skeleton of a fish, or of any other vertebral, is the determination of the vertebral segments, or natural groups of bones which compose the skeleton. A vertebra is defined by the Professor to be *one of those segments of the endo-skeleton which constitute the axis of the body, and the protecting canals of the nervous and vascular trunks:* such a segment may also support *diverging appendages*. The elements of a vertebra are—1. The body or *centrum*, from which the others radiate; 2. *Two neurapophyses*, which, rising upwards, form the neural canal, that incloses and protects the longitudinal central chord of the nervous system; 3. *Two parapophyses* or transverse processes; 4. *Two pleurapophyses* or costal processes; 5. *Two hæmapophyses*, which form, with the centrum, a canal for lodging the central organ and large trunks of the vascular system. This canal is on the ventral, that is, the opposite side of the centrum to the neural one, and is less regular and more interrupted. 6. A *neural spine*, which crowns the neurapophyses, or is interposed between their tips, and is very conspicuous in the figure of the skeleton of the perch, as it is in most fishes. 7. A *hæmal* spine. 8. Two *diapophyses* or upper (anterior or proximal in fishes) transverse processes of human anatomy; and, 9. Two *zygapophyses* or oblique processes.

In fishes a complete typical vertebra can only be obtained from the head: in the rest of the column the hæmapophyses are always absent or unossified; their hæmal canal being formed by modifications of the parapophyses. The number of vertebræ is governed by the number of pairs of nerves that unite with the spinal chord, and varies greatly in different species, being very numerous in the vermiform or serpentiform *Apodes*, and some *Plagiostomi*, and few in the *Plectognathi*. In many species they are extensively anchylosed. The earlier stages of vertebral development are permanently represented in the lowest fishes. In the Lancelet, which is at the bottom of the scale, the entire vertebral column consists of a gelatinocellular chord and its membranous sheath. In the Lam-

[1] Chemical composition of bones of the cod after drying—

Phosphate of lime with trace of fluate	57·29
Carbonate of lime	4·90
Phosphate of magnesia	2·40
Sulphate, carbonate, and chlorate of soda	1·10
Gluten and chondrin	32·31
Oil	2·00
	100·00

Bibra, *Owen's Lectures*, &c.

prey, cartilaginous arches and spines are added above the "chorda," in the membranous wall of the neural canal, and in the tail also beneath it. In the Sturgeon and Chimæra the bases of the cartilaginous arches inclose the "chorda." In the Lepidosiren, the neural and hæmal arches and their spines are ossified, but the centrums are still confluent as a dorsal membrano-gelatinous chord; and Agassiz has shown that this was the condition of the vertebræ of the most ancient fossil fishes—those of the Silurian and Devonian rocks. In many Sharks and Rays the "chorda" is encroached upon by osseous or cartilaginous convergent laminæ, and by concentric, successively shorter, centripetally developed cylinders, and is thus reduced to a string of gelatinous beads, each bead occupying the interspace between the opposed concave surfaces of the vertebral bodies. This moniliform state of the "chorda" is persistent in most osseous fishes; whilst in some others the gelatinous biconical segments of the "chorda" are insulated by the completed centripetal process of ossification; and in one genus, the *Lepidosteus*, they are converted into osseous balls, fixed to the fore part of each vertebral body, which plays in the concavity or cup of the vertebra next in advance. The slightly compressible jelly-bags that fill the concave opposing articular surfaces of the vertebræ are admirable contrivances for facilitating the motions of the fish. The neural and hæmal arches and spines are bony in all *osseous fishes;* and in all fishes chondrification and ossification of the vertebral column commences in these arches. The skeleton of fishes presents many instances of what Owen terms "vegetative repetition of perivertebral parts." There being no distinct neck in fishes, we find no peculiar cervical vertebræ, the series posterior to the head consisting of abdominals and caudals. With the former the ribs are connected, and in the latter the hæmal canal is formed by the deflection and union of the parapophyses, as mentioned above. The pleurapophyses, or ribs, are generally articulated in fishes to the ends of the parapophyses, but in *Platax* and *Polypterus* they articulate with the bodies of the vertebræ. In the Salmon and Dory they continue to be attached to some of the parapophyses after these are bent down in the tail to form the hæmal canal and hæmal spines. The *Diodontidæ*, *Ostracionidæ*, *Fistularidæ*, *Syngnathidæ*, *Cyclopteridæ*, and *Lophiidæ*, are destitute of ribs.

Slender supplementary ribs often issue from near the head of the ribs, passing outwards and backwards from between the lateral muscles. Professor Owen names them "epipleural spines." They are highly developed in the *Salmonidæ*, *Clupeidæ*, and *Scomberidæ*. In the common Herring, dermal bones are connected with the lower ends of the ribs, and have been called, though erroneously, sternal bones, since they do not belong to the endo-skeleton.

In osseous fishes, imposed above the proper neural spines, there is a second row of spines belonging to the dermo-skeleton, of greater or less extent, and serving to support the dorsal fin or fins. From their bases other spines of an inverted shape usually descend into the intervals of the neural spines, and are hence named by Owen "interneural spines." These interneurals are sometimes in lateral pairs, as in the *Pleuronectidæ*, the *Chætodontidæ*, *Zeidæ*, and some other compressed fish.

The modifications of the dorso-interneural and dermal spines are repeated on the ventral aspect, posterior to the anus, producing inter-hæmal and dermo-hæmal spines which support the anal fin. Each dermal spine or ray is either readily divisible into two laterally, or presents a furrow indicative of a tendency to such a division. The caudal fin is extended also on compressed intercalary and dermal spines, diverging from a few coalescent and abbreviated caudal vertebræ. In the base of the caudal formed of these elements, the hæmal spines are more developed than the neural ones in very many species, as in the *Salmonidæ*, and

then they press upwards the short and almost obsolete vertebral centra which form the tip of the spinal column, and into which the spinal marrow is not extended. This larger development of the hæmal processes elongates the upper lobe of the fin, and gives a very unsymmetrical form to the caudal of Sharks, Sturgeons, and Elephant fish. Fishes pos-

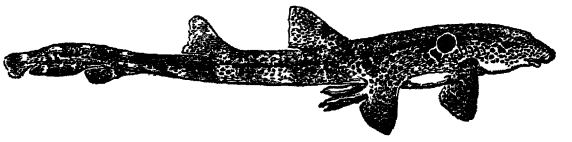


Fig. 11.

Hemiscyllium trispeculare, Australian shark of the family of *Scylliidæ*.

sessing such a caudal are named by M. Agassiz "heterocercal;" and those with a symmetrical caudal fin he denominates "homocercal," including, however, in the latter group the existing fish wherein the obliqueness of the caudal vertebræ does not affect, in a decided way, the shape of the caudal fin, the *Salmonidæ*, for instance, being homocercals.

Among the palæozoic fishes the heterocercal fishes greatly predominate; all that have been found in the magnesian limestone, and in older strata, having the superior lobe of the tail prolonged. The only existing osseous fishes that are recognised by M. Agassiz as heterocercal belong to the genus *Lepidosteus*.

The size, number, and shape of the vertical fins depends on the development and grouping of the accessary and intercalary spines, the proper neural and hæmal spines of the endo-skeleton showing no direct indication of the existence or position of those fins; but it is convenient to notice them in connection with the vertebral column, as the systematic arrangements of ichthyologists have had much reference to the number, relative position, and condition of the rays of those fins, in regard of their being simple and spinous, or jointed and forked. We have already noticed the terms Malacopterygian and Acanthopterygian as derived from these varieties of structure. Species occur among the *Gobiidæ* and some other families of fish, in which there is much difficulty in deciding to which of the two groups they belong. In the Lancelet and Lamprey, the dorsal and caudal fins are simply cutaneous folds, with scarcely distinguishable soft fibres for rays. *Synbranchus gutturalis*, and *Channomuræna*, have nearly obsolete rays at the tip of the tail only; and in *Gymnomuræna* the folds as well as rays are wanting. The interneural and dermal spines seldom coincide in number with the neural spines. They are often more numerous, but more frequently less numerous. The sucking apparatus on the head of the Remora is an assemblage of peculiarly modified and connected dermal spines. Great development of the dermal spines often renders

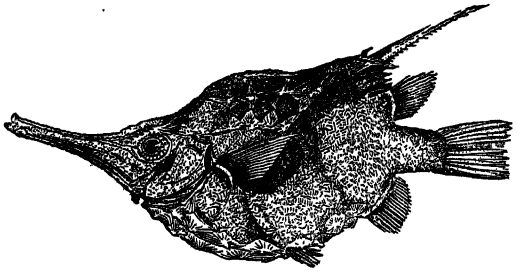


Fig. 12.

Centriscus humerosus of the *Fistularidæ*, representing in the Australian seas the Mediterranean "Snipe-fish."

them powerful weapons of defence, as in *Trachinus*. The *Chimæræ*, *Cestracions*, Piked Dog-fish, and *Balistes*, are

Intr duction. Osteology.

furnished with a stout bony spine at the front of the dorsal fin; and the Sticklebacks (fig. 13) have curious sculptured bony spines in the ventrals as well as in the dorsals. In most *Siluridæ* the pectorals are supported by a strong and dangerous spine. Many of the rays have detached serrated spines on the upper part of the tail; and in palæontology similar spines, named "Ichthyodorulites," are the sole indications remaining of the plagiostomes of former epochs. The Siluroids and Trigger-fish (*Balistes*) are remarkable among bony fishes for these dermal weapons.

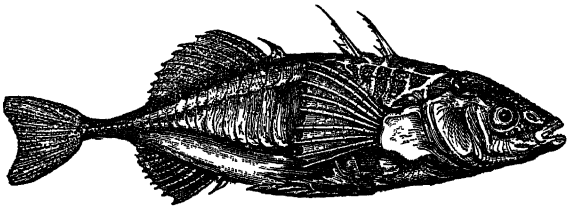


Fig. 13.
Gasterosteus insculptus, discovered by Sir Edward Belcher in the high latitude of 77°, at the northern outlet of Wellington Sound, when in search of Sir John Franklin.

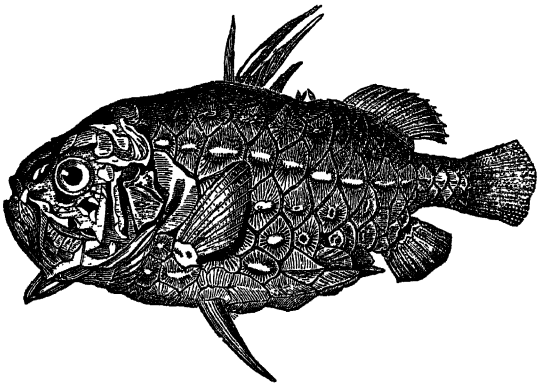


Fig. 14.
Monocentris Japonica.

Introduction. Osteology.

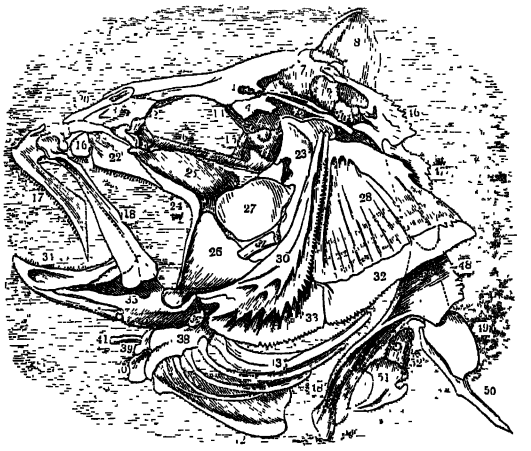


Fig. 15.
Skeleton of a Perch's Head.

That the skull[1] (fig. 15) consists of a series of four vertebræ modified for containing the cerebral enlargement of the anterior end of the nervous column, has been most fully demonstrated by Professor Owen. Each is divided into a *neural arch* with which the centrum and parapophyses are more immediately connected, and a *hæmal arch* with its appendages.

A. Beginning next the trunk, the following are the names of the neural arches in the order of their succession:—I. Epencephalic arch. II. Mesencephalic arch. III. Prosencephalic arch. IV. Rhinencephalic arch.

AA. The hæmal arches are,—1. Scapular or scapulo-coracoid. 2. Hyoid or stylo-hyoid. 3. Mandibular or tympano-mandibular. 4. Maxillary or palato-maxillary. The appendages of the hæmal arches are,—1*st*, The pectoral. 2*d*, The branchiostegal. 3*d*, The opercular. 4*th*, The pterygoid.

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[1] For the sake of more clearly exhibiting the relations of the different members of the osteological system, and to furnish a key to figures, we here subjoin a TABLE of the names of the parts of the skeleton as fixed by Owen, with Cuvier's synonyms.

c. denotes *centrum*; n. *neurapophysis*; s. *spine*; par. *parapophysis*; pl. *pleurapophysis*; h. *hæmapophysis*; hs. *hæmal spine*; d. *diverging appendage.*

The numbers after the French names have reference to figures 10, 15, 20, and 21.

ENDO-SKELETON.

OCCIPITAL VERTEBRA.

Owen's Names.		*Cuvier's Names.*	
Basi-occipital	*c.*	Basilaire	5.
Exoccipital	*n.*	Occipital latéral	10.
Supraoccipital	*s.*	Interpariétal	9.
Paroccipital	*par.*	Occipital externe	8.
Supra-scapula	*pl.*	Surscapulaire	46.
Scapula	*pl.*	Scapulaire	47.
Coracoid	*h.*	Huméral	48.
Clavicle	*d.*		
Humerus	*d.*	Troisième os de l'avant bras	
Ulna	*d.*	Radial	52.
Radius	*d.*	Cubital	51.
Carpals	*d.*	Os du carpe	64.
Metacarpo-phalanges	*d.*	Rayons de la pectorale	65.

PARIETAL VERTEBRA.

Basi-sphenoid	*c.*	Sphénoïde postérieur	6.
Alisphenoid	*n.*	Grande aile du sphénoïde	11.
Columella			
Parietal	*s.*	Pariétal	7.
Mastoid	*par.*	Mastoïdien	12.
Stylohyal	*pl.*	Styloïde	29.
Epihyal	*h.*	Grandes pièces latérales	37. 38.
Cerato-hyal	*h.*		
Basi-hyal	*hs.*	Petites pièces latérales	39. 40.
Glossohyal	*hs.*	Os lingual	41.
Urohyal	*hs.*	Queue de l'os hyoïde	42.
Branchiostegal	*d.*	Rayon branchiostège	43.

FRONTAL VERTEBRA.

Presphenoid	*c.*	Sphénoïde principale	5.
Entosphenoid	*c.*		
Orbito-sphenoid	*n.*	Aile orbitaire	14.
Frontal	*s.*	Frontal principal	1.
Post-frontal	*par.*	Frontal postérieur	4.
Tympanic			
Epitympanic	*pl.*	Temporal	23.
Mesotympanic	*pl.*	Symplectique	31.
Pretympanic	*pl.*	Tympanal	27.
Hypotympanic	*pl.*	Jugal	26.
Mandible		Mâchoire inférieure	
Articular	*h.*	Articulaire	35.
Surangular	*h.*	Súrangulaire	
Angular	*h.*	Angulaire	36.
Splenial	*h.*	Operculaire	37.
Dentary	*hs.*	Dentaire	34.
Preopercular	*d.*	Pré-opercule	30.
Opercular	*d.*	Operculaire	28.
Subopercular	*d.*	Sous-opercule	32.
Interopercular	*d.*	Inter-opercule	33.

NASAL VERTEBRA.

Vomer	*c.*	Vomer	16.
Pre-frontal	*n.*	Frontal antérieur	2.
Nasal	*s.*	Ethmoïde	3.
Palatine	*pl.*	Palatin	22.
Maxillary	*h.*	Maxillaire supérieur	18.
Pre-maxillary	*hs.*	Inter-maxillaire	17.
Entopterygoid	*d.*	Ptérygoïdien interne	25.
Pterygoid	*d.*	Transverse	24.

B. The bones of the Splanchno-skeleton constitute in the skull,—*a.* The ear-capsule or petrosal and otolite. *b.* The eye-capsule or sclerotic and pedicle. *c.* The nose-capsule or ethmoid and turbinal. *d.* The branchial arches.

C. The bones of the Dermo-skeleton belonging to the skull are,—*α.* Supra-temporals. *β.* Supra-orbitals. *γ.* Sub-orbitals. *δ.* Labials.

A. I. The Epencephalic arch consists of the *basi-occipital*, on which there is an excavation similar to one on the first abdominal vertebra, and with which it is articulated through the intervention of a capsule filled with jelly. This articular cup varies from a deep conical excavation common to many fish, to the almost flat surface which it presents in the Holibut, and, what is extremely rare, to a convex surface as in *Fistularia*. In the Carp, the under surface of the basi-occipital forms a broad triangular plate, on which there is planted the large upper pharyngeal grinding tooth. This bone is the centrum of the arch. The ex-occipitals or neurapophyses are articulated one on each side to the basi-occipital, and, in most fishes, they expand on the upper surface of that bone, so as to meet and support the medullary column; but sometimes a space is left between them, as in the *Lepidosiren*, whose basi-occipital completes the *foramen magnum* of the skull. The *par-occipitals* form the upper lateral curve of the arch, and are wedged in between the ex-occipitals and the *supra-occipital*, which forms the key of the arch, and raises a strong compressed crest-like spine from the whole length of its mesial line; a transverse supra-occipital ridge coming from each side of the base of this spine runs outwards laterally to the external angles of the bone. The supra-occipital is separated from the frontals in the Salmonoid, Clupeoid, Cyprinoid, Muræoid, and Salamandroid families; but, in the majority of fishes, it runs forward between the parietals to join the frontals. In *Lepidosteus*, it is itself divided by a median suture. In greatly compressed skulls, the occipital spine is usually very lofty; and, in *Ephippus*, its peripheral edge swells out like the crest of a helmet, whence the fish is named the Light-horseman. In depressed skulls, on the contrary, the spine is low and merely projects backwards, as in the Pike and Salmon; while in some it is wholly obsolete, as in the flat-headed *Remora*. In the unsymmetrical skulls of the *Pleuronectidæ*, it is pushed from its usual place by the par-occipitals, and one of its lateral plates is not developed. In broad depressed skulls the *par-occipital* forms a strong crest, and exceeds the ex-occipital in size. In *Synodus*, *Callicthys*, and *Heterobranchus*, the par-occipital is visible only at the back part, not on the upper aspect of the skull. The outer projecting process supports the upper fork of the first piece of the scapular arch, sometimes, as in *Ephippus*, by a distinct articular cavity.

Introduction. Osteology.

The members of the occipital vertebræ are the parts which are commonly most completely ossified, and in *Polypterus* they are anchylosed into one piece. Both the par-occipital and the ex-occipital are excavated for lodging the posterior and external semicircular canal of the enormous internal organ of hearing, and the acoustic capsule, or petrous bone, as it is named from its hardness, is intercalated between the par-occipitals and the ali-sphenoids. In the Carp, a chain of ossicles connects the air-bladder with the organ of hearing.

II. The Mesencephalic arch has for its centrum the *basi-sphenoid*, which is always connate with the pre-sphenoid (belonging to the next arch), and forms with it a long sub-triedral bone (basi-pre-sphenoid), usually split or forked posteriorly, more or less expanded beneath the cranial cavity, and then continued forwards, along the base of the inter-orbital space to near the fore part of the roof of the mouth, where it terminates by a cavity that receives the pointed end of the vomer. This end of the basi-pre-sphenoid is twisted up in the *Pleuronectidæ*. The longer and narrower the skull, the longer in general is the basi-pre-sphenoid. Rarely does any portion of it show on the floor of the cranial cavity, but in the Cod a small part supports the pituitary sac; in *Fistularia* a transverse ridge of it appears within the cranial cavity, and in some other fishes it sends a small process up on each side. The *ali-sphenoids* or neurapophyses of this arch are articulated firmly to the sides of the basi-sphenoid, their bases usually expanding over this bone so as to meet and form part of the floor of the cranial cavity. In some fishes, as in the perch and carp, these expanded plates of the bases are raised from the basi-sphenoid so as to form a sub-cranial canal which exists in the Salmonoids, Sparoids, Scomberoids, and is very remarkable in *Ephippus*, and most fishes that have lofty compressed skulls. It exists in some Clupeoids, but not in the Salamandroid fishes. In deep and compressed skulls the ali-sphenoids are narrow and

Ectopterygoid		
Malar		
Squamosal		
SPLANCHNO-SKELETON.		
CAPSULES OF ORGANS OF SENSE INTERCALATED WITH THE CRANIAL BONES.		
Petrosal } Acoustic Otosteal }	Rocher	13.
Ethmoid and Ethmo-turbinal	Sphénoïde antérieur	15.
Turbinal	Nasal	20.
BRANCHIAL ARCHES.		
Hypo-branchial	Pièce interne de partie inférieure de l'arceau branchiale	57.
Cerato-branchial	Pièce externe de partie inférieure de l'arceau branchiale	58.
Epi-branchial	Partie supérieure de l'arceau branchiale	61.
Pharyngo-branchial	Os pharyngien supérieur	62.
DERMO-SKELETON.		
Supra-orbital scale-bone	Sur-orbitaire	
Supra-temporal scale-bone	Sur-temporal	72.
Sub-orbital scale-bones	Sous-orbitaires	19.
Lachrymal	Lachrymal	19.
Labial	Labial	
ENDO-AND EXO-SKELETON OF THE BODY AND TAIL.		
Abdominal vertebræ	Vertèbres abdominales	67. 68.
Caudal vertebræ	Vertèbres caudales	69.
Centrum	Corps du vertèbre	67. 68. 69.
Neurapophysis	Partie annulaire	
Neural spine	Apophyse épineuse	*c.*
Interneural spine	Interépineux	74.
Dermo-neural spine	Rayons dorsales	75.
Zygapophyses	Apophyses articulaires	
Parapophyses	Apophyses transverses	
Hæmal canal	Anneau inférieur	
Hæmal spine	Apophyse épineux inférieur	
Interhæmal spine	Interépineux	6.
Do., aggregated at base of caudal fin	Plaque triangulaire et verticale	70.
Dermo-hæmal spine	Rayon de l'anale et du caudal inférieur	78.
Spinous rays	Rayons épineux ou aiguilleus	75.
Soft-jointed or branching rays	Rayons articulés, mous ou branchus	71. 75-82.
Pleurapophysis or rib	Côte	72.
Epipleural spine	Appendice or stylet	73.
Ventral fins, being the hæmapophysis with diverging appendage of the last abdominal vertebra	Nageoires ventrales abdominaux et subbrachiens.	
Pubic bone in fishes; the representatives of the femoral, tibial, and tarsal bones, are wanting	Un seul os représentant l'os innominé, la cuisse, la jambe, et le tarse	80.
Metatarso-phalangeal jointed rays	Rayons mous du nageoire ventrale	82.

Introduction. Osteology.

high plates, while in low and flat heads their longitudinal axis is the longest. In skulls of the ordinary form, they are sub-circular, and are perforated as in the Carp, or this perforation may be replaced by a deep anterior notch, as in the Cod. Its connections vary with its relative size, and, according as the petrosal, which interposes between it and the ex-occipital, is greater or smaller or wholly wanting. The *parietals* or spine of this arch are most commonly two in number. In the Cyprinoid and Salamandroid fishes, they unite above by a longitudinal suture (the sagittal); in the Cyprinoid *Catastomi* a mesial rectangular cartilaginous plate interposes between the ossified side plates; in the Salmonoids they soon coalesce; and in some Siluroids they coalesce with the supra-occipital as well as with each other. In the Pike, Perch, and Cod, and most osseous fishes, the parietals are separated from each other by an anterior prolongation of the supra-occipital. The *mastoids* or parapophyses of the parietal vertebra are interposed between the ali-sphenoids and parietals, and project outwards and backwards farther than the par-occipitals, forming the second strong transverse process at the side of the cranium. This process is developed from the outer margin of the bone. The inner side of the bone lodges part of one of the semicircular canals. The great cavity named "otocrane," which lodges the proper acoustic capsule or petrosal, whether osseous or cartilaginous, is formed by the ex-occipital, par-occipital, ali-sphenoid, mastoid, and sometimes the parietal and supra-occipital.

III. The Prosencephalic or frontal arch is based on the *pre-sphenoid* already described in connection with the basi-sphenoid. The *orbito-sphenoids* or neurapophyses of the frontal vertebra are usually square, but sometimes semicircular or semi-elliptic, as in the Cod; larger in the *Malacopteri*, but very small usually in the *Acanthopteri*, and cartilaginous in the *Sclerogenidæ*. The olfactory nerves pass out of the skull by the superior interspace of the orbito-sphenoids, and the optic nerves by their inferior interspace or by a direct perforation. The *mid-frontal* bone completes this arch above, and always enters into the formation of the cranial cavity though its major part forms the roof of the orbits. It is single, and sends up a median crest in the Cod, the Ephippus, and some other fishes, but is more commonly divided along the median line. Each of the halves sends up its own crest in the Tunny. In the Salamandroid fishes, each frontal sends down a vertical plate to the sphenoid, thus forming a canal through which the olfactory nerves run. The side walls of this canal make a double bony partition between the orbits. The *post-frontals* or parapophyses of the frontal vertebra partly underlie the mastoids, and complete their prominent crest.

IV. The Rhinencephalic arch terminates the axis of the skull anteriorly, and protects the olfactory ganglions and nerves. The centrum of the nasal vertebra is named the *vomer*. Its posterior point is wedged into the under part of the pre-sphenoid; it expands and becomes thicker, anteriorly, where its lateral angles are articulated to the pre-frontals. Its upper surface supports the nasal bone, and its under surface, which enters into the composition of the roof of the mouth, is in many fishes dentiferous. The same is often the case with the palatine bones, which abut against it laterally, and also form part of the roof of the mouth. The presence or absence of these teeth has been made much use of for characterizing genera and large groups of the osseous fishes. In *Lepidosteus* the vomer is cleft by a median fissure. In *Polypterus* it is confluent with the basi-sphenoid. The *pre-frontals* or neurapophyses of the nasal vertebra defend and support the olfactory ganglions, bound the orbits anteriorly, give a surface of suspension to the palatine bones, and through them for the palato-maxillary arch; and they also give attachment to the large pre-orbital or lachrymal scale bone when this exists. In the Cyprinoids and most Clupeoids the pre-frontals form part of the interobital septum. In the *Congeridæ* we recognise the pre-frontals in the confluent parts of the nasal vertebra by the external groove conducting the olfactory nerves to the nasal capsules, and by the inferior process from which the palatine bone is suspended. In the *Muræniдæ* also the pre-frontals are plainly confluent with the nasal bone, and furnish the well-marked articular surfaces for the palato-maxillary bone. In the Cod the palatine arch is chiefly, but not wholly, suspended to the pre-frontals. The *nasal-bone* or spine of the most anterior arch of the skull is usually single, and terminates forwards in a thick obtuse extremity. In the Salmonoids and some other fishes, it is broad, but not deep; in *Istiophorus* it is long and narrow; in the *Discoboles* and *Lophobranchii* it is a short vertical compressed plate, and it is wanting in *Lophius* and *Diodon*, or merely membranous. It is articulated above and behind to the frontals and pre-frontals; and below, either directly or by cartilage, to the vomer. In the Flying Gurnard it has no immediate connection with the vomer; but this is a rare exception. In the Salamandroid fishes, the nasal is divided by a median suture. The horn-like projection from the forehead of *Naseus* is formed

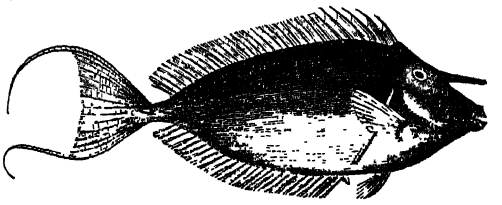


Fig. 16.
Naseus longicornis, one of the *Theutyidæ*.

chiefly from the frontal bone, a small nasal being articulated beneath. This nasal is trifid anteriorly; its lateral divisions articulating with the pre-maxillaries, as in *Citharinus*. The *turbinal bone* or osseous capsule of the nose, belonging to the splanchno-skeleton, is situated at the side of, or above the nasal; the pre-maxillary and maxillary bones are usually attached to its extremity through the medium of cartilage. In the *Muræniдæ*, the normal elements of the nasal vertebra coalesce into a single bone. The spine of this vertebra or nasal bone forms the usual obtuse extremity beneath the skin of the upper part of the snout, and it is dentiferous, as in the *Lepidosiren*; it is intimately confluent anteriorly with the centrum or vomer, the limits being indicated by the interruption of the median series of vomerine and nasal teeth.

This completes a compendious view of the neural arches of the four cranial vertebræ which have for their primary function the protection of the ganglionic brain, in which the spinal chord ends anteriorly. From the complete osseous skull of a fish, there are many descending modifications, until we come to the vermiform Lancelet, which wants the cerebral expansion altogether; the gelatinous "chorda dorsalis" being terminated by a tapering end, invested by a membrane, without any addition of cartilaginous or osseous coverings.

B. *Sense capsules* of the splanchno-skeleton intercalated with the neural arches. Some of these have been already noticed. In the *Ammocœtes*, cartilage is developed for the protection of the acoustic organ in a skull, otherwise mostly fibro-membranous. (*a.*) The bones entering into the formation of the otocrane for the lodgement of the labyrinth have been named above; but it is the *petrosal* which is the bone specially designed to form the acoustic capsule, though in fishes it is less confined to that function than in the higher vertebrals in which it exclusively envelopes the labyrinth. Its ossification commences late in the osseous fishes. It is very small in the Cyprinoids, and in them Cuvier describes it as a dismemberment of the

mastoid; but in the Perch, where it is more developed, he recognises it under its proper name. In the Cod it has a larger size, and the two otocranes are completely separated from each other.

b. The *optic capsule* or sclerotic investment of the eye is cartilaginous in the Chondropterygians and in semi-osseous fishes, but in most osseous fishes it is bony. An orbit for lodging the eye-ball is formed by the pre-sphenoid, orbito-sphenoid, frontal, post-frontal, pre-frontal and palatine bones; its wide outer opening is often circumscribed by the chain of sub-orbitals or scale-bones below, and less frequently by one or more supra-orbitals above. In the Shads, *Erythrinus*, *Citharinus*, *Hydrocyon*, *Cyprinus*, and many other *Malacopteri*, and in *Synbranchus*, the orbits are separated from one another by an osseous septum, but in general the septum is incomplete or wanting; in *Lepidosteus* and *Polypterus* it is double.

c. The *nose-capsule* is formed by the *ethmoidal* which enters into the walls of the cranium, and the *turbinal* which belongs to the nose, other bones, as the vomer and nasal, being accessaries. The whole capsule is cartilaginous in cartilaginous and semi-osseous fishes, and the ethmoidal part continues so in many osseous fishes. The cartilaginous capsules and pituitary expansions are proportionally large in the Chondropterygii and Lepidosiren, communicating with each other in the latter by membranous slits; but in the higher fishes they form a pair. The *turbinals* in osseous fishes are generally thin, more or less elongated, scales situated at the sides of the nasal bone and ascending processes of the pre-maxillaries.

AA. The *inferior* or *hæmal* arches of the cranial vertebræ are essentially four in number in the osseous fishes, and in most of these have radiating appendages. A special visceral system of bony arches, called "branchial," also exists in fishes for the support and movement of the gills.

4. *Palato-maxillary arch.* Of this inverted arch, the palatine bones are the piers, and their points of suspension are their attachments to the pre-frontals, the vomerine, and nasal bones. The arch is completed by the maxillary and pre-maxillary bones, the symphysis of the latter forming its apex. The palatine or pleurapophysis of the nasal vertebra articulates at its peripheral extremity with the maxillary, to which it affords a more or less moveable joint. In the Parrot fishes and Diodons the articulation is analogous to that of the mandible below, with the tympanic pedicle. In the Salamandroid fishes it is a fixed suture. In *Mormyrus* these ends of the palatines meet and unite at the mesian line. In fig. 19, representing the jaws of *Alepisaurus*, the palatines are seen to be strongly armed, each of them having two pairs of tall lancet-shaped teeth, one pair nearly under the nostrils, the second pair not so tall, further back, and closely followed by ten much shorter ones. The *maxillary* or hæmapophysis of the nasal vertebra lies between the palatine and pre-maxillary. On the extent to which these two bones enter severally into the orifice of the mouth, and on their dentiferous or edentulous conditions, many divisions of fishes made by ichthyologists are mainly founded. In the Salmonoids the maxillary joins to the lower end of the pre-maxillary, forming,

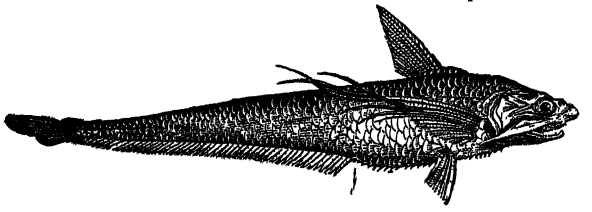


Fig. 17.
Coilia Playfairii, one of the *Clupeidæ* of the China seas

together with it, the upper half of the border of the mouth, and it supports teeth. The same form prevails with the Clupeoids. In *Thrissa* and *Coilia* of this family the pre-maxillary is very small, and the large dentiferous maxillary is prolonged beyond the corner of the mouth (fig. 17). In the *Plectognathi* the two bones coalesce. In *Lepidosteus* these bones also form a single dentiferous arch, but they are subdivided into many pieces, a condition which seems to have prevailed with the ancient Salamandroid fishes. It is dentiferous and largely developed in *Polypterus*, but very diminutive in the Siluroids, and wanting in the *Muræniдæ*.

The *pre-maxillary*, or the hæmal spine of the nasal vertebra, is more commonly directed transversely than longitudinally. Its nasal branch, or pedicle, is of unusual length in fishes with protractile snouts, such as the *Menidæ*, *Zeidæ*,

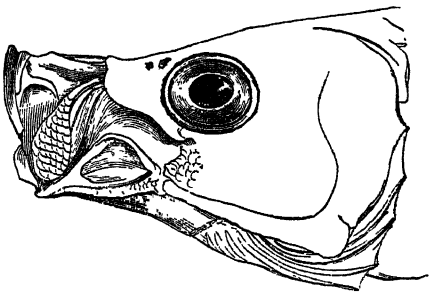


Fig. 18.
Emmelichthys nitidus (*Erythrichthys Schlegel*), from Western Australia.

Epibulus, *Emmelichthys*, and others. Commonly, its labial border is beset with teeth; and in many groups of fish it forms, with its fellow and the mandible, the whole margin of the mouth, the maxillaries in that case lying in folds of skin. This extension of the pre-maxillary is well shown in the *Alepisaurus*, a predaceous Sphyrœnoid; there it is

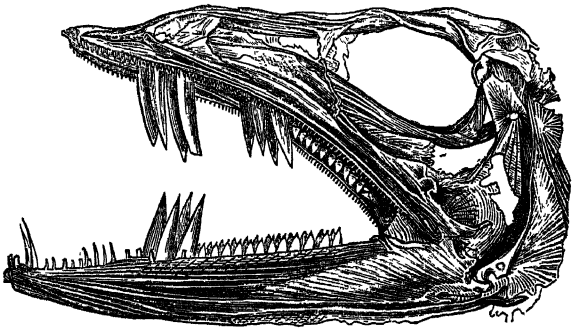


Fig. 19.
Alepisaurus, one of the *Sphyrænidæ*, a predacious family, nearly allied to the Scomberoids. The upper border of the mouth is formed wholly by the pre-maxillaries, which are armed with small teeth. Valenciennes, who knew the fish only from a drawing, places it among the *Salmonidæ*.

closely set by a series of small teeth (fig. 19). The small bony piece above the maxillary in the Trout, Herring, and Pike, seems to belong to the series of mucous or scale bones.

The *diverging appendage* of the palato-maxillary arch consists of the pterygoid and entopterygoid bones, which are the less constant parts of the arch. They are connate with the palatine in most Salmonoids and Eels, while Muræna wants the entopterygoid, and its pterygoid is disconnected from the maxillary arch. Most fishes, however, have both bones.

3. The *tympano-mandibular arch* has the true inverted or hæmal character, its apex formed by the *epi-tympanics* or pleurapophyses of the frontal vertebra hanging downwards below the vertebral axis of the skull. In most fishes, its lower end is bifid, and supports two inverted arches, the mandibular and the hyoidean. The *meso-tympanic* is articulated above to the epi-tympanic and pre-opercular, anteriorly to the pre-tympanic, and by its lower end to the

hypo-tympanic, reaching almost to the mandibular trochlea. It is the "symplectic" of Cuvier, and it is confluent in the Siluroid, Murænoid, and some other fishes with the epi-tympanic. The pre-tympanic "caisse" or "os tympanicum" of Cuvier, receives, in its posterior margin, the fore part of the meso-tympanic, and the upper and fore part of the hypo-tympanic. It is confluent with the latter in Conger and Muræna, and it does not join either of these bones in the *Lepidosteus*. *The hypo-tympanic* bears the convex articular trochlea for the lower jaw upon its inferior apex. The *Epibulus* presents a remarkable, much elongated, and slender modification of it, carrying the lower jaw at an unusual distance from the base of the skull, and allowing it to swing backwards and forwards on its long pedicle as on a pendulum. In the *Muræniдæ* the tympanic pedicle is a strong triangular plate affixed to the cranium by its base or shorter side, and carrying the mandibular joint backwards beyond the occiput. The *mandible* or lower jaw is the hæmapophysis of the frontal vertebra, and completes the arch below by its ligamentous or bony symphysis with its fellow. Each branch or half consists most commonly of two pieces, sometimes of three or more, the one articulated to the suspensary pedicle being the proper hæmapophysis, and the extreme one completing the arch and supporting the teeth being the hæmal spine. The *diverging apparatus* of the tympano-mandibular arch consists of the opercular bones of the gill-cover, which, by its movements, opens and closes the branchial aperture on each side of the head, thereby regulating the currents through the branchial cavity. It may be considered as a kind of short and broad fin. The first or most anterior, and the chief medium of attachment of the appendage, is the *pre-opercular*, which commonly has a crescentic or angular form. In the Cod it is forked above, and in the *Sclerogenidæ* the enormously developed second suborbital scale bone crosses the cheek to be articulated to it. The opercular is commonly the largest of the remaining pieces of this appendage, and is chiefly connected with the posterior margin of the pre-opercular, but very generally it is partially attached above to the outer angle of the epi-tym-



Fig. 20.
Hyoid bone of the Perch.

panic. In the *Lophius*, its posterior margin is coasted by a long slender fin ray, and the *sub-opercular*, which forms the posterior and lower angle of the gill-cover, carries out the resemblance to a fin by its radiated structure. All the framework of this fin has the form of rays in the Plagiostomes. The lowermost piece, called the inter-opercular, is articulated to the pre-opercular above, the sub-opercular and angle of the opercular behind, and usually to the back parts of the mandible in front. In conjunction with the pre-opercular, it is more elongated in the very long head of *Fistularia* than the other two pieces of the appendage. It is wanting in the *Siluri*, and the sub-opercular is wanting in the Shad. In *Muræna*, the small opercular bones are articulated only to the lower part of the tympanic pedicle. The smoothness or serratures of the posterior edges of these bones, more especially of the pre-opercular, and the numbers and situations of the spines which emanate from them, furnish characters to ichthyologists for the discrimination of many species and groups of species.

2. The *hyoidean arch* is suspended in osseous fishes, as we have already had occasion to say, to the mastoid, through the medium of a fork of the epi-tympanic bone; and its bony arch is completed by the two small, cubical *basi-hyals*. The anterior part of the arch is formed by the *stylo-hyal*, *epi-hyal*, and *cerato-hyal*, the first-named being joined at its upper end by ligament to the *epi-tympanic*, and the others descending from it in succession. The cerato-hyal is the longest and largest, and supports the diverging appendix of the hyoidean arch named *branchiostegals* or gill-cover rays, and on which the membrane that closes the branchial chamber is extended. The number of these rays varies greatly. They are only three, and these comparatively broad and flat in the Carps, while in *Elops saurus* they amount to more than thirty. They are of very great length in the Angler, and spread out the gill membrane like a great bag on each side of the head.

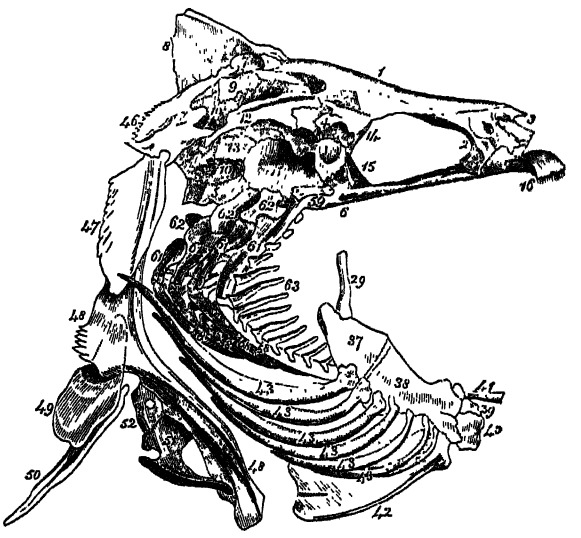


Fig. 21.
Gills of the Perch.

In *Pisoodonophis cancrivorus* the *branchiostegals* are thirty-three in number on each side, very long, and as fine as hairs, and the curves they make in the branchiostegal membrane are different on the two sides of the head.

d. The *branchial arches*, which appertain to the system of the visceral skeleton, succeed the hyoidean arch, and are more or less closely connected with its key-stone, the basi-hyals. Six of these arches are usually developed in embryo, and five are usually permanent, four of them supporting the gills, and the fifth circumscribing the opening of the gullet and beset with teeth. This last is called the *pharyn-*

geal arch, the rest *branchial arches*. The arches adhere by their lower extremities to a chain of ossicles, and curving as they ascend, nearly meet at the base of the cranium, to which they are attached by ligamentous and cellular tissue. Each of the first three branchial arches, independent of the basal key bones, or *basi-branchials*, consists of three or four pieces, which have a certain elastic or flexible movement on each other. The lowest of these pieces is the short *hypo-branchial;* the next, the long *cerato-branchial*, is grooved on the outside, and supports the dentigerous processes, or tubercles, named *rakers*. Above this is an *epi-branchial* similarly formed. To it, in the second and third arches, the short, broad, dentiferous epi-branchial is commonly attached. The fourth arch consists of the cerato-branchial, the epi-branchial, and the pharyngo-branchial pieces. The fifth arch usually consists simply of the cerato-branchial element, but in *Anabas* it supports a pharyngo-branchial. This last-named bone is often expanded, and more or less dentiferous: it is termed by Cuvier "the inferior pharyngeal bone," and the upper dentiferous portions of the arches are called the superior pharyngeal bones." In *Cottus*, these superior bones are blended into one piece. A peculiar development of the epi-branchial and pharyngo-branchials of the first two or three arches, serves the office, in a group of fishes, the *Labyrinthibranchii*, of retaining a supply of water for moistening the gills when the fishes are temporarily out of their proper element.

1. *Scapular arch.* This inverted cranial arch is attached to the par-occipital; or to that bone and the mastoid; or to the same bone and the petrosal, as in the Cod; or to the par-occipital and basi-occipital, being essentially the hæmal arch of the occipital bone, to which it is constantly attached wholly or in part. In the Eels it is feebly developed, and only loosely suspended behind the skull; and in the Plagiostomes it is removed further back to a distance from its proper vertebra. Its superior piece is the *supra-scapula*, then follows the *scapula*, and the arch is completed below by the union of the frequently very strong and firm *coracoid* with its fellow. The coracoids defend and support the heart, and give attachment to the diaphragm, which separates the pericardial and abdominal cavities.

The scapular arch usually supports a *diverging appendage* on each side, constituting the pectoral fin. The pectoral fin rays are analogous to the fingers of the higher animals, the lowest ray, when the fin is laid back to the side of the fish, answering to the thumb. The bones which support these rays are homologues of the bones of the fore extremities of the higher vertebrals, and have been named accordingly. In the Cod tribe, and most other fishes, there is, however, no separate representative of the *humerus*. The *radius* is of enormous size in the *Lampris* and in Flying-fish. It is anchylosed to the ulna in *Silurus* for the firmer support of the pectoral spine, and in *Lophius*, both radius and ulna are extremely small, and connate with the coracoid. The *carpals*, usually four or five, but sometimes only two, progressively increase in length from the ulna to the radial side. In the Wolf-fish they are broad flat bones. The *metacarpals* and *phalangeals* are in the Cod twenty in number, all soft-jointed, and sometimes bifurcate at the distal end.

In the osseous fishes the pectoral fins present a series of modifications. In the *Acanthopterygii* the ulnar ray is a hard unjointed spine. In the Gurnards, Choridactyles, and several other genera of *Sclerogenidæ*, the three lower rays are detached and free, and there is reason to believe that these rays are used like fingers as organs of touch when the animal swims close to the sandy bottom of the sea. The pectoral fins are very largely developed in the *Exocœtus;* it is also large in *Dactylopterus*, *Trigla*, and *Prionotus*, as well as in several other forms of the *Sclerogenidæ*.

In the Cod and Carp there is a single styliform bone, named the *epi-coracoid*, because it is attached to the upper end of the coracoid. In the Perch, and most other fishes, it consists of two pieces. In *Centriscus scolopax*, *Argyreiosus vomer* and *Siganus*, it is joined by its lower end to its fellow, thus completing an inverted arch behind the scapular one. The epi-coracoids are absent or are very slender spines in the Wolf-fish, Mullet, Goby, Stickleback, *Remora*, *Cepola*, *Uranoscopus*, the Blennies, Siluroids, and Apodal fishes. The apodal Sandlance, however, possesses the epi-coracoids.

Ventral fins. The rays of the ventral fins are supported by two bones, which are named *pubic bones*, and represent the lower part of an inverted hæmal arch. In no fish is this incomplete pelvic arch directly attached to the vertebral column. In all fossil fishes belonging to deposits anterior to the chalk, the ventrals are placed towards the posterior end of the abdomen, and hence, and from the consideration of the position of the rudiment of the ventral in the embryo fish, it may be inferred that these pubic bones are the hæmapophyses of the last abdominal vertebra. In Acanthopteri the anterior ray of the ventral may be spinous.

In the *Malacopteri* all the ventral rays are soft, multi-articulate, and bifurcate. The normal position of the ventral hæmapophysis is under its proper vertebra, but the relative length of the pubic bones in different fishes, places them under the abdomen, or pectoral fins, or gills; hence Linnæus's division of the fishes into abdominal, thoracic, and jugular, and, when the ventrals are wanting, apodal. Cuvier substituted the term subbrachial for thoracic and jugular. The ventrals are better developed in the Plagiostomes than in other fishes, and connected with this fin, in the male *Plagiostomes* and *Chimeræ*, there is the peculiar intromittent organ of generation named the "clasper."

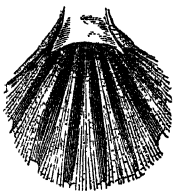


Fig. 22.
United ventrals of *Gobius ommaturus*, a Chinese fish.

In the *Gobies* (fig. 22) and *Gonorhynchus*, the ventrals are united to each other by a membrane; and in *Cyclopterus*, *Gobiesox*, and *Lepadogaster* (fig. 23), they so united as to form a suctorial foot, by which these fish can attach themselves to a rock.

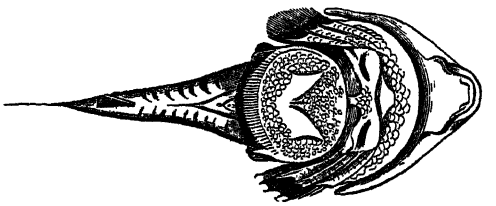


Fig. 23.
Lepadogaster puniceus, a Discobole or Cyclopteroid. A sucking apparatus is formed round the basis of the ventrals.

We have allotted more space to the skeleton of fishes than our limits will permit us to devote to the rest of the ichthyic structure, because the soft parts and dermal system cannot be properly apprehended or referred to without a competent knowledge of the bony or cartilaginous endoskeleton by which they are sustained.[1]

[1] In adopting Professor Owen's osteological system, we have thought it proper, to avoid mistake, to use his own words as often as we could; but as our extracts from his elaborate and exhaustive work are very compendious, and not always in the order he pursued in his lectures, they are not marked by inverted commas as quotations.

c. *Dermal or Exo-skeleton.* To this system the scales belong, each being secreted, like a tooth, in a depression or pocket of the skin, to which it adheres under the cuticle. They are very generally imbricated with the posterior end extruded and free, but the skin usually extends over the surface of the anterior end to a greater or less extent; or the scale may be entirely imbedded beneath the cuticle. Professor Agassiz considered the form of the scales to bear so strong a relation to the rest of the ichthyic structure and the general economy of a fish, that he founded upon it his primary divisions of the class, of which he characterized four. The fish of his Cycloid order have scales composed of concentric layers of horn



Fig. 24.
A Cycloid scale of *Lampanyctes* (or *Myctophum*) *resplendens*, one of the nocturnal *Scopelinæ* of the great group of *Salmonidæ*.

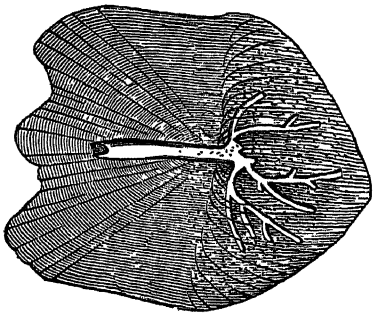


Fig. 25.
Scale of a Labroid.

or bone, without spinous margins, and not covered by enamel. He believed that a close relationship existed between the absence of pungent teeth on the scales, and the want of spinous rays in the fins, and that this order has a considerable correspondence with the *Malacopterygii* of former ichthyologists. The *Cyclo-Labridæ*, however, and many *Gobiidæ*, are exceptions to this correspondence, and others exist. Most commonly the Cycloid scales are imbricated; occasionally they are placed side by side, in contact but not overlapping; sometimes they are more remote; and in *Anguilla*, the narrow, oblong cycloid scales are in groups lying at right angles to each other, so as to produce a kind of lattice-work under the cuticle. Some genera of fishes with smooth scaleless skins come into this order. The Ctenoid order of fish have horny or unenamelled bony scales, with spinous teeth on the posterior edges of the layers like a comb (figs. 27, 28, 29, and 31). As the scales grow their spinules wear off, and in some species we observe no more than a single series on the posterior edge of the last formed layer of the

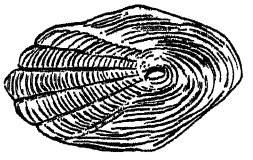


Fig. 26.
Cycloid scale of *Gadopsis marmoratus*, an Acanthopterygian with rudimentary thoracic pectorals. It inhabits the rivers of Southern Australia.

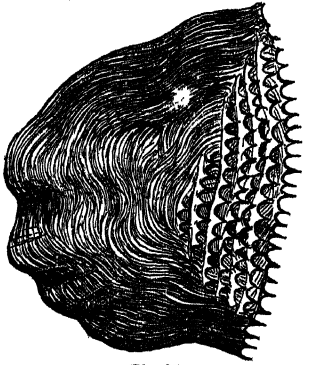


Fig. 27.
Ctenoid scale of *Scatophagus multifasciatus*, one of the *Squammipennes* or *Chætodontidæ* from the Australian seas.

scales (fig. 28); in others the teeth are more persistent, though the earliest, which are the nearest to the centre of the disk, are generally the smallest. There are some

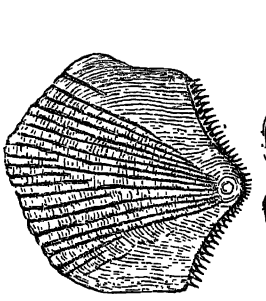


Fig. 28.

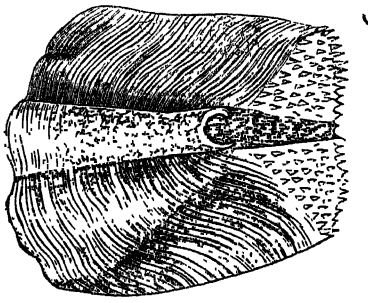


Fig. 29.

Fig. 28. Ctenoid scale of *Gobius ommaturus*.
... 29. Ctenoid scale of *Psettus argenteus*, a Chætodontoid.

scaleless groups associated with Ctenoids. Scales of this and the preceding order have most commonly grooves radiating from the centre of the disk over that part which remains in the cuticular pouch, and crenatures on the basal



Fig. 30.
Scale from the head of *Macrourus Australis*.

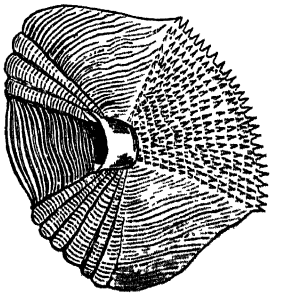


Fig. 31.
Ctenoid scale of *Lethrinus cynocheilus*, one of the Norfolk Island *Sparidæ*.

edge corresponding with the number of grooves. In both orders, also, the most common circumscription of the scale is circular or subcircular; occasionally they are irregular or oblique; and the scales in one part of the fish differ from

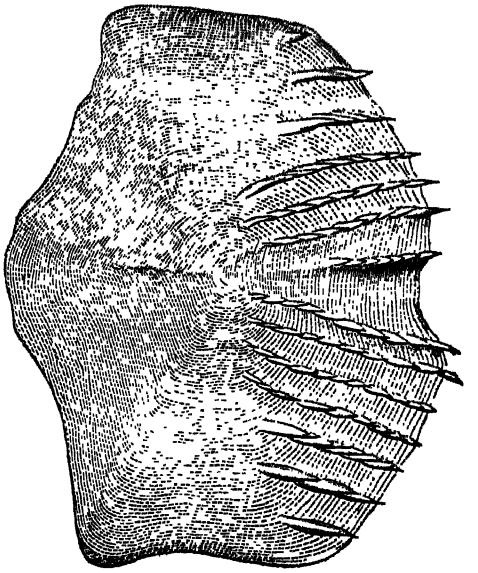


Fig. 32.
Scale from the lateral line of *Macrourus Australis*.

those in another, in outline, and more frequently in size. In some Labroids the largest scales are on the base of the caudal fin, but in most of the osseous fishes the largest lie towards the middle of the sides of the body. The Ctenoid scales are mostly imbricated.

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In Ganoid fishes the plates or scales are covered by a thick coat of enamel, and are sometimes of considerable dimensions; and in many of the extinct species which compose the bulk of this order the enamelled plate is rhomboidal, with a hook at its anterior angle, which assists in retaining it in its place. The recent species included by Agassiz in this order do not form a natural group.

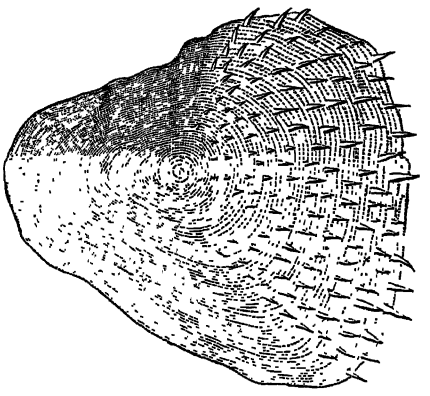


Fig. 33.
Scales of *Macrourus cœlorhynchus.*

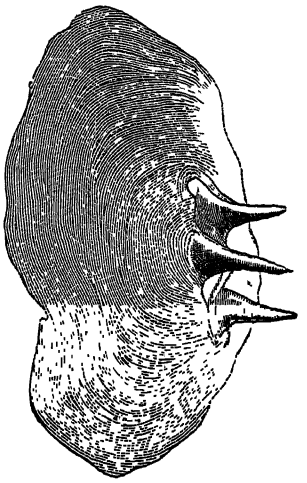


Fig. 34.
Scale of *Macrourus trachyrhynchus.*

Fishes of the Placoid order have the skin covered with irregular plates of hard bone, varying greatly in shape and size. In the Rays and Monk fish they form large, rough, or spinous tubercles; and in the Dog-fish, fine-grained shagreen. As formed by Agassiz, the order corresponds with the *Cartilaginei* or *Chondropterygii* of authors, and includes species with smooth skins. For the arrangement of fossil fish these divisions were well devised, but, as may be expected, a system based on the variable characters of a portion of the dermal skeleton fails in defining natural groups. Used in conjunction, however, with the other parts of the structure, Agassiz's discoveries are of great importance for the purpose of classification.



Fig. 35.
Placoid scales of *Aleuteres trossulus*, one of the *Balistidæ*, from Australia.

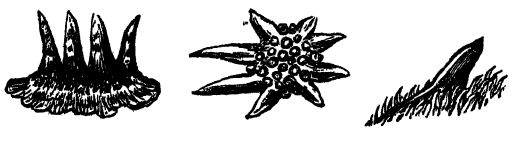


Fig. 36.
Scales from different parts of the body of *Aleuteres variabilis.*

Along the side of an osseous fish, there is a line running from the head to the caudal fin, or even through the latter, called the *lateral line.* It is nearer the back in some fishes than in others; very generally it runs at mid-height, sometimes it ceases a long way before the caudal fin; and in *Chirus* there are several lateral lines, the upper one coasting the back, and the lower one the edge of the belly. This line is muciferous, being connected with a series of glands. In the *Anguillæ*, the mucous ossicles lying like the scales under the cuticle are scarcely visible, and in many scaleless vermiform apodals the line is still less conspicuous; but in these slimy fishes the whole skin is densely studded with glands and their ducts. The scales that cover this line, or lie in immediate contact with it, above and below, are constructed with a tubular arch along their middle, or a simple perforation in the disk, or with a mere notch on the edge for the exit of the mucoduct (figs. 25, 29, 32, 38, 39, 40, 41, 43, and 44). The scales are sometimes larger than the ordinary ones in the same fish, occasionally they are smaller, and sometimes they are the only ones, the rest of the body being naked. Very



Fig. 37.
Ctenoid scales from the lateral line at the base of the caudal fin of *Caranx parapistes*, a Scomberoid from North Australia.

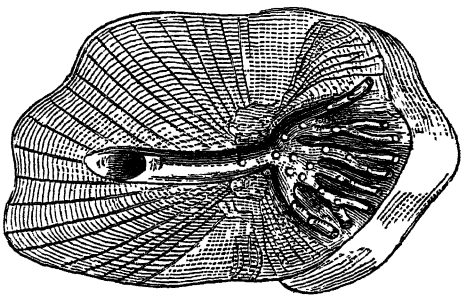


Fig. 38.
Cycloid scale from the lateral line of *Labrus laticlavius*, an Australian Cyclo-Labroid.

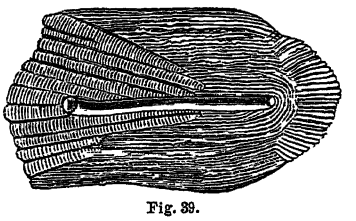


Fig. 39.
Cycloid scale from the lateral line of *Odax lineatus*, a genus closely allied to *Scarus.*

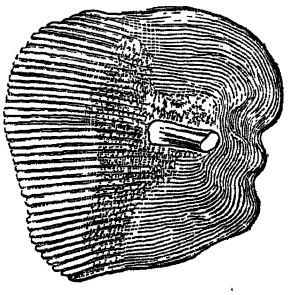
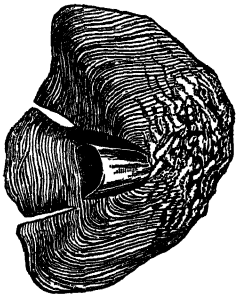


Fig. 40.
A Cycloid scale from the lateral line of *Lutodeira salmonea*, one of the *Gonorhynchidæ* from Torres Straits and Polynesia.



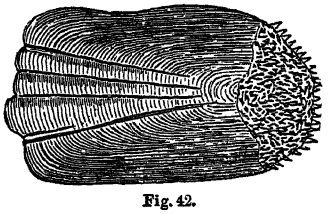


Fig. 41.
Fig. 41. A cycloid scale from the lateral line of *Saurus undosquamis*, one of the North Australian *Scopelinæ.*
... 42. Ctenoid scale of *Platycephalus cirrhonasus*, one of the *Sclerogenidæ* of Botany Bay.

Fig. 42.

Introduction. Dermal Skeleton.

frequently they have strange irregular forms (fig. 44), and

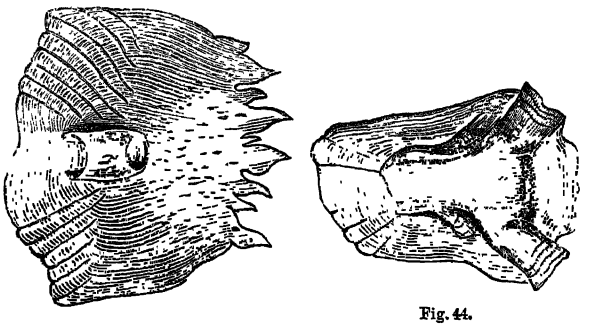


Fig. 44.

Fig. 43.

Fig. 43. Figured Cycloid scale from the lateral line of *Hæmerocœtes acanthorhynchus*, a Gobioid inhabiting the seas of New Zealand.
... 44. Scale from the lateral line of *Trigla pleuracanthica*, one of the Australian *Sclerogenidæ*.

they are in some cases peculiarly armed. The lateral line may be traced forwards on the head to one or more little bones named *supra-temporals*, and thence over the cheek along the *sub-orbital* series of bones to the first and usually largest of the series, named the *pre-orbital*, as may be well observed in fig. 8, page 207. All these bones are constructed so as to protect the muciferous canals, and in many fishes they are mere osseous pipes. In the *Gadidæ* and in *Macrourus*, the pre-orbital and following bones of the chain are largely developed and fold down, forming large semi-canals. These bones are strongly armed in some *Acanthopteri*, particularly the *Sclerogenidæ*, in which the second of the sub-orbitar chain emits a spine or series of spines or tubercles, and is prolonged to articulate with the pre-opercular. The marginal serratures of the pre-orbital are conspicuous in *Mugil*, and furnish characters for other genera of *Acanthopteri*. The *supra-orbitals*, though less constant than the sub-orbitals, belong to the same system. The Carp has one above each orbit, and the Lepidosteus three. The *turbinals* are also considered by Professor Owen to appertain to the dermal system. They are wanting, together with the sub-orbitals, in many of the serpentiform apodals; but the turbinals exist, though of very small size, in the Conger.

Of the other dermal bones of fishes our notice must be very cursory. The head of the Sturgeon is protected by large dermal plates closely arranged, and the rows continued along the trunk of the fish are, as we have mentioned above, examples of the Placoid scales of Agassiz. The sternum,

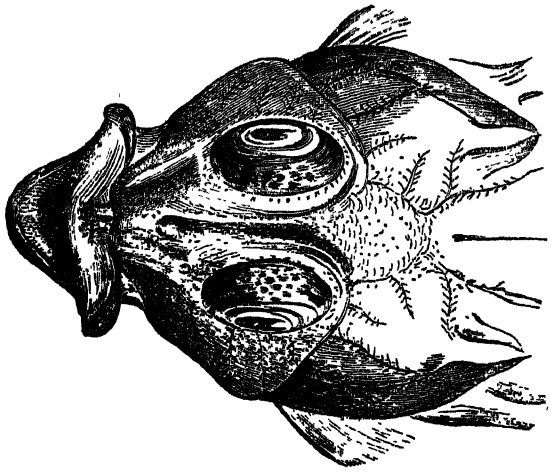


Fig. 45.

Head of *Bovichthys variegatus*, one of the *Uranoscopidæ* from Sydney, to show the branching mucoducts.

as it has been called, of the Herring, is formed of a series of acutely bent dermal bones, and the Dory has two rows of plates along the belly. In the *Ostracionidæ* and *Syngnathidæ* the fish is wholly or completely encased in scales, so connected as to admit of few motions of the body. And in the Gurnards, and many other *Sclerogenidæ*, some genera of *Siluridæ*, the great *Sudis* among the *Clupeidæ*, and *Polypterus* among the *Ganoids*, the cranial and humeral bones of the endo-skeleton present hard, rough, shagreened surfaces exteriorly, in which the soft epidermis is not perceptible, and the resemblance to the dermal plates of the Sturgeon is close. In many other fishes, also, the cranial bones emit processes from their outer surfaces, which serve as canals for the mucoducts.

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SECTION IV.—THE MUSCLES AND MUSCULAR MOTIONS OF FISHES.

The spinal column, composed of numerous articulations united by cartilages which permit of certain movements, curves with great facility from side to side; but the vertical motion is much more restricted, chiefly in consequence of the projection of the upper and under spinous processes of the vertebræ.

The great organ of movement in all fishes is the tail. The muscles by which it is brought into play extend in lengthened masses on either side of the vertebral column. The body being rendered specifically lighter by the distention of the swim-bladder when that exists, is impelled forwards by the rapid flexure of the tail acting laterally upon the water. The head of fishes exercises but slight movement, independent of the rest of the body; but the tympano-mandibular arch, often the maxillary and premaxillaries, the hyoid and branchial apparatus, and occasionally the scapular arch, have more or less motion. The finny terminations of the last named appendage and of the pelvic bones, as well as the vertical fins, are seldom at rest.

SECTION V.—THE NERVOUS SYSTEM AND SENSES OF FISHES.

The spinal chord, which terminates anteriorly in an enlargement named the brain, consists of a dorsal and ventral pair of columns, the former having for its function the receiving of impressions made on the peripheral surfaces of the body by external objects, and the latter, that of directing the voluntary muscular movements,—they are the nervous centres of *animal life*. Each consists of an intimate aggregation of nervine matter named ganglions. From the sensorial and motor columns on each side of the chord, nervous filaments, more or less in number, proceed, and being invested by a common membrane, pass out between the vertebræ to all parts of the body; one on each side between every pair of vertebræ, the number of vertebræ being in fact regulated primarily by the number of pairs of spinal nerves. It would be correct to say that the nerves of motion arise from the motor column, and that the nerves of sensation terminate in the sensorial one. For, though the trunks of the nerves lie in a common envelope, the distribution of the former may be compared to a tree having one or more roots, with a trunk giving origin to numerous branches, and innumerable twigs; while the sensorial nerves are like streams formed by minute rills, uniting in a river that terminates by one or by several mouths. To serve the involuntary muscles, as the heart and arterial system, and also to supply the viscera that perform the functions of digestion, assimilation, secretion, or to preside over *organic life* there is a separate system of ganglia and network of nerves that has been named the *sympathetic*. Under this general description the nervous systems of all the vertebrals may be comprehended; but in the higher classes, the development is much more full than in fishes,

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and among fishes the Lancelet offers the simplest nervous system of the whole series of vertebrated animals.

The spinal chord, or the nervous columns, for which, independent of its protecting investments, the term *myelon* has been well devised by Professor Owen, is extremely short in those fishes whose lumpish shape originates in the abreviation and coalescence of the posterior vertebræ. In *Orthagoriscus* and *Lampris*, the whole myelon appears to be a minute ganglionic process of the brain. In *Tetrodon* and *Diodon* it is also very short, or about a twentieth of the length of the fish; but the rest of the neural canal is in them occupied by a bundle of caudal nerves, usually named, from their resemblance to the tail of a horse, *cauda equina*. *Lophius* has a myelon which reaches the twelfth vertebra; but its pointed end is concealed by a long *cauda equina*. In most fishes there is no *cauda equina*, and the myelon runs to the end of the neural canal.

In fishes the brain consists of a few ganglionic masses, which vary in number in different groups of species, and, as has been mentioned, are wholly wanting in the lowest form of the class. It is proportionally larger in the young fish, and Professor Owen states that, on an average, its weight is only a three-thousandth part of that of the whole fish. Carus estimated the brain of the Burbot (*Lota*) as forming the seven hundred and twentieth part of the entire weight; and that of the Pike has been found to be the thirteen hundred and fifth part.

We mean to mention only the more constant or important encephalic masses, and even these in a very cursory way. The myelon, on expanding into the brain, assumes the name of "epencephalon," which is protected by the occipital neural arch of the skull. In proceeding from the spinal column onwards towards the nose, the first rounded masses that we observe in the epencephalon are not constantly present in fishes, nor do they exist in any other class of vertebrals. They are called "vagal lobes," and are largely developed in the *Cyprinidæ*, and enormously in the Torpedo, Narcine, and other electric Rays. In these they supply the large electric nerves. They are also large in *Gymnotus*, which, however, does not receive its electric nerves from these organs. The medulla oblongata, and cerebellum, are more constant parts of the occipital division of the brain. Fishes that possess much muscular energy, and take their prey by the velocity of their movements, have the largest cerebellum; and the other extreme of its size is found in the feeble Myxine or Glutinous Hag which passes its parasitic existence buried in the flesh of other fishes. It is also a mere fold in *Polypterus*, and is very small in the sedentary *Discoboli*, whose ventral fins are employed as suckers to attach the fish to the rocks. Among osseous fishes the cerebellum attains the largest size in the warmer-blooded, impetuous Tunny; and in the cartilaginous Sharks it is still more largely developed. The next division of the brain, the "mesencephalon," protected by the neural arch of the parietal vertebra, is usually larger than the other divisions in osseous fishes. To it belong the two optic lobes, whose function is denoted by their name. They are hollow in most fishes, and are often larger than the cerebellum, as in *Polypterus* and *Lepidosiren*, of equal size with that organ in Eels, and smaller in the Sharks and in *Amblyopsis*. Their existence at all in this fish, which is blind, and in the Myxine, which is equally destitute of sight, shows that they have some other function than merely communicating with the optic nerves. The "prosencephalon," inclosed in the neural arch of the frontal vertebra, corresponds to the cerebral hemispheres of the higher vertebrals. It is smallest in the Myxines, equal to the cerebellum in the Perch, and exceeds in size that of the Stickleback, Gurnard, *Lepidosteus*, *Lucioperca*, *Amblyopsis*, and *Raia*. In *Polypterus* and *Lepidosiren* it surpasses all the rest of the brain.

The fourth and last division of the brain, protected by the nasal neural arch, consists of two lobes, named "rhinencephala" or "olfactory lobes," as they send forwards the nerves that supply the organ of smell.

Introduction. Nervous System.

Organ of Vision.—The position, direction, and dimensions of the eyes of fishes vary greatly. In some they have an upward aspect, and are often very close upon each other; in others they are lateral, and so wide apart as to be even directed slightly downwards. But of all anomalies, one of the most extraordinary which their position presents, is that of the *Pleuronectes* (such as Turbot, Flounders, Soles, &c.), in which the two eyes are placed, as it were, the one above the other, and both upon the same side of the head. In certain species of the Eels and *Siluri*, they are so small as to be scarcely visible; while in other groups, such as *Priacanthus*, *Pomatomus*, and *Orthagoriscus*, they surpass in proportional diameter whatever is known of the same organs in the higher classes. Some ichthyologists have remarked that fishes which habitually descend to great depths in the ocean have large eyes; and in the internal parasites and in fishes which live in subterranean waters, we have examples of the most rudimentary form of the organ of vision. In the Glutinous Hag, and in the *Amblyopsis spelæus*, the eye is merely a minute black fold of skin on which a cerebral nerve terminates. In *Apterichthys cœcus*, the eye-ball, still rudimentary, is covered by the skin. It may be said in general that the eye of fishes is large, and that its pupil especially is broad and open; a character probably connected with the necessity of collecting whatever devious rays of light may penetrate the obscure depth of waters. Fishes have no true eyelids. The skin always passes over the eye, to which it is slightly adherent; and it is for the most part sufficiently transparent for the passage of the solar rays. In some species, such as Eels, it passes over without the slightest fold or duplication. In others, as the well-known Mackerel and Herring, it forms an adipose fold both before and behind; but these folds are fixed, and being unprovided with muscles, have no mobility. Sharks have one, somewhat more moveable, on the inferior margin of the orbit. The globe of the eye itself is very slightly moveable, although, like that of man, it is furnished with six muscles. Perhaps the most singular eye presented by the class of fishes is that of *Anableps*, which has two corneæ, separated by an opaque line, and two pupils pierced in the same iris, so that one might deem it double; but there is only one retina, and a single vitreous and crystalline humour.

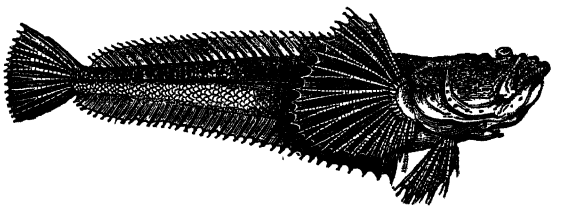


Fig. 46.

Uranoscopus macropygus, an Acanthopterygian fish in which the only spinous ray is one in front of the ventral fin. The points of the pubic bones are also spinous, and the undeveloped interspinous bones of the first dorsal lie beneath the skin. The eye-ball is retractile to beneath the edge of the orbit.

In *Uranoscopus macropygus* and others of that genus, the eyes can be elevated and depressed at the will of the fish, on a cylindrical stem, above or below the plane of the flat dorsal aspect of the head on which it is situated; and in the ferocious *Zygæna*, the eyes are stilted out from the sides of the head on cartilaginous expansions of the skull. Fishes, in the range of their vision and acuteness of sight, are very far inferior to birds, and inferior generally to reptiles and beasts, yet, at the same time, it is evident that they perceive their prey from a considerable distance; and the angler, who knows either how rapidly they seize, or how

cautiously they avoid his lure, and with what discrimination they sometimes prefer one colour or kind of artificial fly to another, must be impressed with the belief that the vision, at least of certain species, is by no means devoid of clearness and precision.

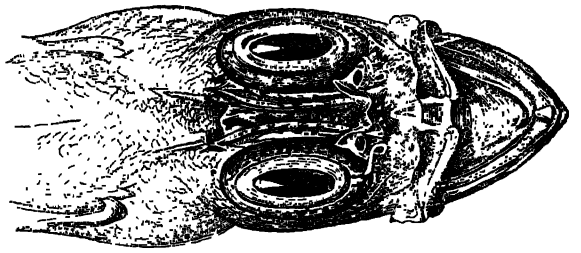


Fig. 47.
Shows the large eyes of *Sebastes percoides*, one of the *Sclerogenidæ* or *Triglidæ*, a family whose home is at the bottom of the sea, and have very commonly the lower rays of the pectoral fins detached and organized as feelers

We shall not repeat here the notices that we have already had occasion to take of the *organ of hearing*. In Sharks, a canal extends from the interior organ of hearing to the hinder part of the head, where it is closed by the skin, and in the rays there is a very minute external orifice to the canal, closely approximated on the dorsal aspect of the head to its fellow. In osseous fishes there is no such mechanism, and the sonorous vibrations are conveyed to the labyrinth through the solid parts; but in the Carp and certain Siluroids, the air-bladder would appear to be accessory to the acoustic organ, as it is connected with it by a chain of ossicles. The general structure of the organ of hearing in fishes is doubtless specially adapted for the sensation of the sonorous undulations of the element in which they live.

A few lines may now be devoted to the consideration of the *sense of smell*. The nostrils of fishes are not so placed as to be traversed by the respiratory medium in its course to the organs of respiration. They consist merely of two openings, situate on the muzzle, and lined by the pituitary membrane, which is raised in extremely regular folds. Their shape is sometimes oblong, sometimes round or oval. They are placed either at the end of the muzzle or on its sides; sometimes on its superior face, and even occasionally, as in Skates (fig. 48), and Sharks, on its under surface near the angle of the mouth. In the Lamprey they are approximate on the top of the head, and open by one common orifice (fig. 49). In the great majority of fishes each nostril opens by two orifices, the one posterior to the other, and in some cases at a considerable distance. These are what are called double nostrils, an inaccurate term, in as far as each pair of holes leads only to a single cavity. The margins of the anterior orifice are often tubular, as in the Eel, and sometimes a single side of the tubular margin is prolonged into a tentacular appendage, as in several *Siluri*. In the genus *Lophius* the nostrils are borne upon a little pedicle, so as somewhat to resemble mushrooms. Various other modifications are observable in different genera, although not necessary to be here narrated.

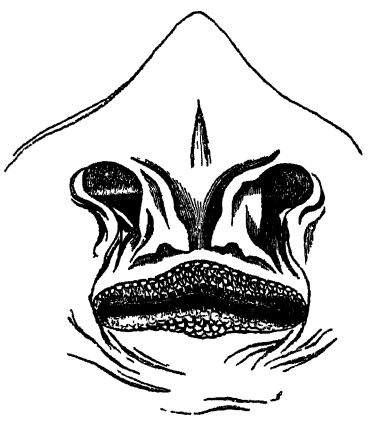


Fig. 48.
Nostrils of *Raia Lemprieri*, an Australian Skate.

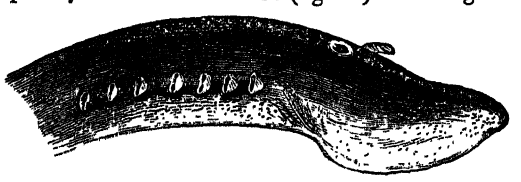


Fig. 49.
Head of *Petromyzon mordax*, showing the single nostril tube and seven branchial orifices.

It is certain that fishes possess the faculty of perceiving odours; that various scents attract or repel them; and there is no reason to doubt that the seat of that perception lies in the nostrils. It may be reasonably conjectured that its strength depends mainly on the degree of development produced by the number and extent of the interior folds of the pituitary membrane.

The essential character of the organ of smell in fishes is that the pituitary sac has one or more external openings not communicating with the mouth or fauces except in the *Dermopteri*, and in these the naso-palatine canal is not traversed by the water in its course to the gills. In some *Synbranchidæ*, the posterior nasal aperture is situate on the white parts, within the edge of the lip, in this respect agreeing with the *Lepidosiren*. Long debates on the conflicting claims of the latter to be ranked as a fish or a reptile, have turned on the position of the posterior nostril. *Tetrodon naritus* is an exception to the general rule of double nostrils, in having merely a single wide opening, coextensive with the dimensions of the pituitary sac, but bordered by membrane. In other Tetrodons the sac is closed by a thin membrane, in which there are two small openings close to each other. The *Chromidæ* also, and the Ctenoid *Labridæ*, have but one opening to each sac; and in some few fishes there is a barbel merely, without an aperture, in place of a nostril.

In regard to the *sense of taste* in fishes, it is evident that as, with few exceptions, they swallow their food rapidly and without mastication, their perception of that faculty must be in noways acute. The same may be inferred from the fact of their tongue being almost immoveable, often entirely osseous, or beset with teeth or dental plates, and from its receiving very slender nerves, and these but few in number. Even those species of which the jaws are so armed as to enable them to cut and bruise their aliment, cannot long retain the latter in their mouths, on account of the position and the play of the respiratory organs. No salivary glands discharge their moisture on the organs of taste. The tongue itself is not seldom entirely wanting; and even when it



Fig. 50.
Mouth of *Plotosus megastomus*, one of the *Siluridæ*. This fish feeds at the bottom, and the barbels developed round the mouth are organs of touch. Teeth are seated on the inner lips and move with them.

exists in its most distinct and apparently fleshy state, it consists merely of a ligamentous or cellular substance, applied on the surface of the lingual bone. It is never furnished with muscles capable of producing any movement of extension or retraction, as in quadrupeds.

Fishes cannot be said to be more highly favoured in respect to the *organs of touch* than those of taste. The faculty is greatly deadened over the general surface by the coating of scales, and in the particular members by the inflexibility of the rays. It is chiefly confined to the lips, and even these parts in many species are themselves as hard and insensible as bone. Certain soft and delicate appendages called *barbels*, possessed by many species, such as the Cod and Loach, are supposed to enjoy a more delicate perception of the sense of touch; and among the *Sclerogenidæ* there are many species that have one or more rays of the pectoral detached from the membrane, so as to become truly delicate, flexible fingers, not for prehension but for touch. The common Gurnard has been seen in a clear sea swimming along near a sandy bottom, and exploring it with these special organs of touch. It is by means of the *dermis* that that peculiar matter, so remarkable for its silvery metallic lustre, and which bestows so much of brilliancy upon the class, is secreted beneath the scales. It is composed of of small polished plates resembling burnished silver, and capable of being removed by washing, either from the skin itself, or from the inferior surface of the scales. It is this substance that is used in the formation of false pearls. It is also secreted by many species in the thickness of the peritoneum, and in the envelopes supplied by that part to particular viscera, especially the swimming bladder.

It thus appears that the external senses of fishes convey to them few lively or distinct impressions; and by whatever scenes in nature they are surrounded, their perceptions are probably indistinct and dull. Their sexual emotions, cold as their blood, indicate only individual wants. Few species pair, or enjoy any connubial gratification, for the males seek the eggs rather than the females which deposit them, and neither sex ever recognises its offspring. At least the exceptions to these general laws are extremely few, and when they occur they are of the lowest animal description. A pair of Congers are so dead to external impressions at the time of sexual congress, and so automatically, as it were, engaged, that they have been taken by the hand together out of the water. Sharks and

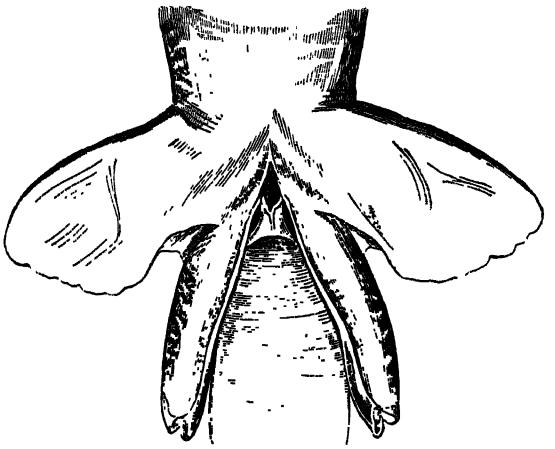


Fig. 51.
Pectoral fins and claspers, or intromittent organs of the male *Hemiscyllium trispeculare*.

Rays have special organs that make some approach to those of the two higher classes of vertebrals. We have no means of knowing much of the loves of a Dog-fish or Skate, but the prevailing economy of fishes may be said in all these respects to be exactly the reverse of that of birds. These gay creatures of the sky have the power of surveying distinctly at a glance an immeasurable extent of horizon; their acute perception of hearing appreciates all sounds, and every intonation; and their glad voices are exquisitely skilled in their production. Though their bills be hard, and their bodies covered by down and feathers, they are by no means deficient in the sense of touch. They enjoy all the delights of conjugal and parental affection, and perform their incumbent duties with devotedness and courage; they cherish and defend their offspring, and will sometimes die in their defence; and of all the wonderful labours of instinctive art, none is so beautiful as the formation of their mossy dwellings. With what deep and continuous affection does the female brood over her cherished treasures! how unwearied is the gallant male in his tender assiduities, and in the rich outpouring of that varied song by which he seeks to soothe her sedentary task! The same principle of attachment and discrimination is even made available in a state of domestication by the skill of all-engrossing man. A bird acquires a knowledge of its master, and submits to and obeys that master's will; and the proud falcon, which in its natural state

"Doth dally with the wind, and scorn the sun,"

will wheel in airy circles over a well-trained dog, or stoop its boldest flight at some familiar urchin's call. Other species will even imitate man's noblest faculty, the power of speech,—and it is thus with somewhat doubtful feelings that we deny to them the gift of reason.

But the silent dweller in the deep knows few attachments, expresses no language, cherishes no affections. Constructing no dwelling, he merely shelters himself from danger among the cavernous rocks of the ocean, or beneath the murky shade of the overhanging banks of rivers; and the cravings of hunger seem alone to exercise a frequent or influential action over his monotonous movements. We must not, however, suppose that the life of fishes is not one of enjoyment, for we know that the great Creator "careth for *all* his creatures;" and it ought perhaps rather to be said that we cannot appreciate the nature of their feelings, than that they are in any way fore-doomed to a negation of pleasure. Assuredly, however, the hand of nature has been most prodigal in bestowing on their external aspect every variety of adornment. Their special forms are infinite, their proportions often most elegant, their colours lively and diversified, and nothing seems wanting in them to excite the admiration of mankind. Indeed it almost appears as if this prodigality of beauty was intended solely for such an end. The brightness of metallic splendour, the sparkling brilliancy of precious gems, the milder effulgence of the hues of flowers, all combine to signalize fishes as among the most beautiful objects of creation. When newly withdrawn from their native element, or still gliding submerged in its liquid coolness, their colours, fixed or iridescent, are seen mingling in streaks or bands, or broader flashes, always elegant and symmetrical; sometimes richly contrasted, sometimes gradually softened into each other; and in all cases harmonizing with a chaste fulness of effect, which Titian or Rubens might envy, but could never equal. For what reason, then, it has been asked, has all this adornment been so lavishly bestowed on creatures which can scarcely perceive each other amid the dim and perpetual twilight of the deep? Shakspeare has already said that there are "more things in *heaven* and *earth* than are dreamt of in our philosophy;" and we fear it is no answer to the foregoing question to add, that the same observation applies with even greater truth to the "*waters beneath the earth.*"

SECTION VI.—THE NUTRITION, MANDUCATION, AND DEGLUTITION OF FISHES.

The nutritive functions of fishes follow the same order

of progression as those of the other vertebrated classes; they seize, and some divide, their food with their teeth; they digest it in the stomach, from whence it passes into the intestinal canal, where it receives a supply of bile from the liver, and frequently a liquid similar to that of the pancreas; the nutritive juices, absorbed by vessels analogous to lacteals, and probably taken up in part also directly by the veins, are mingled with the venous blood which is flowing towards the heart, from whence it is pushed to the branchiæ, in which, coming into contact with the water, it is converted into arterial blood, and then proceeds to the nourishment of the whole body. As in other animals, also, certain properties are carried off from the blood by transpiration, the secreting power of the kidneys, &c.

Fishes in general are extremely voracious, and the rule of "eat or be eaten" applies to them with unusual force. They are almost constantly engaged in the pursuit and capture of their prey; their degree of power in these respects depending of course on the dimensions of the mouth and throat, and the strength of the teeth and jaws. If the teeth are sharp and hooked, they are capable of securing the slenderest and most agile animals; if they are broad and strong, they are able to bruise the hardest aliment; if they are feeble or entirely wanting, they are only serviceable in procuring some inert or unresisting prey. Fishes indeed show but little choice in the selection of their food, and their digestive powers are so strong and rapid as to suffice to dissolve very speedily all kinds of animal substances. They greedily swallow other fishes, notwithstanding the sharp spines or bony ridges with which they may be armed; they attack and devour crabs and shell-fish, gulping them entire if they cannot otherwise attain their object; they do not object occasionally to swallow the young even of their own species, and the more powerful kinds carry their warfare into other kingdoms of nature, and revel on rats, reptiles, and young ducklings, to say nothing of the ferocious Shark, which not seldom makes a meal even of the lord of the creation. The species which live chiefly on vegetable substances are few in number.

The growth of fishes depends greatly on the nature and supply of food, and different individuals of the same species exhibit a great disparity in their respective dimensions. They grow less rapidly in small ponds or shallow streams, than in large lakes and deep rivers.[1] The growth itself seems to continue for a great length of time, and we can scarcely set bounds to, certainly we know not with precision, the utmost range of the specific size of fishes. Even among species in no way remarkable for their dimensions, we ever and anon meet with ancient individuals, favourably situated, which vastly exceed the ordinary weight and measurement of their kind.

The *teeth* of fishes are more variable in form, structure, number, and position, than those of any other class of animals. They are depressed prisms of three, four, five, or six sides in *Myletes*, *Myliobates* or *Scarus*. More generally they are round and tapering, varying in length and thickness from the "short obtuse cone," to the "long conical," "subulate," "acicular forms," even to such fineness as to be named "ciliiform." Their points may be curved, reflexed, and bent at right angles, and their bases may be fixed or moveable. In some *Gobiidæ* their forms and free motion have caused them to be compared to the keys of a piano. When acicular or ciliiform teeth are arranged so closely as to resemble the pile of velvet, they are said to be "villiform" (*en velours*); and when coarser and straight, or with their points bent back, they are "card-like," or "cardiform," or they may be rasp-like or carduliform (*en râpe ou en cardes*). The *Chætodontidæ* are named from their seti-

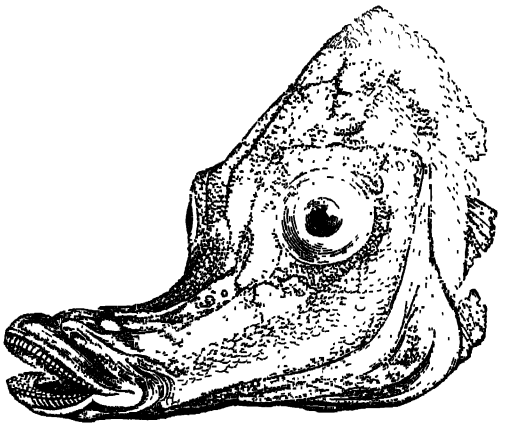


Fig. 53.

Head of *Histiopterus recurvirostris*, one of the *Squamipennes* or *Chætodontidæ*. The teeth, as in the true Chætodons, are closely set, but they are stouter than the "villiform" teeth, and even than those usually named "setiform," having a resemblance to the cylindrical blunt fibres of whalebone in a scrubbing-brush, hence they may be termed coarsely "brush-like" (*en brosses*). They are somewhat thicker than the strong hairs of an elephant.

form teeth. In the *Sphyræna* we have examples of teeth exactly resembling the blade of a surgeon's lancet (*vide* fig. 19), and in Sharks the teeth have a variety of forms, from the long triædral dagger or spike-nail of *Oxyrhina* and *Odontaspis*, to the serrated or lobed cutting teeth of *Galeocerdo*, *Carcharodon*, *Cacharias*, and other genera, set in a row so as to make a most powerful instrument, by which one of these creatures is able to divide a man's body into two at a single bite, down to the pavement-like or tessellated teeth (*en pavés*) of the Dog-fish, or *Cestracion*, used for crushing. The Carp has a crushing apparatus at the entrance of the gullet. In *Myliobates*, *Aëtobates*, *Rhinoptera*, the pavement formed by the broad teeth is of the most regular and beautiful kind. In *Scarus* and *Hoplegnathus* or *Scarodon*, the teeth are so united to the premaxillaries and mandible as to form but a single tooth in each jaw, while in *Calliodon*, the union of the teeth

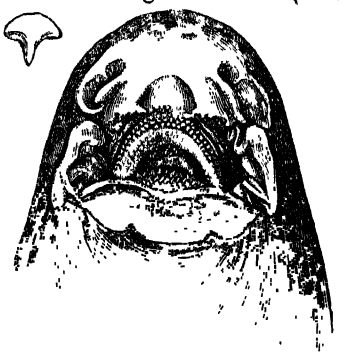


Fig. 54.

Orifices of the mouth and nostrils of *Hemiscyllium trispeculare*. The teeth are scated in the skin covering the cartilages of the jaws, and, as the skin grows outwards (peripheral) like the nails of a man's fingers, the teeth as worn drop off, or desquamate, and are succeeded by others from within, gradually rolling over the cartilages. Fig. 11 gives a full-length view of this fish.

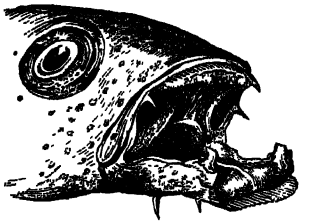


Fig. 52.
Petroscirtes Bankieri.

[1] The writer of this treatise kept a minnow little more than half an inch long in a glass tumbler for a period of two years, during which time there was no perceptible increase in its dimensions. Had it continued in its native stream, subjected to the fattening influence of a continuous flow of water, and a consequent increase in the quantity and variety of its natural food, its cubic dimensions would probably have been twenty times greater; yet it must have attained, prior to the lapse of a couple of years, to the usual period of the adult state. (J. W.)

with the bone is less complete, and their edges rise above the general surface. In *Diodon*, we have the same kind of single tooth in each jaw, or rather confluence of teeth and jaw. In *Tetrodon*, the dentiferous jaws are divided by a mesial suture so as to present two compound teeth above and as many below.

In the *Plagiostomes*, the teeth are limited to the *maxillary* and *mandibular* bones, while in the genus *Cyprinus* teeth are wanting in the jaws, but, as mentioned above, these fish have grinding teeth on the pharyngeals and basi-occipital. In the *Catastomi* of the Cyprinoid family, the pharyngeal teeth are arranged on a crescentic bone like the teeth of a curved comb, the points being thickened for grinding. In *Scarus*, besides the solidly aggregated jaw-teeth above mentioned, there are also pharyngeal grinders. In *Crenidens*, thin tricuspid teeth placed in many close rows on the jaws, serve to cut the tender fuci on which these fishes feed. In passing through the whole series of fishes, we find teeth on the nasal bone, as in *Muræna*, where they stand in a row round the edge of the bone, and in one down the longitudinal mesial line; on the pre-maxillary, the maxillary, the palatines, the vomer, the hyoid-bones, the branchial arches, and especially on their processes, named "rakers." Teeth occur on the maxillary only when it enters into the composition of the orifice of the mouth, as in the *Clupeidæ* and *Salmonidæ*. In *Pristis*, of the Ray tribe, the flat snout, greatly prolonged, and well ossified, is set on each side by a series of very strong nail-shaped teeth, whence its name of Saw-fish among sailors, though it is in reality a weapon that wounds by repeated blows, not by cutting longitudinally like a saw. This snout forms a dangerous sword in the hands of the Polynesians who use it as such. The Lampreys have rows of teeth on the lips, as well as strong pharyngeals. Commonly the teeth do not cross the symphysis of the jaw, there being in most cases a line of division between the pre-maxillaries or at the union of the limbs of the mandible. Instances to the contrary have already been mentioned in *Scarus*, *Hoplegnathus*, and *Diodon*. In *Notidanus*, *Scymnus*, and *Myliobates*, among the Plagiostomi, we have also examples of this departure from the dental type of the higher animals.



Fig. 55.

Jaws of *Hoplegnathus* (*Scarodon* Schlegel). The upper jaw is constituted by the pre-maxillaries coalescent into a single bone, and having the teeth so intimately incorporated with their substance as to make a solid, smooth, gorget-shaped bone; the forms of the teeth, however, faintly showing. The same is the case with the maxillary, the symphysial line being obliterated as completely as in the human under jaw.

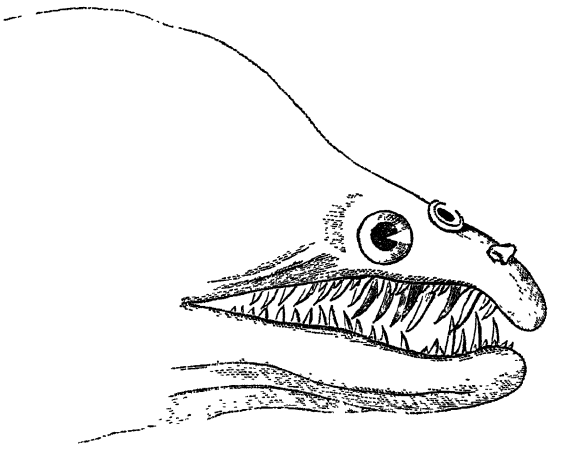


Fig. 58.

Jaws of *Enchelynassa Bleekeri*, one of the *Muræniдæ*. In this genus, teeth stand round the edge of the nasal bone and down its mesial line; two small ones exist on the vomer; two rows on the palatine bones and mandible. The hinder nostril is funnel-shaped.

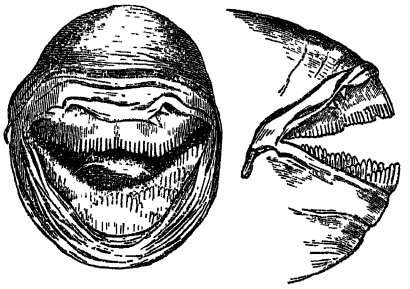


Fig. 56.

Teeth of *Calliodon chlorolepis*, a Scaroid fish from Hong Kong. In this genus the teeth are less intimately united to the jaw-bones than in *Scarus* and *Hoplegnathus*. In the upper jaw the teeth consist of narrow chisel-shaped denticles, so grouped as to indicate four teeth with curved crenated edges on each pre maxillary and limb of the dentary piece of the maxillary. In the latter the four teeth stand out more distinctly, the one next the medial line being so intimately coalescent with its fellow as to form merely one tooth of the same shape as the others, and seated in front of the symphysis. So considered, it is a pairless median tooth, followed on each side towards the corner of the mouth by three others. There are also two small subulate canines or buck-teeth on each pre-maxillary. The fish is the "Scaly King-fisher" of the Chinese, who give it this name because it has bright celandine-green, orange, and yellow colours.



Fig. 57.

Teeth of *Tetrodon bimaculatus* of the *Ostracionidæ* family of *Plectognaths*, similar to those of *Scarus* and *Hoplegnathus*, but the mesial symphysis of both jaws remaining non-coalescent, four teeth are formed, as the generic name denotes.

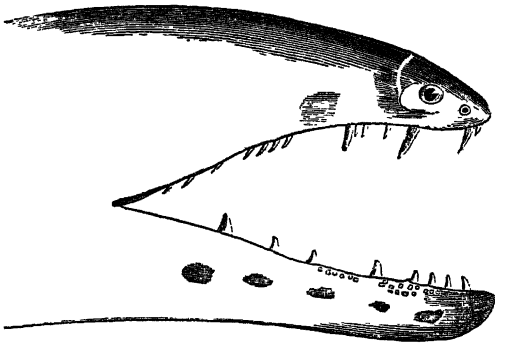


Fig. 59.

Jaws of *Brachysomophis horridus*, one of the *Ophisuridæ*, which have one row of teeth round the margin of the nasal, one row down the mesial line of that bone, and one on the vomer; a row on the mandible, and two rows on the palatines.

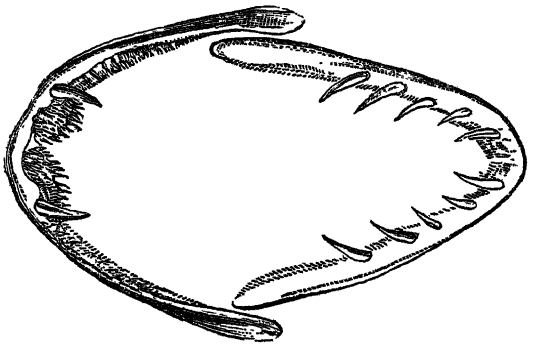


Fig. 60.

Jaws of *Plectroposma dentex*.

Introduction. Digestive System.

In the majority of osseous fishes, besides the lips, which, having no peculiar muscles, can exert but little strength in retaining the aliments, there is generally in the inside of each jaw, behind the anterior teeth, a kind of membranous fold or valve, formed by a replication of the interior skin, and directed backwards, of which the effect is to hinder the alimentary substances, and especially the water gulped during respiration, from escaping again by the mouth. This structure does not, as formerly supposed, constitute a character restricted to the genus *Zeus*, but exists in an infinity of fishes. The food seized by the teeth of the jaws, and detained by the valve just mentioned, is carried still farther back by the teeth of the palate and tongue when these exist, and is at the same time prevented by the rakers of the branchial arches from penetrating between the intervals of the branchiæ, where it might injure the delicate organs of respiration. The movements of the jaws and tongue can thus send the food only in the direction of the pharynx, where it undergoes additional action on the part of the teeth of the pharyngeal bones, which triturate or carry it backwards into the œsophagus. The last-named part is clothed by a layer of strong, close-set, muscular fibres, sometimes forming various bundles, the contractions of which push the alimentary matter into the stomach, thus completing the act of deglutition.[1]

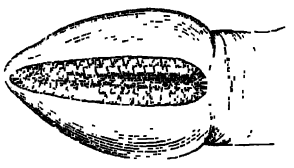


Fig. 61.
Labial teeth of *Petromyzon mordax*.

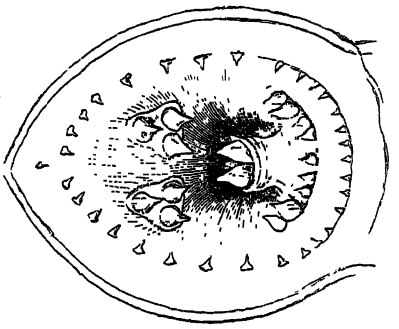


Fig. 62.
Pharyngeal teeth of *Petromyzon mordax*.

SECTION VII.—THE CIRCULATION OF FISHES.

Fishes, in common with warm-blooded animals, are provided with a complete circulation for the body, and with another equally complete for the organs of respiration, and with a particular abdominal circulation terminating at the liver by means of the *vena portæ;* but their peculiar character consists in this, that the branchial circulation alone is provided at its base with a muscular apparatus or heart, corresponding to the right auricle and ventricle of the higher classes, while nothing of the kind exists at the base of the circulating system of the body; in other words, the left auricle and ventricle are entirely wanting—the branchial veins changing into arteries without any muscular envelope.

The muscular apparatus of their circulation is composed of the auricle, the ventricle, and the bulb of the pulmonary artery, and the auricle itself is preceded by a large sinus, in which all the veins of the body terminate; thus there are in a single series four cavities separated by constrictions, into which the blood must flow in its progress from the body to the branchiæ. Their size is small in proportion to the dimensions of the body, and does not increase in the same ratio with the growth of the individual. Three of these receptacles, the auricle, the heart, and the bulb, are lodged in a pericardium, which is itself placed beneath the pharyngeal bones, between the inferior parts of the branchial arches, and for the most part protected externally by the scapular arch. Except in the *Plagiostomes*, the great venous sinus is not placed in the pericardium, but between the posterior partition of that cavity and the membrane which represents the diaphragm, and which is merely the anterior portion of the peritoneum strengthened by aponeurotic fibres. This sinus is extended transversely, and receives by several different trunks the veins of the liver, of the generative organs, of the kidneys, of the fins, branchiæ, and throat; and finally those of the head, which themselves partly pass by a sinus at the back of the cranium. The first-mentioned sinus sends the whole of this blood by a single orifice of its anterior convexity into the auricle, which receives it through the opening of its anterior portion. Two thin membranous valvules protect this communication, and are turned towards the auricle. The latter organ is placed in the pericardium, in front of the great sinus, and above the ventricle, that is, on its dorsal aspect. The ventricle presents very various and often remarkable configurations. In osseous fishes it is usually of a tetrahedral form,—in the cartilaginous kinds more frequently rounded and depressed. It is situate beneath the auricle, the cavity being so turned as to be almost vertical next that organ, and horizontal towards the bulb. Its coats are extremely robust, and furnished internally with powerful fleshy columns, its substance being composed of two different layers. But it is in the bulb of the branchial artery that we find the most vigorous fibres, usually disposed in a circular form. The prolongation of this bulb issues from the pericardium, and becomes the branchial artery, advancing forward beneath the single chain of small bones which unites the arches of the branchiæ. The branchial artery soon divides, and in such a manner as to send a branch to each branchia. These branches pass along a hollow groove on the convexity of each branchial arch, and more external than the vein which follows the same track, but in an opposite direction. To the arch are attached a great number of leaflets, parallel to each other, usually terminated in a forked point, and sometimes deeply divided. The principal branch which passes along the groove of the arch gives a smaller branch to each of the leaflets; and this branch, after being twice bifurcated, furnishes an infinity of lesser branchlets, which meander over the surface of each leaflet, till they finally terminate in extremely minute veins. These little vessels meet on each side in a branchial vein, which proceeds along the internal margin of the lateral lobe of the leaflet, and the two veins open into the trunk of the great vein of the branchia.

Introduction. Vascular System.

On passing out of the dorsal side of the branchiæ, the branchial veins assume the structure and functions of arteries; even before their arrival at this point, the anterior nave already sent several branches to different portions of the head; and it is necessary to remark, that the heart and several parts situate in the chest receive their blood from a branchial vein, by means of an offset issuing from near its source, and consequently anterior to its exit from the branchiæ. Nevertheless, it is only by the re-union of the

[1] The various notices (as already intimated) of the internal structure of fishes contained in the article COMPARATIVE ANATOMY of this work (vol. iii.) absolve us from the necessity of presenting any details regarding the form and constitution of the intestinal canal, and of certain other important interior organs of the class. The forms of the stomach, whether "siphonal" or "cœcal," the *pancreatic apparatus* passing from slender cœcal appendages to the intestinal canal, which secrete a proper fluid but do not admit the food, gradually increasing in complexity to the pancreatic conglomerate gland of the sturgeon, are parts of structure which the ichthyologist is required always to pay attention to; and also to the extension of the inner coats of the intestine by valvular folds, producing a more extensive secreting surface, and delaying the passage of the food. The two forms of spiral valves in the lower gut of sharks, and in some of the osseous apodals, require special notice.

Introduction. Vascular System.

trunks proceeding from the four branchiæ that the great artery is formed which carries the blood to the viscera and all the parts of the trunk, and which is by consequence the representative of the aorta of the Mammalia,—but of an aorta which possesses neither auricle nor ventricle at its base. Thus, according to Cuvier's views, the left cavities of the heart of quadrupeds do not exist in fishes, but are replaced by a simple vascular apparatus, situate above the branchiæ, in like manner as the right cavities are placed beneath them.

SECTION VIII.—THE RESPIRATION OF FISHES.

It is by an almost infinite subdivision of the vessels over the surface of the branchiæ or gills, that the blood of fishes becomes subjected to the influence of the circumambient water, which is made to flow incessantly between the branchiæ by the movement of the jaws, and of the opercular and hyoidean apparatus. This mode of respiration is as necessary to fishes as the direct respiration of air is to other animals. If the air is expelled by ebullition from the water, fishes cannot live; and many species are obliged to rise frequently to the surface for the purpose of breathing atmospheric air. It is easy to suffocate various kinds, by keeping them beneath the surface, inclosed in a gauze net. The absorption of oxygen, however, is comparatively small among these aquatics, for it has been calculated that a man consumes fifty thousand times more than is required by a Tench. When fishes are deprived of water, they perish not so much for want of oxygen, as because their branchiæ become dry, and unable to perform their functions duly. Hence the species of which the branchial orifice is small, as the Eel, or those which possess receptacles for moisture, like *Anabas* and *Ophicephalus*, long survive exposure; while such as have their gills greatly cleft and open, as the Herring, expire almost instantly when withdrawn from their moist abode. Some fishes, as *Amphipnous cuchia*, and *Saccobranchus singio*, have a pulmoniform sac for supplying air to the gills.

SECTION IX.—THE AIR-BLADDER OF FISHES.

One of the most remarkable and characteristic organs of fishes is the air or swim-bladder. In many genera it has no opening or external communication, and in these the air which it contains must be the result of secretion. It is composed of an extremely fine internal tunic, of another of a thicker texture and peculiar fibrous structure, remarkable for producing the finest kind of isinglass, and is inclosed within the general coating with which the peritoneum invests the other viscera. It is sometimes simple, as in Perch, sometimes furnished with more or less numerous appendages, as in some of the Haddock tribe, or branched, as in certain *Sciænæ*. Occasionally we find it divided, as it were, into two or more parts, by a constriction, as in the genus *Cyprinus*, many of the *Siluridæ*, and others. It is chiefly among the abdominal fishes that we find it communicating by a tube with the intestinal canal, and either directly with the œsophagus, as in *Cyprinus*, or with the base of the stomach, as in the Herring. That of the Sturgeon opens into the former portion by means of a large orifice. Professor Owen states generally that the contents of the air-bladder consist in most fresh-water fishes of nitrogen, with a very small quantity of oxygen and a trace of carbonic acid; but that in the air-bladder of sea-fishes living at great depths, oxygen predominates. Biot found as much as 87 per cent. of oxygen in the air-bladder of deep-sea Mediterranean fishes. Dr Davy[1] in the air-bladder of fresh-run Salmon found a trace of carbonic acid, and 10 per cent. of oxygen, the remainder of the air being nitrogen. Humboldt found 4 per cent. oxygen, and 96 per cent. nitrogen, in the air-bladder of *Gymnotus*. That the air-bladder is homologous with the lungs of the higher animals, is the opinion of the best physiologist of the present day. These in their embryo state have gills, the lungs being developed when needed. In fishes the gills are persistent, while the air-bladder is simple and embryonic, having chiefly a mechanical function to perform. In the Salmandroid *Ganoidei*, however, various *Siluroids*, and *Protopteri*, the air-bladder shows some pulmoniform complications. The *Lepidosiren* of the Gambia remains buried in the mud during the dry season, and its respiration is performed by pulmonary air-bladders, which have short, wide tracheæ, kept open by cartilaginous orifices; and all the oxygenation of the blood required during the torpid condition of the fish is effected in the blood-vessels ramified over the air-bladders.

The more obvious use of this organ seems to be to maintain the fish in equilibrium, or to lighten or increase its relative weight, so as to cause an ascension or a sinking, in proportion as the bladder is compressed or expanded. This is probably effected by the contraction or dilatation of the ribs. At all events it is certain, that when the air-bladder bursts, the fish remains at the bottom, usually turning up its belly, and exhibiting other irregularities in its locomotion. Another curious effect is observable in regard to fishes which have been suddenly brought from a great depth by means of a long fishing line, and which having no time either to compress or partially empty the organ in question, the air which it contains being no longer pressed by the heavy weight of water, either expands so as to burst the bladder, or by its dilation forces the stomach and œsophagus into the fish's mouth. When the air-bladder is pierced artificially, the fish almost immediately turns upon its back, and sinks to the bottom.

Though of the highest importance in the structure of such species as possess it (and these are by far the greater number), yet the air-bladder is not indispensable in the general economy of the class of fishes.[2] In some fishes it is no bigger than a pea; in several genera (*e.g.*, *Pleuronectes*) it is entirely wanting, and the species in such cases generally remain at the bottom, and, swimming obliquely on one side, propel themselves forward by a nearly vertical motion of the tail. In such cases both eyes are on the same side, and the whole structure of the fish, especially the skeleton of the head, presents an unsymmetrical aspect of a very extraordinary kind.[3] In many cartilaginous fishes, such as Rays (commonly called Skates), the absence of the swimming bladder seems compensated by the enormous size of the pectoral fins, which, of all the external organs, are probably the most efficient in raising the body, as the caudal extremity is the power chiefly employed during an onward course. The Lamprey, which has neither swimming bladder nor pectoral fins, dwells in the mud. Flat fishes being unprovided with swimming bladders, are supposed for that reason to raise themselves with difficulty to the surface; and they do not appear to strike the water laterally like other fishes, but swim rather after the manner of the *Cetacea*, by a motion alternately up and down. In all the other animals of this class the chief organ of progressive motion is the tail, or prolongation of the body, terminated by a caudal fin, the position of which, unlike that of the great aquatic mammalia called whales, is vertical. The reason of the difference is obviously this: a true fish, pos-

[1] *Transactions of the Royal Society of Edinburgh*, xxi., p. 245, 1855.

[2] *De Aure et Auditu*, &c.

[3] In several insects of the genus *Blatta* we have observed a want of symmetry both in the size and markings of the elytra. We do not mean an accidental variation of one side, but an evidently pre-ordained disparity of form and colour.

Classification.

sessing the power of extracting air from water by means of its gills, does not (except at rare intervals) require to mount to the surface for the performance of the vital act of respiration; but all cetaceous animals being furnished with lungs, which cannot perform their functions except through an immediate communication with the atmosphere, require their bodies to be terminated by a horizontal expansion, the action of which is the most efficient for an ascending course. It is, however, difficult to account for the fact that so considerable an organ as the swimming-bladder should have been denied to so many species, not only of the more indolent kinds, which dwell composedly at the bottom of the waters, but to many others which yield to none of their class in the ease and velocity of their movements. Its presence or absence does not even accord with the other conditions of organization; for while it is wanting in the common Mackerel, it is found to occur in a closely allied species, the *Scomber pneumatophorus* of Laroche. Weber has pointed out a remarkable connection between the air-bladder and the acoustic organs in the head.

Classification.

We have already alluded to a singular peculiarity connected with the organization of certain fishes—we mean the power of conveying electrical shocks. In Torpedos, the apparatus consists of two organs, built up of membranous tubes filled with mucous matter, divided by transverse chambers closely set together, like the cells of honeycomb, and disposed in two groups placed on each side of the head. They receive enormous branches of nerves from the fifth and eighth pair. In the *Gymnotus* the electric organs are four, and occupy the under surface of the body throughout its entire extent to a considerable thickness. It is composed of parallel plates separated by thin layers of mucilage. The effect of this natural galvanic pile will be detailed in the course of the systematic portion of this article, when we shall have occasion to mention the electric fishes in their proper place.

CLASSIFICATION OF FISHES.

A "natural arrangement" of fishes or of any other class of animals implies an accurate knowledge of their whole structure, internal as well as external, by which they can be grouped in the order of their affinities, placing those species together which agree with one another in the greatest number of important characters. Naturalists have generally come to the conclusion that the series of species is not a linear one; some have one portion of their frames, some another, specially organized for the part the species has to play in the system of nature; and so the affinities branch off in several directions. The nervous system being that by which an animal has perception of external objects, and directs its motions accordingly, and which presides moreover over those operations of organic life that are not obedient to the will, would be one important basis of classification, but its various modifications of structure in fishes are still too imperfectly known, and the labour and skill necessary for the elucidation and discrimination of its parts and their functions are such that, practically, it has hitherto been as yet but little referred to in the arrangements of the systematic ichthyologist. The same is true in a greater or less degree of the other parts of the organism employed in nutrition, respiration and circulation, secretion, generation, and development; most of the arrangements of fishes that have hitherto appeared being based on the organs of locomotion and the external integument, the latter the most variable certainly that could have been chosen, but at the same time the least important. We have scaly, partially scaly, and scaleless species in the same genus of some particular groups. Agassiz has been labouring assiduously on embryonic development as a basis of arrangement; but as far as we know, has not yet published a system founded on his researches in this direction. All attempts at classification of fishes which have hitherto been given to the world, violate more or less anatomical affinities; the best on the whole that has been proposed, is that of Professor Johannes Müller, which we shall follow, adopting the modifications of Professor Owen. It would be a great help to the memory were the divisions of the class of equal rank to approach to equality also in the number of species that they embrace, but this cannot be; though most probably the disparity in the size of the groups would be considerably lessened were we acquainted with all the species secluded in the depths of the sea, and still unknown, as well as with the forms of the extinct fishes. The *Salamandroid* Ganoids which abounded in variety and number in another epoch of the earth's history, have only a few existing representatives; and of the palæozoic fishes with soft skins that are less likely to be preserved than the strongly cuirassed Ganoids, we know absolutely nothing, not even that such were then created.

In his arrangement of fishes, Müller finds characters which he considers to be of the highest importance in the vascular system. The heart of fishes is a venous or branchial one, consisting of an auricle in which the veins terminate, and a ventricle for transmitting that venous blood to the gills where it is aerated and whence it circulates through the body without the intervention of a special propelling organ like the systematic side of the heart of a higher animal; but merely through the general contractile power of the arteries. In most fishes there is a thick muscular swelling of the commencement of the arterial system close to the ventricle, and which, in fact, may be called a third chamber of the heart. The blood is prevented from regurgitating into the ventricle on the contraction of the bulb by valves; and the number of these valves, and the presence or absence of the thick muscular coat of the bulb, furnish characters of groups so constant, that Müller says he is acquainted with no others, either anatomical or zoological, which equal them in certainty. The *Plagiostomi*, or cartilaginous fishes, as restricted by the removal of several groups that were included among them by the older ichthyologists, have *three or more longitudinal rows of valves* within the muscular bulb. A still *greater number of valves* are present in the bulb of the existing Ganoids; but in the large group formed by the osseous fishes after the Ganoids have been removed from them, *two opposite valves* are placed at the origin of the bulb, and no more. This great group Müller names *Teleostei*, or perfect osseous fishes; and he includes in it the six following orders mentioned in the subjoined table,—*Acanthopteri*, *Anacanthini*, *Pharyngognathi*, *Physostomi*, *Plectognathi*, and *Lophobranchii*. The *Cyclostomes* of Cuvier, or the Suckers, want the *bulbus arteriosus*, or thickened muscular tunic, but have *two valves* at the origin of the branchial vessel like the *Teleostei;* while the Lancelet (*Amphioxus*) wants the *heart* itself, the circulation being carried on by the muscularity of the entire vascular system. This fish, therefore, he considers as the type of a sub-class which he names *Leptocardii*. Another sub-class, termed *Dipnoi*, includes fishes which have scales, with both lungs and gills. In all, he makes six sub-classes of fish—1. *Teleostei;* 2. *Dipnoi;* 3. *Ganoidei;* 4. *Elasmobranchii;* 5. *Marsipobranchii* or *Cyclostomi;* 6. *Leptocardii*. In the subjoined modification of his arrangement by Professor Owen, these sub-classes are not preserved, the class being sub-divided into nine orders, and again into sub-orders. A few changes have been made by us in the termination of the names of

Classification—Dermopteri.

families, to reduce them to an uniform nomenclature, and some groups that have been recently characterized have been introduced.

CLASS OF FISHES.

Order I.—DERMOPTEROUS FISHES.

Sub-Order I.—PHARYNGOBRANCHS.

This order is named from the cutaneous vertical fins, in which the mucoid rays are extremely soft and delicate, or altogether imperceptible, and from the want of pectoral or ventral members. The first two sub-orders are founded on the different developments of the respiratory organs. In the first the pharynx itself is organized for respiration, and two processes having the function of gills project freely into the cavity of the mouth; the water necessary for respiration flowing over them by the same canal which carries the food; there being no lateral gill-openings through the skin. Of this sub-order the best known representative is the *Amphioxus lanceolatus* of Yarrell (*Branchiostoma lubricum*, Costa), which was first made known to the world as a *Limax* or Slug by Pallas, who received it from the Cornish coast. Recently Mr Couch rediscovered it on the same shores, and Mr Yarrell has described it in his excellent work on British Fishes, according to its true affinities as a fish, though its want of a head was puzzling. Its structure has since been investigated by Ratke, Johannes Müller, Owen, Goodsir, Swan, and other first-rate comparative anatomists,—many specimens having been procured among the gravel and rocks of the sea-beaches in the south of England, also in the Irish Channel, on the Norway coast, and in the Mediterranean. The longitudinal slit forming the orifice of its mouth, resembles, to the unassisted eye, that of a Lamprey, its jointed labial feelers looking like moveable teeth. It is a thin semi-transparent creature about an inch and a half long, without jaws, but having a large buccal cavity into which the short vascular processes that perform the function of gills project freely, without cartilaginous supports or lateral attachments. The buccal cavity communicates by a small pharyngeal opening with a wide barrel-shaped œsophagus, which occupies more than a fourth of the whole length of the fish, and whose interior surface is ciliated throughout, and organized to assist in respiration. Vessels that ramify over its vertical ciliated bands communicate with the dorsal and ventral portions of the vascular trunk that carries on the circulation, without the intervention of a central propelling organ. There is, however, beneath the posterior end of the expanded œsophagus a small widening of the circumferential vessel which pulsates rythmically, and which Professor Owen considers to be a rudimental representation of the branchial heart of the Myxinoids, the next order of fishes in point of organization. The peculiarity of shape which distinguishes the Lancelet from all other fishes, arises from all its nerves of the senses devolving from the myelon or spinal marrow, without the production of a ganglionic brain, and consequently, without the necessary expansion of the protecting integuments which make the head, and in animals more advanced in the scale, provide sockets for the sense capsules. The only cartilaginous part of this fish is a jointed hæmal arch which extends from the anterior end of the spinal chord on the ventral aspect to the orifice of the pharynx, and serves to support the oral filaments. It represents the labial arch of the higher Myxinoids. Though this little creature wants jaws, it has, as we have just mentioned, a large buccal cavity which, as in other fishes, admits not only food, but also aerated water, to the respiratory organs, and an enormous œsophagus having the double function of deglutition and respiration. The intestine proceeding from the œsophageal bag is slender, almost straight, and terminates at the anus, about one-fourth of the whole length of the fish from the point of its tail. In its motions, the Lancelet is lively and active, and shelters itself quickly from observation among the gravel. In 1853 Sundevall distinguished two American species of *Amphioxus* or *Branchiostoma*, the *B. caribæum* from the West Indies, and *elongatum* from Peru; but Professor Peters on comparing the species found that *caribæum* was identical with the European one. Dr Gray has described a Borneo specimen as a distinct species, so that the genus probably is not so poor in species as was at first supposed.

Classification—Dermopteri.

CLASS.—PISCES.

Order I.—DERMOPTERI.

Vermiform, abrachial and apodal; endo-skeleton unossified; exo-skeleton and vertical fins muco-dermoid; no pancreas; no air-bladder.

The devolopment of the skull in the Dermopterous fishes is arrested at more or less embryonic stages, but in each genus it proceeds in a specific direction; thus, in the Lancelet, evolving an articulated labial arch and its numerous filaments; and in the Myxinoids and Lampreys forming a more complex system of lateral and labial cartilages; or modifying the palatine, maxillary, and hyoid rudiments in relation to the suctorial function of the mouth. The olfactory organ, which is double in all other fishes, is single in this order; and the eye is rudimentary, being merely a small fold of skin coated with a speck of dark pigment. It is probable that this point is sensitive to light, as the lowest member of the order, the Lancelet, quickly secludes itself among gravel when exposed to light. In *Ammocœtes* and the Myxinoides the cartilaginous capsules of the acoustic organs retain the embryonic position of projecting spheres at the base of the cranium; these are less prominent in the Lampreys; in the Plagiostomes they are imbedded in the walls of the cartilaginous skull; and in the bony fishes they are walled up by ossification. The oral filaments and soft integuments of the anterior end of the Lancelet and Myxines receive many nervous twigs from the fifth pair; and touch seems to be the most important sense in these low vertebrals.

Sub-Order I.—PHARYNGOBRANCHII.

Cirrhostomi, aliorum. Gills free, pharyngeal; no heart. A single genus of few species.

Family I.—AMPHIOXIDÆ.

Genus I. Amphioxus, Yarrell. (*Branchiostoma*, Owen.) Respiratory processes projecting from above the pharynx into the large cavity of the mouth. Interior mucous coat of the widely dilated œsophagus organized for aërating the blood. Mouth edentate, furnished with exterior labial barbels.

Sub-Order II.—SUCKERS.

Genus *Heptatrema*, Dum. (*Bdellostoma*, Müll. Act. Berol, 1838.) A single species is known, the *Petromyzon cirrhatus* of Forster, who discovered it in Queen Charlotte's Sound, on Cook's second voyage. It has since received the appellations of *Heptatremus Dombeyi* and *Bdellostoma Forsteri*. It is a lively, active fish, inhabits rocky bottoms, lies in wait for fishes on which to prey, and was frequently taken by our voyagers adhering to pieces of fish which had been let down into the sea as bait. It has the power of emitting an immense quantity of mucus from all parts of its skin. The New Zealanders roast and eat it.

Myxine, Linn. (*Gasterobranchus*, Bloch.) The species best known, *Myxine glutinosa*, Linn., or Glutinous Hag, was classed by Linnæus with the *Vermes*. The mouth is a membranous ring, with a single tooth on its superior part; while the strong teeth of the tongue are arranged in two rows on each side, so as to give to these animals the appearance of having lateral jaws, like insects or *Nereides*; but their tongue performs the office of a piston in exhausting the mouth so as to enable them to adhere to other

Classification—Dermopteri.

bodies, like the Lamprey. The lips are furnished with eight cirrhi, and above is a spout-hole communicating with the mouth; the body is nearly cylindrical, and terminates in a fin which surrounds the tail. The intestine is simple, wide, and straight, as viewed externally, but it is plaited within; the liver has two lobes; the eggs grow to a considerable size. When taken and confined in a large glass jar, a single fish will pour so much mucus from its lateral pores as to give the water the appearance of jelly.

Ammoccetes. Body cylindrical, with numerous annular lines around it, that give it much the appearance of a worm. It lives in the mud of rivers. Mouth incapable of adhering *by suction* to other bodies; fins very shallow; tail sharp at the tip. The only species is *P. branchialis*, Shaw (the *Pride* of Pennant), which grows to six or eight inches long, and is as thick as a goose-quill. It inhabits the rivers of Oxfordshire, and occurs in various parts of the European continent.

Petromyzon, Dum., or Lamprey. The tongue, acting like a piston in the circular mouth, is capable of vigorous motion, and is an essential part of the mechanism by which the fish is enabled to attach itself firmly to stones, or to fasten itself to the larger fishes, which it is thus enabled to suck and devour at its leisure. The dorsal fin is farther forward than the anus, and a second unites with the tail. The European species are,—*P. marinus*, the Greater Lamprey, which grows to the length of more than three feet. It is considered as a delicate food, and is caught as it ascends rivers in the end of winter and spring. Colour yellowish, marbled with brown. First dorsal fin very distinct from the second. This fish is common in the Severn, and in the mouths of many European rivers. Its supposed *hermaphroditism* is mentioned by Sir Everard Home.—*P. fluviatilis*, the Lampern, or Nine-eyed Eel. Length from twelve to eighteen inches; olive back, silvery below; first dorsal distinct from the second. Two thick teeth, separate, in the top of the maxillary ring. Ascends rivers from the sea; swarms in the Thames, Severn, and Dee. Vast quantities taken in England are sold to the Dutch for the Turbot fishery. It abounds in the rivers on the southern side of the Baltic. Both these animals are very tenacious of life, and will live many days out of water.—*P. planeri.* About ten inches long; greatly resembles the preceding; but the two dorsal fins are united. It is also an European river fish. Figs. 61, 62 show the dentition of *Petromyzon mordax*, an Australian species; the lips and their teeth being shaved off in the latter to show the pharyngeal teeth.

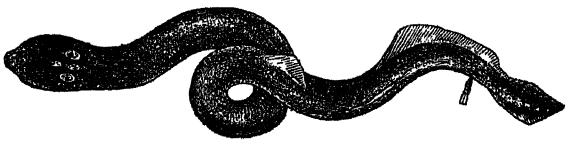


Fig. 63.

Fig. 49 represents the lateral gill-openings of the same species, and fig. 63 the entire fish.

Sub-Order II.—MARSIPOBRANCHII.

Cyclostomi, Dum., Cuv. Gills fixed, bursiform, inoperculate, receiving the respiratory streams by apertures usually numerous and lateral, distinct from the mouth; a heart.

These are vermiform fishes whose vertical fins are folds of skin surrounding the tail, and the rays scarcely to be perceived in any part, being soft and rudimental. They are the first in the ascending series of fishes in which the anterior end of the myelon has that ganglionic development which constitutes the brain in fishes, and which have a cartilaginous cranium for its protection. In *Ammocœtes* the persistent cranial cartilage resembles the first appearance of the cartilages in the embryo of the higher fishes. In the Myxinoids the neural and hæmal canals of the spinal column are formed of layers of the sheath of the gelatinous dorsal chord; the neural canal extending along the whole upper part of the chord, and the hæmal canal being confined to the tail. In the Petromyzons cartilaginous plates are developed in the fibrous sheath, which is the first indication of neural arches. A cartilaginous barrel-shaped basket, homologous with the branchial skeleton of osseous fishes, is provided for the support of the gills and the canals leading to them. This cartilaginous frame-work is termed by Cuvier *cotes branchiales;* and he observes, that though it is much developed in the Cyclostomes, it is scarcely perceptible in the Rays and Sharks. There are no other ribs in this order. The Marsipobranchs, however, resemble the Plagiostomes in having an undivided cephalic cartilage, a spout-hole in the head, and a spiral valve in the intestine. In all other respects they differ from them, and especially in the complete absence of gill-arches, want of jaws, in the total absence of a muscular tunic to the *bulbus artenosus*, and in the arterial valves beyond the branchial opening of the ventricle being only two; they differ further in the genital organs of the one sex having no oviduct, and in the other no seminal duct.

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The gills of Lampreys and Myxines are little bags, each of which has its proper artery; and its proper orifice in the pharynx through which the water flows in to pass out on the dermal side by another hole. These purse-shaped bags are called fixed lungs, in contradistinction to the gills of osseous fishes, whose exterior edges are free and pectinated; but Professor Owen has observed that if one side of one of the sacs were adherent to the adjacent side of another, and then each bag slit open and detached from the outer integument, a gill would be formed receiving its blood from two arterial branches, and resembling, were it pectinated, the gill of an osseous fish. The genera have been characterized by the number of the exterior gill-openings.

The *teeth* in the Marsipobranchs are composed of indurated albuminous matter, and when macerated, flake off in successive hollow cones. Agassiz, from investigations into the embryology of fishes, thinks that the Marsipobranchs are not a proper order of fishes, but merely embryonic forms of the more developed Sharks and Rays from which they ought not to be dissevered in our systems.

Family I.—AMMOCŒTIDÆ.

Genus I. Ammocœtes, Dum. Mouth semicircular, edentate, the posterior lip being transverse, cirrhated within; gill-bags seven, each with an external lateral aperture, and receiving streams of water from the œsophagus without a separate trachea. Olfactory organ single, opening in the median line of the dorsal surface of the head, whence a narrow canal, strengthened by cartilaginous rings, runs to the bottom of the skull, and terminates by a valvular opening in front of the occipital cartilage. The pituitary lining is plaited longitudinally.

Agassiz describes a new species, *A. borealis.*

Family II.—MYXINIDÆ.

Internal branchial openings œsophageal and equal in number to the branchial sacs; external ones as many, lateral; or only one common to all the gills of a side, and then situated on the ventral aspect; four barbels on the snout, and two on each side of the mouth which is circular; one tooth on the roof of the mouth, two rows on the tongue. Eye as lowly organized as in the Lancelet. Naso-palatine tube having a valve at its opening on the roof of the mouth.

Genus I. Myxine, Lin. (*Gastrobranchus*, Bloch.) Saccular gill-bags, six on each side, receiving the streams of water from the œsophagus by as many short tubes. The efferent tubes empty the water into a common lateral canal which terminates on the ventral aspect of the fish at the end of the first third of its length. Between this aperture and its fellow of the other side, there is a larger opening rather to the left of the mesial line, which admits the water into the œsophagus.

Genus II. Heptatrema. Seven lateral branchial apertures. At the extremity of the snout a depressed opening of a canal leading to the gills. Four rostral cirrhi; as many labial ones. Eyes white lateral points.

Family III.—PETROMYZONTIDÆ.

Branchial organ of each side divided by transverse partitions into seven fixed chambers, which receive the water from a median canal, distinct from the œsophagus, by as many round holes, and permit it to flow out by an equal number of lateral cutaneous orifices; the median canal lies beneath the œsophagus, opens anteriorly into the fauces by a doubly valvular orifice, communicates with the gill-chambers to the right and left, and is closed at the posterior end. Nostril single; tubular on the top of the head, leading to a globular nasal sac from a tube that descends to the base of the skull and the membrane of the palate, which closes it, leaving no perforation there. Cuvier compares this tube to a trachea. Mouth variously armed with teeth.

Genus I. Petromyzon, auctorum.

Dr Gray has recently proposed a new arrangement of the Lampreys.

Classification—Dermopteri.

(*a.*) SUB-FAMILY.—PETROMYZONINA.
(With distinct teeth and eyes.)

GENUS I. PETROMYZON. Two conical upper pharyngeal teeth close together; a single crescentic under one; numerous conical labial teeth, two fringed lingual ones. *P. marinus*, and four other species.

GENUS II. LAMPETRA. Upper and under pharyngeal teeth transversely crescentic; labial teeth in two rows on the border of the lips; more interior lateral teeth bigger, irregularly twice or thrice notched; lingual teeth pectinate. *P. fluviatilis, planeri*, and two other species.

GENUS III. GEOTRIA. Upper and under pharyngeal teeth transversely crescentic, the upper one-lobed; labial teeth numerous, remote, pointed, the interior ones the biggest; lingual teeth long, conical, curved. One species. *G. australis.*

GENUS IV. VELASIA. Upper and under pharyngeal teeth transversely crescentic; the upper bilobate; labial teeth narrow, truncate, the interior ones the biggest; lingual teeth rather long, curved. *V. chilensis.*

GENUS V. CARAGOLA. Two upper, three-lobed, pharyngeal teeth, widely apart; under one crescentic, nine-lobed; labial teeth four-bundled; lingual teeth flat. *C. lapicida.*

GENUS VI. MORDACIA. Two upper pharyngeal teeth; the lateral ones trilobate; nine under conical ones in a curved row; labial teeth conical, in a single series on the margin of the lip; lingual teeth long, conical, curved. *P. mordax.*

(*b.*) SUB-FAMILY.—AMMOCŒTINA.
(Without teeth and with obscure eyes.)

GENUS VII. AMMOCŒTES. Five species.

SUB-ORDER III.—RIBBON APODALS.

These delicate, semi-transparent, and scaleless fishes are inhabitants of all the oceans, and the species are probably numerous, though it is only in localities where much attention is paid to fish that they are likely to be noticed. They are many, and of considerable variety of form in the Mediterranean, and one species is occasionally taken by keen naturalists on the English coasts. Several have been described that inhabit the Indian seas; and on Sir James Clark Ross's antarctic voyage one specimen was obtained in a high southern latitude. The absence of ossification in the skeleton, the gelatinous condition of the sheath of the spinal marrow, which, in the form of a "chorda dorsalis," reaches into the base of the skull; and the persistence of the primordial cartilaginous cranium are reasons for placing these fishes with the *Dermopteri.*

SUB-ORDER III.—APODES LEMNISCATI.

Ribbon-shaped, extremely compressed fishes. Gills free, subopercular; no air-bladder. Skeleton cartilaginous; no scales. Blood colourless; no spleen.

FAMILY I.—LEPTOCEPHALIDÆ, Bon.

Helmichthyidæ, Köll. Small, greatly compressed, blade-shaped, apodal, diaphanous fishes, totally destitute of scales, with a lateral line formed by the intersection of the muscular layers; some have, some want teeth; and the pectoral fins are also present in some species, and wanting in others. The anus is placed on the ventral edge of the fish, before or behind the middle, and the simple straight gut runs near the ventral edge of the fish. Their skeleton is very incomplete and cartilaginous, and the myelon is obscurely visible through it. In most, the anal and dorsal, uniting at the end of the tail, form a pointed or blunt, but very seldom a forked caudal, in which the rays are generally discoverable.

GENUS I. ESUNCULUS, Kaup. *Leptocephali* with small pectorals and a forked caudal. One species, Italy.

GENUS II. HYPRORUS, Köll. Jaws straight, much elongated, with merely traces of dentition. Hinder nostrils before or over the eyes; muciferous pores along the jaws and round the eye. Body elevated and gibbous at the occiput; tail pointed. Pectorals minute; rudimentary anus before the middle; caudal not distinct from the other vertical fins. One species, Messina.

GENUS III. OXYSTOMUS, Rafin. (*Tilurus*, Köll.) Distinguished from *Leptocephalus* by the rayless, cutaneous dorsal fin commencing at the occiput, and by the upper and under transverse muscular bands not making an angular interruption or break anteriorly at their intersection; no anal fin; anus far back, near where the tail is attenuated into a longish filament. Head small; mandible a trifle longer; pointed teeth on both jaws; gill-openings furnished with distinct opercula, and squeezed together on the throat. Three species.

Classification—Dermopteri.

GENUS IV. LEPTOCEPHALUS, Lin. (*Helmichthys*, Rafin.) Distinguished from *Oxystomus* by none of the species having the tail so prolonged into a hair-like point, and by the muscular bands making a distinct angular intersection anteriorly. Some species have, others want teeth; there are species in which the teeth can be seen only through a microscope, and others whose pointed teeth are distinctly visible to the naked eye. Most have small pectorals, but some show not even a trace of these fins. At the end of the gut there is an anal opening as fine as a hair, which gives exit to the fluid excrement. Eighteen species.

GENUS V. CHEILOBRANCHUS, Rich. Form compressed; body linear-lanceolate. Head very small; snout obtuse; jaws equal. Mouth small; teeth uniserial, acute, becoming blunt with age, closely ranged so as to form an incisorial series; lips loose. Anus before the middle; dorsal and anal mere cutaneous folds without rays or interneural bones; a single interneural at the point of the tail, which supports seven or nine jointed rays; caudal united with the cutaneous dorsal and anal; muscular layers forming chevrons, which have the apex of the angle on the lateral line, and directed forwards, as in *Leptocephalus*; abrachial and apodal. Gill-opening under the throat, a small transverse slit, common to the two sides, without a division in the middle; the edge of the membrane free; a cutaneous fold, ending on each side in a minute lobe, forms the posterior edge of the opening, and seems to be capable of acting like a valve, with the aid of an interior membranous fold; branchiostegals three; a minute genital papilla; a single pancreatic cæcum was observed; the intestine appeared to be straight, with a stomachal dilatation. The skin is smooth, but minutely pitted, as if from microscopical sunken scales. Vertebræ 73, ossified. Two species—one obtained at Penguin Island, in Lat. 72. S.

ORDER II.—MALACOPTEROUS FISHES.

SUB-ORDER I.—SERPENTIFORM APODALS.

In the Lancelets, the only representatives as yet known of the order of *Dermopteri*, we have seen that the skeleton is membranous, that the spinal nervous chord is continued to the anterior end of the fish without expansion, and that in conformity with this simplicity of the nervous centre, the head cannot be distinguished from the body, and may be said to be wanting,—the only part of the face that is developed being the mouth and oral filaments. In the Suckers the skeleton rises from the soft membranous condition of that of the *Ammocete*, to the production of a tendinous spinal chord filled with gelatine, and partially encompassed by cartilage; teeth exist on the palate and lips, though as yet seated only in the soft parts, and formed of indurated mucoid matter; while the jaws are wanting. The group we have now to speak of consists of fishes with a well ossified skeleton, and a head that is at once recognised as such, but with the bones of the face less fully developed than in osseous fishes more highly organized. A single bone represents the nasal, ethmoid, and vomer, or it may be said that these three bones have coalesced into one, which is firm and strong. The pre-maxillaries and the maxillary are wanting, the palatines coming in contact with the lips to form the lateral portions of the upper jaw, which are opposed to the mandible,—the teeth which arm these bones standing in reverse order with regard to one another; for instance, when they are biserial, and the inner row is the tallest on the palatines, the outer row of the mandibulars is the tallest, and is opposed to the lower rank of the palatines. In the mammals a similar reversal of the sides of the molar teeth may be noticed in comparing the upper and lower jaws.

This sub-order does not embrace all the fish that want ventral fins, there being many examples of such in other groups, but it may be viewed as presenting an analogy to the *Cetacei* among mammals. Neither does the vermiform type belong exclusively to these Apodals; we shall find it manifested repeatedly in other parts of the series of fishes.

The table in small type gives the technical characters

Classification—Malacopteri.

of the various divisions and sub-divisions of the order, and our limits will not permit us to do more than to notice a few of the species that inhabit the British waters, or that are otherwise interesting from some particulars in their history or economy.

In this order the forms of the teeth vary greatly. In a few species they are mere grinding machines, in the majority, long, slender, and sharp for the retention of their prey; in others, they are variously lobed, fine-edged, cutting instruments. On these different kinds of dentition, the genera and minor groups are, in many instances, founded. The arrangement of the entire sub-order is that of Dr J. Kaup of Darmstadt, from whose catalogue, written for the British Museum, we have borrowed it.

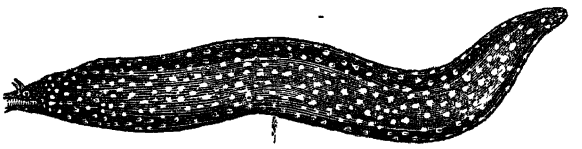


Fig. 64.
Muræna pavonina.

The *Muræna Helena*, or *Roman Muræna*, abounds in the Mediterranean, and was introduced by the luxurious Romans of antiquity, in crystal vases, to the table before being cooked, that the guests might admire its variegated skin. This fish is very voracious, and feeds on all sorts of animal matter. The Romans fed them in ponds, and Pliny has recorded the atrocities of Vedius Pollio, who used to punish his offending slaves by throwing them alive to his *Muræna*. We have seen this fish repeatedly taken at Gibraltar, between three and four feet in length. The skin is beautifully marbled with yellow sub-angular markings on a rich brown ground. When captured in nets it lives long out of the water, and is capable of biting very severely, from the sharpness of its numerous teeth.

A Murry is noticed in the narrative of *Cook's Third Voyage to the Pacific* in these words:—"Amongst these were some large eels, beautifully spotted, which, when followed, would raise themselves out of the water, and endeavour, with open mouth, to bite their pursuers."

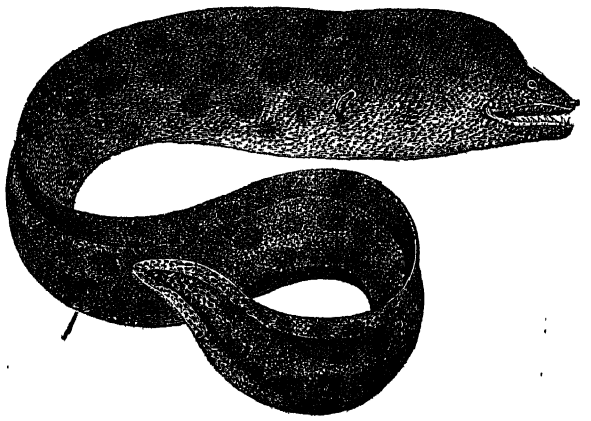


Fig. 65.
Sidera pantherina.

The *Anguillidæ* are a family whose members exhibit little variety of form, and it contains only a single genus. From the common Eel, however, most of our ideas respecting the Apodals have originated. *Anguilla vulgaris.* We have observed these fish in considerable numbers leaving fresh-water lakes in the night time, and frequenting meadows, seemingly for the purpose of preying on slugs and snails. They easily move on the land, with a motion resembling that of snakes. The Eel grows to the size of two or three feet, and is sometimes said to reach five or six feet in length. It abounds in many European rivers. Eels are caught in immense numbers in the rivers emptying themselves into the Baltic; and they form a considerable article of trade. Two thousand are stated to have been caught at one sweep in Jutland; and in the Garonne 60,000 were taken in one day by a single net.

"That Eels migrate towards brackish water," observes Mr Jesse, "in order to deposit their roe, I have but little doubt, for the following reasons. From the month of November until the end of January, provided the frost is not very serious, Eels migrate towards the sea. The Thames fishermen are so aware of this fact, that they invariably set their pots or baskets with their mouths up stream during those months, while later in the spring and summer they are set down stream. The best time, however, for taking Eels, is during their passage towards the sea. The Eel-traps, also, which are set in three different streams near Hampton Court (the contents of which, at different times, I have had opportunities of examining), have invariably been supplied with Eels sufficiently large to be breeders, during the months I have mentioned. This migratory disposition is not shown by small Eels; and it may therefore be assumed that they remain nearly stationary till they are old enough to have spawn. I have also ascertained that Eels are taken in greater or lesser numbers during the months of November or December, all the way down the river to the brackish water. From thence the young Eels migrate, as soon as they are sufficiently large and strong to encounter the several currents of the river, and make their way to the different contributary streams. I have also been able to trace the procession of young Eels, or, as it is called here, the *Eel-fuir*, from the neighbourhood of Blackfriar's Bridge, as far up the river as Chertsey, although they probably make their way as far, or farther than Oxford. So strong, indeed, is their migratory disposition, that it is well known few things will prevent their progress, as, even at the locks at Teddington and Hampton, the young Eels have been seen to ascend the large posts of the flood-gates, in order to make their way, when the gates have been shut longer than usual. Those which die stick to the posts; others, which get a little higher, meet with the same fate, until at last a sufficient layer of them is formed to enable the rest to overcome the difficulty of the passage. A curious instance of the means which young Eels will have recourse to, in order to perform their migrations, is annually proved in the neighbourhood of Bristol. Near that city there is a large pond, immediately adjoining which is a stream. On the bank between these two waters a large tree grows, the branches of which hang into the pond. By means of these branches, the young Eels ascend into the tree, and from thence let themselves drop into the stream below, thus migrating to far distant waters, where they increase in size, and become useful and beneficial to man. A friend of mine, who was a casual witness of this circumstance, informed me that the tree appeared to be quite alive with these little animals. The rapid and unsteady motion of the boughs did not appear to impede their progress."

"All authors agree," adds Mr Yarrell, "that Eels are extremely averse to cold. There are no Eels in the Arctic regions, none in the rivers of Siberia, the Wolga, the Danube, or any of its tributary streams. It is said there are no Eels in the Caspian or Black Seas, but they abound in the Mediterranean; and M. Risso has described eight species in his work on the *Natural History of the Environs of Nice.* There is no doubt, also, that fishes in general, and Eels more particularly, are able to appreciate even minute alterations of temperature in the water they inhabit. The brackish water they seek to remain in during the colder months of the year, is of a higher temperature than that of the pure fresh water of the river, or that of the sea.

Classification—Malacopteri.

It is a well-known law in chemistry, that when two fluids of different densities come in contact, the temperature of the mixture is elevated for a time, in proportion to the difference in density of the two fluids, from the mutual penetration and condensation. Such a mixture is constantly taking place in rivers that run into the sea, and the temperature of the mixed water is accordingly elevated." As Eels are well known to breed in ponds, it may be inferred that their descent to the brackish water, though customary, is not indispensable. They sometimes attain a great size. The species (or variety) called the *Sharp-nosed Silver Eel* has been taken near Cambridge of the weight of twenty-seven pounds.

Order II.—MALACOPTERI.

Physostomi, Müll. Endo-skeleton ossified; exo-skeleton, in most as Cycloid, in a few as Ganoid scales. Fins supported by rays, all, save the first, sometimes in the dorsal or pectoral, soft or jointed abdominal or apodal. Gills free, operculate; a swim-bladder and air-duct.

Sub-Order I.—APODES ANGUIFORMES.

Malacopterygii apodes (partim), Cuv. Elongated fish more or less approaching to vermiform, covered with a thick slimy skin; the majority scaleless, but in some genera small scales are imbedded in the skin. No developed ribs in the skeleton. Stomach cæcal. Pancreatic cæcal appendage to the intestine wanting. The greater number have a swimming-bladder, which is often very curiously formed, but never double. Fin rays simple, not jointed.

Section A.—*Phaneromycteres.*

Labial olfactory organ opening by the posterior nostril on some part of the head above the mouth, so as to be exposed.

Family I.—SYNBRANCHIDÆ, Kaup.

Uni-aperturidæ, auct. Both gill-openings enveloped by a border of the common integument, so as to present externally only a single medial orifice. Pectorals and other fins wanting, or almost obsolete. Species few, confined to the seas of Asia and South America.

Genus I. Amphipnous, Müll. (*Unibranchapertura*, Hamilt. Buch.; *Synbranchus*, Cuv.; *Ophichthys* et *Pneumabranchus*, M'Clell.) A membranaceous partition separates the branchial efferent tubes, and is continued to the verge of the common orifice. Four gills, the third one having short fringes; the fourth, a membrane with merely faint notches on its extremity. Vomerine teeth strong, in two rows, eight in each, standing well apart; palatine teeth small and thin, a little larger on the point of the bone; mandibular teeth pluriserial at the symphysis, uniserial towards the corner of the mouth. On the occiput there is a sac which can be filled with air, and is connected with the gills. Fine scales form a multitude of elevated longitudinal lines on the body. The only trace of a fin is a slight one on the thin tapering end of the tail. One species, *A. cuchia.*

Genus II. Ophisternon. (*Unibranchapertura*, Lacèp.; *Ophisternon*, M'Clell.; *Synbranchus*, Cant. and Bleek.) *Four* fringed branchial arches, which discharge the water that has passed over them by two tubes divided by a thin partition, inclosed by the skin of the throat so as to form one transverse oval opening. No air-bag on the occiput, and no swim-bladder. Branchiostegals six, bony. Posterior apertures of the nostrils between the eyes; anterior nostrils minute, one on each side of the snout. Teeth fine, blunt on the upper jaw, almost setaceous, crowded into a triangle on each side of the symphysis; vomerine teeth larger, in a single series; mandibular ones somewhat bigger still, and truncated. One species, *O. bengalensis.*

Genus III. Synbranchus, Bloch. Have all the characters of *Ophisternon*, but the four fringed gills are not separated under the throat by a partition, and the solitary gill-opening does not make the angular inflection that it does in *Monopterus*, *Ophisternon*, and *Amphipnous*. Hinder nostrils opening above the eyes, and capable of being shut by a cutaneous flap. Two species, one Indian, the other South American.

Genus IV. Monopterus, Lacèp. *Three* gills only. No occipital air-bags. No protruding nasal teeth; the palatine teeth meet in an angle with the vomerine ones anteriorly, and are there pluriserial, but diminish to two and one row towards the corner of the mouth; vomerine teeth triserial anteriorly, uniserial posteriorly; ranged in two bands, which meet in an acute angle anteriorly, and diverge posteriorly. Like *Amphipnous* and *Ophisternon*, the exterior gill-opening is angular, and below the outer integument there is a membranous partition between the gills. One species, *M. javanicus.*

Classification—Malacopteri.

Family II.—MURÆNIDÆ, Kaup.

In most of the genera no pectorals. Gill-openings lateral. Skin smooth and slippery, without scales. Mostly or wholly marine fishes.

(*a.*) Sub-family.—MURÆNINÆ.

Uniserial teeth on nearly all the dentiferous bones of the mouth.

Genus I. Muræna, Kaup. Uniserial nasal teeth, three on the mesial line. Twenty-four species. Figure 64 represents *Muræna pavonina.*

Genus II. Sidera, Kaup. Only one short conical tooth on the mesial line; biserial, low, granular teeth on the vomer, the rows coalescing in a point posteriorly; opening of the jaws not wide. Skin spotted. Two species. Figure 65 represents *Sidera pantherina.*

(*b.*) Sub-family.—THYRSODEINÆ.

Within the outer palatine teeth, a second row that varies much in the number of teeth which compose it.

Genus III. Enchelynassa, Kaup. Fore nostrils short, infundibuliform, and capable of being closed by a cutaneous tag of its hinder border; hinder nostril longish, oval, surrounded by an elevated cutaneous border, and nearly as large as the eye. Rictus of the jaws gaping in the middle, owing to the length of the teeth; nasal teeth, five long ones anteriorly, followed by three or four smaller ones; in the second row three long moveable teeth standing near the corner of the eye; nineteen greater and smaller palatine teeth, with six more acicular ones in an interior row; on the mesial line of the nasal, three long moveable teeth; on the vomer, two short conical ones; mandibular teeth, twenty-two small ones in the exterior row, and five long ones in an interior row. One species. The teeth are shown by figure 58.

Genus IV. Eurymicтera, Kaup. Fore-nostril tube projecting outwards beyond the lip; lips expanding on the upper and under jaws; hinder nostril over the eye, and encompassed by an infundibuliform border. Nasal teeth eleven, with five small intercalary ones in the posterior part of the row; palatines thirty in the outer row, five larger ones forming an inner row; from seven to ten on the vomer, the extreme ones minute; mandibulars twenty-seven of a side, with five bigger ones near the symphysis in a second row. Body slim. Jaws deeply cleft. Dorsal fin commencing at the occiput. One species.

Genus V. Enchelycore, Kaup. Jaws incapable of shutting close from the length of the teeth; hinder nostril strikingly large, longer than broad, and situated before the eye; fore nostril-tube so unusually short that it does not pass over the edge of the lip, and it has no lid; eye in the middle of the length of the snout; the thin outstretched upper jaw curves upwards. Twenty-four slender teeth, some of them elongated, forming the outer row on the nasal bone; eight moveable latter ones in a second row; three on the mesial line; eighteen outer palatines; three moveable bigger ones making an inner row; about fifteen small, pointed vomerines, and thirty-seven fine mandibular ones, with two bigger moveable ones at the symphysis. One species.

Genus VI. Thyrsoidea, Kaup. *Muræna* in the construction of the fore and hinder nostrils, and presenting no prominent character whereby they may be distinguished from the *Muræna* proper, except that they possess a more or less complete second or inner row of pointed palatine teeth.

The numerous species (33) may be grouped according to the number of rows of their vomerine and palatine, and by the patterns which the colours of their bodies assume;—some are reticulated, others spotted, others again of one uniform colour in the upper, or both above and below.

Genus VII. Limamuræna, Kaup. Abbreviated *Thyrsodeinæ*, whose hind nostril-tubes project still more than those of *Muræna helena.* Ten or twelve nasal teeth, with some scarcely perceptible ones at their bases: three on the mesial line; palatine teeth biserial, but the inner row of six generally defective, sometimes altogether wanting; four to six vomerine teeth; mandibulars uniserial, nine of them taller than the fourteen others.

Head elongated; snout pointed; front nostril-tubes projecting over the edge of the lip; hinder ones a little exceeding the diameter of the eye in length. Dorsal fin commencing at the occiput. One species.

Genus VIII. Polyuranodon, Kaup. *Thyrsodeinæ*, with three rows of acute teeth on the palatine bones; fourteen uniserial nasal teeth; five or six uniserial vomerine teeth, mandibulars quadriserial anteriorly, biserial towards the corner of the mouth. One species.

Classification—Malacopteri.

GENUS IX. CHANNOMURÆNA, Rich. (*Ichthyophis seu Nettastoma*, Rich., *olim.*) Nostrils like *Muræna;* face short and depressed, but the gape of the mouth extremely wide and long. Body cylindrical, without any vestige of the fold of the skin which contains the dorsal rays in *Muræna*. Tail compressed and thinner at the tip, where a few caudal rays are faintly perceptible. Teeth slenderly subulate, in broad, dense, coarsely villiform plates. One species. It is represented by figure 6.

GENUS X. MURÆNOBLENNA, Lacép. (*Ichthyophis*, Less., Rich. *partim.*) Finless, like *Gymnomuræna*, but differing wholly in the teeth, which are slenderly subulate, rather tall, and thinly set. Vomerines irregularly biserial; nasals, palatines and mandibulars triserial.

GENUS XI. PŒCILOPHIS, Kaup. Murænæ, with blunt or more conical teeth; vomerines round, pavement-like. Hinder nostrils fringed; front ones shortly tubular, not projecting over the lip. Dorsal and anal fins not distinctly perceptible, and the species are therefore to be distinguished from *Gymnomuræna* by the numerous rows of vomerine teeth. Six species, most of which are much spotted.

GENUS XII. GYMNOMURÆNA, Lacép. Destitute of fins; blunt, pavement-like teeth on the border and mesial line of the nasal bone, crowded into a space shaped like the sole of a shoe. Palatine bones rudimentary, supporting small teeth in two or three rows. Body elongated, crossed by white bands. Two species.

GENUS XIII. APTHALMICHTHYS, Kaup. Resembling *Moringua*, but destitute of fins except at the point of the tail, where there is a trace of rays. Eyes covered by the skin. Lower jaw thick and projecting beyond the snout. Nostrils short and tubular, the posterior ones capable of being shut. Tail nearly equally thick throughout. Eleven teeth in the upper jaw, the seven nasals being the longest; five vomerines in one row; ten or twelve mandibulars. One species.

GENUS XIV. UROPTERYGIUS, Kaup. Both jaws furnished with two rows of fine teeth; the teeth in the outer row being short, with reflexed points, those of the inner ones straighter and twice as high; vomerine teeth uniserial, recurved. The only fin is the caudal, seated on the dilating tip of the tail. One species.

GENUS XV. APTERICHTHYS, Dum. (*Cœcilia*, Lacép.; *Sphagebranchus*, Bloch, Cuv.) No fins. Snout lengthened beyond the mandible; gill-openings near to one another, as in *Sphagebranchus;* anterior and posterior nostrils tubular. Body much elongated; tail slender. Teeth acicular and curved, and uniserial on all the dentiferous bones. One species.

GENUS XVI. PRYMNOTHONUS, Rich. Founded on a pencil drawing of Dr Hooker's; has an acute snout, projecting a little beyond the mandible. Acute subulate uniserial teeth, not closely set. Anal aperture near the head, a long even anal with some rays shown posteriorly united to a radiated caudal; a short dorsal fold also united to the caudal. Gill-openings lateral, a small hole in the axilla of what seems to be a small pectoral. No specimen of this form has reached England. It appears to belong to this place.

GENUS XVII. MORINGUA, Gray. Greatly elongated *Muræniæ*, with the mandible longer than the snout. Teeth distinct, acute, and recurved; vomerines uniserial. The dorsal and anal fins commence posterior to the anus, and disappear in the middle of their length, reappearing and becoming higher than before at the end of the tail. Three species.

FAMILY III.—ANGUILLIDÆ.

Teeth card-like or villiform. Gill-openings lateral. Pectoral fins conspicuous; anal and dorsal fins encompassing the tip of the tail, the former beginning generally at a considerable distance from the head; longish oval cycloid scales lying embedded in transverse and oblique groups in the skin, so as to resemble lattice-work. No species have as yet been detected that want the pectoral fins, like the abrachial genera among the *Muræniдæ* and *Synbranchidæ*. The *Anguillidæ* are wholly or mostly anadromous fishes, some of them remaining always in fresh water.

GENUS I. ANGUILLA. Forty-five species.

FAMILY IV.—CONGERIDÆ, Kaup.

A dorsal fin reaching up to the occiput; a naked, scaleless skin; and, for the most part, a very long tail running to a point. Pectorals in some present, in others wanting; a cartilage in the lips.

GENUS I. MURÆNESOX, M'Clell. Snout elongated like that of a Gavial, whereof the dilated spoon-shaped nasal bone overpasses the mandible; the thin lips do not cover the front teeth. Fore nostrils opening by short tubes near the narrowing of the nasal bone; hinder ones often pretty remote from them, placed beneath the eyes. The large eyes placed nearly over the middle of the jaws. Dorsal fin extending forwards to the base of the pectorals; vomer elevated with a furrow in which the bigger teeth stand, and are accompanied by a row of small blunt ones. Sundry rows of teeth on the palatine and mandibular bones; the longest teeth are on the nasal bone and fore part of the mandible.

Classification—Malacopteri.

GENUS II. CONGER, Cuv. Anterior nostrils opening by short tubes close to the end of the snout; posterior ones before the large eyes. Palatine and vomerine teeth slender, but having chisel-shaped crowns, and arranged in so close a series as to produce an incisorial edge. Nine species.

GENUS III. CONGERMURÆNA, Kaup. Posterior nostril a short longitudinal slit before and above the large eye, which is over the corner of the mouth. Teeth flatly rounded in a multitude of rows. Species three.

GENUS IV. UROCONGER, Kaup. Anterior nostril not tubular; posterior ones close before the eye like a small slit. A row of slit-like pores on the border of the upper lip. Tail much elongated, slender towards the end, and tapering to an acute point. Teeth (like those of *Myrus*) very fine, and disposed in two or three rows; nasal and palatine teeth in two rows; front upper jaw teeth boring through the lips; pectoral small and elongated. Gill-openings very large, as compared with those of other genera in this family. One species.

SECTION B.—*Cryptomycteres.*

The olfactory canal, running from the front nostril backwards through the soft parts to the side of the mouth, opens by the posterior nostril in the white integument within the border of the lip; in this respect resembling *Lepidosiren*.

FAMILY V.—OPHISURIDÆ, Kaup.

(*a.*) SUB-FAMILY.—OPHISURINÆ.

Tail ending in a conical point, that separates the ends of the vertical fins; no caudal fin.

GENUS I. LEIURANUS, Bleek. *No vomerine teeth;* uniserial palatine teeth ranged in a crescent; mandibulars also uniserial; upper jaw elongated like that of a shark; mandible extraordinarily short and round. Fore nostrils under the projecting snout; hinder ones in the lip beneath the eye, which is nearer the corner of the mouth than to the point of the snout. Pectoral fins scarcely perceptible. Point of the tail spinous. One species.

GENUS II. CENTRUROPHIS, Kaup. Vomerine teeth uniserial or sometimes sub-biserial; nasal teeth beyond the point of the mandible. Pectoral fins pretty well developed. Six species.

GENUS III. PŒCILOPHIS, Kaup. Three nasal teeth, not implanted out of reach of the mandible; three on the mesial line, the foremost two smaller and side by side. Eleven palatine teeth in a crescent, whose point touches the last of the mesial nasals; eleven vomerines; nineteen mandibulars; teeth generally pointed, short, and recurved. No cuticular processes on the upper lip. Head roundish. Pectoral fins very short; dorsal commencing opposite their bases. One species.

GENUS IV. MICRODONOPHIS, Kaup. Very small pointed teeth, biserial on the nasal and on the symphysial extremity of the mandible. Fins much developed. One species.

GENUS V. CŒCILOPHIS, Kaup. Biserial teeth near the symphysis of the mandible, and not elsewhere. Pectoral fins developed and longer than the rictus of the mouth. Fore nostrils shortly tubular, with a short tag on their under border. Dorsal fin commencing over the points of the pectorals. One species.

GENUS VI. OPHISURUS, Kaup. Head small; snout slender and elongated, its point passing beyond the mandible; gape of the mouth very wide; eyes near the corner of the mouth; fore nostril in the middle between the eye and end of the snout, indistinct and without a tube; and the hinder one rather on the outside of the thin lip. The pectoral fin is about half as long as the mouth.

Nasal teeth, five on the border of the bone, and nine longer ones on the mesial line; thirteen short and pointed ones on the vomer; palatine teeth uniserial, anteriorly, becoming biserial under the eye. One species.

GENUS VII. HERPETOICHTHYS, Kaup. Jaws nearly of equal length; snout bluntish; gape wide; eyes approximating to the snout; head depressed, so that the eyes are rather more on the dorsal than lateral aspect; front nostril-tubes at the end of the snout, and the hinder ones at the commencement of the outer row of palatine teeth; between the two there is a small cutaneous flap on the border of the lip. Pectoral fins pretty short. Six nasal teeth; from nine to thirteen vomerine ones. Three species.

GENUS VIII. BRACHYSOMOPHIS, Kaup. Eye placed at the end of the first fifth part of the length of the jaws, or one of its own diameters from the tip of the snout; fore nostril-tube extraordinarily short; the hinder one a short tube on the inner side of the lip under the eye; gill-openings very large, and approximated to one another. Pectoral fins comparatively small. Border of the lips warty. One species, *B. horridus*, whose jaws are represented by figure 59.

Classification—Malacopteri.

GENUS IX. ELAPSOPSIS, Kaup. Gape of the mouth short; snout elongated, obtuse, stretching beyond the mandible; the short nasal tube wider at its external orifice than at its commencement; eye approximating to the corner of the mouth. Pectoral very small but distinctly visible. Body about equal in length to the tail. Nasal teeth reflex, four in each row, with an odd one in front; vomerine teeth irregularly uniserial; palatine teeth uniserial anteriorly, becoming biserial and sub-triserial. One species.

GENUS X. MYSTRIOPHIS, Kaup. Snout spoon-shaped, its extremity being dilated; fore nasal-tube rudimentary, and in the middle of the rostral expansion; eyes over the middle of the jaws, and though the long head is depressed, they are more lateral than dorsal in their aspect; gill-openings large and near one another. Two species.

GENUS XI. MURÆNOPSIS, Lesueur. Head oval; snout not much elongated; hinder nostril rather on the outside of the thin lip. Pectoral as long, or somewhat longer than the long, straight rictus of the jaws. Teeth all of equal length. Three species.

GENUS XII. ECHIOPSIS, Kaup. Face short; eyes high-placed; fore nostril-tubes short; jaws deeply cleft. Pectoral fins pretty short, about half the length of the oral rictus. Nasal teeth seven; three on the mesial line being the tallest; two rows of vomerines uniting at their posterior termination, biserial palatines, interior row composed of the smallest teeth; two rows on the mandible, the outer row being the tallest. One species.

GENUS XIII. SCYTALOPHIS, Kaup. Teeth all nearly of a size, divergent; anterior nostril-tube distinctly visible. Pectoral pretty well developed. All the teeth biserial except the nasals. Two species.

GENUS XIV. LEPTORHINOPHIS, Kaup. Snout pointed; tubes of the anterior nostrils dependant; posterior nostrils situated before the eyes on the border of the lips; eyes over the middle of the oral rictus. Pectorals developed; anal and dorsal fin becoming higher near their terminations. Two species.

GENUS XV. PISOODONOPHIS, Kaup. Teeth all shortly conical, more or less blunt; anterior nostril-tube projecting; eye approximating to the corner of the mouth. Pectoral more or less fully developed. Eighteen species, some of them all of one colour, others spotted or banded. Eighteen species.

SUB-ORDER II.—APODALS WITH ARTICULATED FIN RAYS.

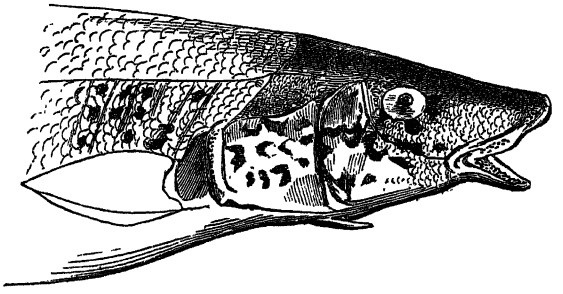


Fig. 66.
Rhamphichthys Müllert.

The GYMNOTIDÆ are apodals, but cannot be associated with the Eels in the sub-order of Serpentiform Apodals, owing to the considerable differences of their organization. Their jaws are complete, they are furnished with ribs, and their fin rays are jointed or branched, in which respect they differ from the preceding sub-order, the chief point of agreement being the want of ventral fins. The *Gymnotidæ* want also the dorsal; but one of the genera has a curious long ray, which commonly lies in a furrow along the top of the rounded back, glued down by mucus. It is named by German ichthyologists "peitsche," or "the whip," and is considered by Dr Kaup to be a representative of the adipose fin on the tail of the *Salmonidæ*. One of the most curious parts of their structure is the forward position of the vent, which in most of the *Rhamphichthi* is before the eye; and in these the anal begins between the gill plates, and extends along the ventral edge of the fish, while the rounded back is destitute of a fin. Examples of a similar forward position of the anus occurs in some other families, but they are very scarce. The *Gymnotidæ* inhabit the rivers and fresh-water lagoons of the warmer parts of South America, Guiana, Surinam, Cayenne, Demerara, Guyaquil, Ecuador,

Classification—Malacopteri.

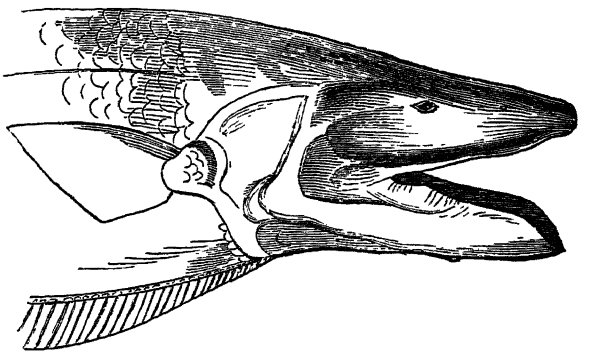


Fig. 67.
Sternarchus Bonapartii.

New Granada, and Brazils. The best known species is *Gymnotus electricus*, or the Electric Eel. This animal has been well described by Dr Garden of Charlestown, by John Hunter, and by Humboldt. It is remarkable for the violence of its electric shocks, which are often so powerful as to stupify a man or a horse. The researches of Hunter detected an electric organ in the posterior part of this fish consisting of four longitudinal fasciculi, which occupy one-half the thickness of the part in which they occur, and about one-third of the whole animal. The larger pair lie above, the smaller below. Each fasciculus is composed of flat partitions or septa, with transverse divisions between them. The outer edge of the septa appear in nearly parallel lines in the direction of the longitudinal axis of the body, and consist of thin membranes, which are easily torn; they serve the same purpose as the columns in the analogous organ of the Torpedo, making the walls or abutments for the perpendicular and transverse dissepiments, which are exceedingly numerous, and so closely aggregated as to seem almost in contact. The minute prismatic cells, intercepted between these two sorts of plates, contain a gelatinous matter; the septa are about one-thirtieth of an inch from each other, and one inch in length contains a series of 240 cells, giving an enormous surface to the electric organs. The whole apparatus is abundantly supplied with nerves from the myelon; and these nerves are seen coming out in pairs from between the vertebræ. In their course they give out branches to the muscles of the back, and to the skin of the animal. In the Gymnote, as in the Torpedo, the nerves supplying the electric organs are much larger than those bestowed on any part for the purposes of sensation or movement. Hunter thinks, however, that these nerves are more considerable in point of size in the Torpedo than in the Gymnote. These organs are attached loosely to the muscles of the back which lie between the larger fasciculi, and they are immediately connected with the skin by a loose cellular texture. Humboldt has given a very interesting and lively description of the mode of capturing the electric Gymnote, as practised in South America, near the town of Calabozo.

These fish abound in the stagnant pools of that vicinity. The Indians are well aware of the danger of encountering the Gymnote when its powers are unexhausted. They therefore collect twenty or thirty wild horses, force them into the pools, and when the fish have exhausted their electric batteries on the poor horses, they are laid hold of without difficulty. The horses at first exhibit much agitation and terror; they are prevented leaving the pool by an inclosing band of Indians, who goad them with bamboos whenever they attempt to escape. "The Eels," says Humboldt, "stunned and confused by the noise of the horses, defended themselves by reiterated discharges of their electric batteries. For some time they seemed likely to gain

Classification—Malacopteri.

the victory over the horses and mules; these were seen in every direction, stunned by the frequency and force of the shocks, to disappear under water. Some horses, however, rose again, and, in spite of the active vigilance of the Indians, gained the shore, exhausted with fatigue; and their limbs being benumbed by the electric explosions, they stretched themselves out upon the ground." "I remember the superb picture of a horse entering a cavern, and terrified at the sight of a lion. The expression of terror is not there stronger than what we witnessed in this unequal conflict. In less than five minutes two horses were already drowned. The Eel, more than five feet long, glides under the belly of the horse or mule; it then makes a discharge from the whole extent of its electric organs, which at once attacks the heart, the viscera, and especially the gastric plexus of nerves." "After this commencement, I was afraid that the sport might end very tragically. But the Indians assured us that the fishing would soon be finished, and that nothing is to be dreaded but the first assault of the *Gymnotus*. In fact, whether the galvanic electricity is accumulated in repose, or the electric organ ceases to perform its functions when fatigued by too long-continued use, the Eels, after a time, resemble discharged batteries. Their muscular motion is still equally active, but they no longer have the power of giving energetic shocks. When the combat had lasted a quarter of an hour, the mules and horses appeared less affrighted; they no longer bristled up the mane, and the eye was less expressive of suffering and of terror. They no longer were seen to fall backwards; and the Gymnotes, swimming with the body half out of the water, and now flying from the horses instead of attacking them, began themselves in their turn to approach the shore."

The electric Gymnote is by no means fierce or voracious; but its electric organs are the instruments by which it procures its prey, and defends itself against alligators and other enemies. It has been several times brought alive to Europe, and some experiments have been made on its electricity, which is conducted and insulated by the same substances as common galvanism. So common is the Gymnotus in some parts of South America, that, in the neighbourhood of Uritucu, a route at one time much frequented has been entirely abandoned, in consequence of the necessity of fording a stream, in which many mules were killed every year by these subaqueous electric shocks.

The genus *Sternarchus* of Schneider was so denominated from the anus being near the sternum. The *Gymnarchus niloticus* is named in Arabic "Del e far."

Sub-Order II.—APODES ARTHROPTERYGII.

Dr Kaup, for the reason stated in the text, has separated *Gymnotus* from the Serpentiform Apodals, and associated it with *Sternarchus* and its allies, forming a group placed by him next the *Malacopteri abdominales*, but the want of ventrals necessitates its separation as a sub-order.

Family I.—GYMNOTIDÆ.

Eel-like, the back round, and without fins; pectorals; largely developed anal fin, extending either to the point of the tail, or leaving the extremity free; with or without teeth on the pre-maxillaries, mandible, and palatines; no teeth on the vomer; scapular arch attached to the head; from the fifth vertebra onwards distinct ribs encompass the belly, and in many species are perceptible through the skin; stomach cæcal; pancreatic cæca; ovisacs pouch-shaped, and their outlets different from those of the Eels; vent and the genital papilla behind it on the coracoid bone, or still farther forward towards the middle of the mandible.

The small fore-bladder under the second, third, and fourth vertebræ is pyriform or heart-shaped, and is double; the outer one being thick, white, and easily torn; the inner one transparent, filled with a gelatinous fluid, and swimming loose in the outer one. This bladder is attached to the acoustic bones of the skull, and is connected by a fine chord with the simple posterior or ordinary swim-bladder, which chord divides, and with its fellow is attached to the stomach. The anterior double bladder closely resembles that of the *Catastomi* (which is followed by two or three ordinary swim-bladders), belongs to the organ of hearing, and corresponds to the membranous labyrinth of the higher molluska.

Classification—Malacopteri.

Genus I. Gymnotus, Linn. *Skin entirely soft, and destitute of scales.* Only one species is known, which resembles *Carapus* in the conformation of the head, position of the nostrils, and dentition; but the *anal fin reaches the point of the tail.* Head oval, flatly depressed; mouth not opening quite as far as under the eyes, furnished with broad lips of equal length; fore nostril a small tube in a bell-shaped superficial depression above and towards the end of the lateral lip; hinder nostril distant about the diameter of the eye from the first one, behind and above it. Longitudinal and transverse rows of pores in cup-shaped depressions on the top of the head; also a row on the mandible; lateral line indicated by a row of distant pores.

About fifty pointed teeth on the upper jaw, and sixty on the under one; a second row behind the middle of the upper ones of about six teeth; along the symphysis of the mandible two short rows, each with two toothlets. Vomer, roof of the mouth, and tongue furnished with lateral, projecting, dentated membranous edgings. Vent before the gill-openings; behind it a small orifice and a small, slender papilla. Pectorals and anal fin enveloped in a thick skin which conceals the rays. One species.

Genus II. Carapus, Müll. and Trosch. (*Carapus*, Cuv. *partim.*) *Broad, depressed, flattish snout; a row of pointed teeth; scales.* No caudal fin. Fore nostril a short tube in a notch near the corner of the mouth; hinder one before the eye, open and distinct; eyes shining through the skin; five broad, flat branchiostegals; anal fin extending almost to the end of the tail; under lip longer than the upper one. Scales of the back and lateral line of equal size. Two species.

Genus III. Sternopygus, Müll. and Trosch. Card-like teeth in numerous rows; small mouth. Body and head compressed; head short; small jaws; occasionally traces of card-like palatine teeth. Tail slenderly prolonged, without a caudal fin. Scales of the lateral line mostly larger than the others.

This genus has the aspect of a *Fierasfer*. Four species.

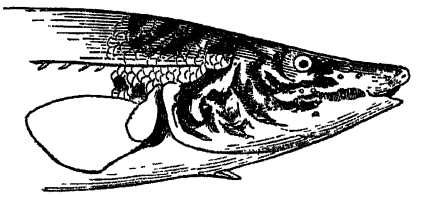


Fig. 68.
Rhamphichthys Artedi.

Genus IV. Rhamphichthys, Müll. and Trosch. A small mouth; no teeth; snout more or less tubularly elongated, and provided with small pores; nostrils not tubular. Head and body compressed, and with an exception scaly. Anal fin long, but leaving the end of the tail free.

The species divide themselves into two groups:—

1. Snout short; largely developed genital papilla. Anus behind the third part of the head; and anal fin commencing at the point of the pectoral. Two species.

2. Anus under or before the eye, and the anal commencing before the gill-opening. Seven species.

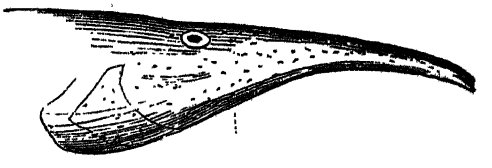


Fig. 69.
Sternarchus oxyrhinchus.

Genus V. Sternarchus, Schneid. Having a *small normally formed caudal fin.* A crowd of teeth on the pre-maxillaries, and two rows of recurved ones on the mandible; no tooth on the symphysis. Head and body laterally compressed, the former naked, the latter scaly. In the middle of the dorsal surface of the tail an elastic ray, which, in the living fish, lies in a furrow and is kept firmly there by the dermal mucus (this ray is homologous with the fleshy fin of the *Salmonidæ*); anus before or under the eye; eye shining through without a lid. Nostrils like small pores. Four branchiostegals in the gill membrane. Three species.

Classification—Malacopteri.

Sub-Order III.—MALACOPTEROUS ABDOMINALS.

CLUPEOIDS OR HERRING FAMILY.

The species of this family are so numerous, and many of them are so much alike, that much confusion prevailed respecting those described by the older authors and the many nominal ones recently introduced into our lists by modern ichthyologists who were not in circumstances that enabled them to profit by the examination of specimens preserved in rich museums. M. Valenciennes has thrown a flood of light into the darkness that previously existed; and it is on his labours that we almost solely rely in our notices of the families described in the *Histoire des Poissons*, subsequent to the death of his illustrious predecessor, Baron Cuvier. He has made use of the varieties of dentition, so great in this family, to characterize his groups; also of the position of the ventrals and of the length of the anal. The comparative length of the mandible has also been taken into consideration by him; in most it projects beyond the snout; a second group is characterized by the snout, owing to the elongation of the nasal, projecting beyond the premaxillaries; which, then, instead of crossing the upper edge of the orifice of the mouth transversely, descend on the sides. In some, the maxillary is prolonged far beyond the corner of the mouth. There are diversities also in the fins: in certain species the anal and caudal are united; and in some, a greater or smaller number of the rays of the pectoral are prolonged into slender-jointed filaments; others again have the anal and caudal united, while the form of the mouth varies. We can notice only a few of the species of this family.

Clupea harengus, Lin. (The Herring.) The investigation of the habits of this fish has not received that attention which its importance as an article of food to the inhabitants of this country demands; and there are several circumstances respecting its economy which still require farther examination. It is generally believed that the Herring inhabits, in winter, the depths of the Arctic Ocean, or other seas in northern latitudes, and that during the rest of the year it makes migrations southwards. In summer and autumn it appears on the north and west coasts of Europe in immense shoals, and about the same season it arrives at some parts of the coast of America and Asia. It has been supposed that those coming from the north divide into two detachments, one of which proceeds along Newfoundland to America, the other along Norway to the south of Europe; and that one subdivision of this second detachment goes up the Baltic, while the other proceeds along Great Britain, Ireland, Germany, and France, as far as the western coast of Spain.

This is the description of the annual migrations of the Herring given by Pennant; but some doubts have been entertained as to its accuracy, from the circumstances,—1*st*, That while in some places the Herrings do not make their appearance for years, in others they are taken in abundance all the year round; and, 2*d*, That they have never been observed on their return northwards. Other naturalists suppose that they come merely from the deep into shallow water during the spawning season, and that in so doing they do not make any very lengthened journeys. In truth, we are not as yet furnished with sufficient data to decide the question; but, in the meantime, we do not feel inclined entirely to reject the generally received opinion, that the Herrings migrate from north to south in summer and autumn.

In migrating, the Herrings proceed in vast troops,—so great, indeed, that the sea is sometimes covered with them for miles, and that they have even been known to be stranded or crushed in immense quantities in confined bays, or when thrown by the wind or by currents upon the shore. The shoals are said to be generally preceded sometimes for days, by one or two males. The largest generally go first, to act in some measure as guides; and as they proceed onwards, immense numbers fall an easy and unresisting prey to rapacious birds, or to their own not less rapacious kindred of the sea.

Classification—Malacopteri.

It is generally believed that the Herrings captured far north are larger, fatter, and of a better quality than those of the south; and for this reason, in the month of July, our fishermen go out to meet the shoals as far as Orkney and Shetland. The greatest number are taken on the coasts of Norway and Sweden, in the first of which countries it is said that about 400 millions are taken in one year, and sometimes 20 millions in a single fishery. The inhabitants in the neighbourhood of Gothenburg, in Sweden, take as many as 700 millions in a year. Herrings are fished also in great quantity in this country, Germany, France, Holland, the United States, and Kamtschatka.

The average size of the Herring is stated to be about ten inches. According to Dr Knox, the females are considerably larger than the males; the largest female he found on the east coast of Scotland measuring eleven inches, the largest male nine inches and a half. It does not appear to be precisely known at what age they attain their full size.

Considerable doubt has at all times prevailed regarding the food of the Herring. They were generally stated to live on small crabs and fishes, and on a minute crustaceous animal named by Fabricius *Astacus harengum*. But this was chiefly matter of supposition; for most practical fishermen described the stomach of the fish when in good state as quite empty, or, at most, as containing a little brownish mucus; and it has appeared difficult to reconcile the fact, that it is when the stomach appears thus empty that the fish is in its best condition, viz., fullest, with the finest flavour, and most capable of keeping,—with the notion, that when it appears upon our coasts it has quitted its natural feeding ground, and has been longer and longer in a state of starvation the more southern the latitude in which it is found. Dr Knox's interesting observation, that the principal food of the Salmon and Vendace consisted of minute crustaceous animals, led him to examine carefully with the microscope the brownish matter contained in the alleged empty stomachs of the Herring; and he then formed the opinion, that this matter consisted of the debris of a very minute entomostracous animal.

It is well known that the Herrings caught upon the east coast of Scotland are much inferior to those taken on the west coast, and more particularly to those of Loch Fine, and other lochs of Argyleshire. Dr Knox states that the Herrings taken near the Firth of Forth in July are foul, or are engaged in spawning, while those of the west coast, in the same season, have the organs of reproduction very slightly developed; and he conjectures that that species of crustaceous animal which forms their appropriate and most favourite food may exist abundantly in the bays on the west coast of Scotland, and either not at all, or not in sufficient quantities, along our eastern coasts. It appears to be chiefly after these fishes have been absent for some time from their proper feeding places that they eat marine worms and small fishes; and when so feeding, they lose much of their flavour, and run rapidly into putrefaction after being captured. The time of spawning seems to vary considerably, both in the same and in different districts; so that we may have spring, summer, and autumn herrings, as we know they have in some parts of the Baltic. During the spawning season they are seen to rub their bellies against the rocks or sand. As many as 68,606 eggs have been counted in one female. The young do not accompany the larger herrings in their migrations. M. Valenciennes, after reviewing many facts collected by different observers, comes to the conclusion that the Herrings are

Classification—Malacopteri.

not nice in their selection of a spawning place, depositing their eggs at the bottom of the sea, sometimes on sand, sometimes on naked rocks, occasionally in sub-marine meadows, in the eddies of currents, at the mouths of rivers, or in the sea far from the shore where the water is tranquil. They change their places of resort, occasionally wholly deserting their former haunts. For a full account of what is known of the economy and habits of the Herring and its fisheries, we must refer to the *Histoire des Poissons* (Cuv. and Valen.), vol. xx., and to the article on FISHERIES in this Encyclopædia. The Herring fishery of France, carried on by the inhabitants of Normandy, dates as far back as A.D. 1030, according to documents still preserved. That of England has been traced to a still higher date; it is named in the records of the Monastery of Evesham as a source of revenue in 709 A.D.; and in the annals of the Monastery of Barking, the tax levied upon it is called Herring-silver. In Iceland the Herring fishery seems to have been so important at an early age, that the word *sild* (Herring) enters into the composition of the names of many mountains in that island. *Harengula sprattus*, Valenc., is the Sprat, so abundant on the English coasts at certain seasons, and from its cheapness is an aliment that serves to vary the diet of the poorer classes. It is the *Sprættè-sild* of the Danes, many of whose sea-terms and names of fish and implements for fishing, have been preserved with slight alteration in the north of England and Scottish lowlands. A second species is named *Blanquette* by the French in the Mediterranean, and is so like the Sprat that most ichthyologists have confounded the two. *Rogenia alba*, Valenc., is the renowned "Whitebait" with which our ministry always regale themselves after winding up their parliamentary labours for the session. Mr Yarrell's able account of it exhausts its history, and need only be referred to here. *Alausa vulgaris*, L'Alose of the French, and the Shad of the English. Ausonius of Bordeaux, who flourished A.D. 380, in his poem on the Moselle, mentions the Shad as the food of the common people—

"Stridentesque focis opsonia plebis alausas."

Alausa pilchardus, the Pilchard so plentifully caught in its season on the Devonshire coast, and consumed by the inhabitants of that county in pies, in which the heads of the fish protrude through the crust, to denote the nature of the contents. It is the Sardinia of the Spanish peninsula and Mediterranean Sea, and the Ceilan of the French fishermen. Its fishery is important to the inhabitants of the south of England, Brittany, Portugal, and Gallicia. At St Yves in Cornwall, 250,000 have been caught in a single draught, and few who have visited Lisbon but must have admired the fleets of sharp-built latine-sailed boats, named "Bean-cods," issuing from the Tagus, to carry on a fishery so invaluable to a Roman Catholic population.

Engraulis encrasicholus, the Anchovy, is another celebrated member of this family, very plentiful in the Mediterranean, and found on the coasts of Greenland, Jutland, and the Baltic; it is occasionally caught in the Irish Channel, but is rare on the English side of the British Channel, though it has been taken, according to Mr Yarrell, on the Hampshire coast, and on Dagenham Breach below Blackwall. Formerly it was more abundant in the British seas, and several acts of parliament passed in the reign of William and Mary regulated its fisheries. It was also a century ago plentiful on the coasts of Brittany, though by no means so now.

Under the head of FISHERIES the statistics of the deep-sea fisheries of Great Britain are fully entered into, and their great importance as a branch of national industry shown in detail. There are, however, wide fields for the employment of British capital in the East, where the supplies are inexhaustible, and the demand in the China and other markets exceedingly great. *Coilia Playfairi* is represented by fig. 17. The *Alausa toli* (Cuv. and Val.) is the subject of a very extensive fishery on the coast of Sumatra, for the sake of its roes, which are salted and exported to China, the dried fishes themselves being sent into the interior of Sumatra. The fish is named "Trúbu" in the Malay tongue, is about 18 inches long, and between fourteen and fifteen millions are caught annually with very rude tackle.

Classification—Malacopteri.

Another of the Herring tribe, the *Engraulis Brownii*, is exceedingly numerous at all seasons in the Straits of Malacca, and at the mouths of the Ganges. From it a delicious condiment named "Red fish" is prepared by adding vinegar made of the juice of the Cocoa palm, ginger, black pepper, and powdered red-rice to the salted fish. *Dussumiera acuta* and *Clupeonia perforata*, also members of this family, are taken at Penang, and brought to table under the denomination of "Sardines." They are said to have a delicate flavour; but the *Meletta venenosa*, which occasionally visits those seas in shoals, is poisonous, and has produced death when eaten by mistake for the "Sardine." The poisonous fish has red eyes. These facts are from Dr Cantor, whose work on the Malayan fishes goes more into detail.

SUB-ORDER III.—ABDOMINALES.

FAMILY I.—HETEROPYGII.

Tellkampf characterized this family from the blind fish found in the Mammoth Cave of Kentucky, *Amblyopsis spelœus*. It is distinguished from the other *Physostomi abdominales* by the position of the vent on the throat before the ventrals, and small eyes covered with skin; it possesses no accessory gills, no adipose dorsal; a simple swim-bladder; a cæcal stomach; and pancreatic cæca. The very forward position of the anus occurs in other families, notably in *Gymnotidæ*, also in several of the *Tœnioïdæ*, and *Lophiidæ*. Dr Wyman, on examining the fish, could discover no ocular speck, but a pretty large optic nerve. Agassiz is inclined to consider the *Amblyopsis* as an aberrant form of the *Cyprinidæ*, but until he has investigated its embryology he reserves his decision.

GENUS I. AMBLYOPSIS. Characters those of the family.

GENUS II. CHOLOGASTER, Agassiz. Habit that of *Amblyopsis*, but it has eyes; it has likewise a guttural anus, but wants the ventrals wholly. There are two horn-like processes on the snout. One species, *C. cornutus*.

FAMILY II.—APHRODEIRIDÆ, Bon.

This family, founded on a single species, is placed by the Prince of Canino in the order of *Heteropygii*, comprising *Amblyopsis* also. Both agree in the guttural position of the anus, but M. Valenciennes places *Aphrodederus* among his Percoids, near *Pomotis*. The characters of the family are those of the genus.

GENUS I. APHRODEDERUS, Lesueur. Scaly *Acanthopteri*, with a single dorsal on the summit of the fusiform body; pectorals and subbrachial or abdominal ventrals; anus before the pectorals, under the gill-openings; branchiostegals six. No spine in the ventrals; a spinous point to the operculum, and crenatures on the suborbitar scale bones. Scales ctenoid. Stomach very small, siphonal, gut running forward from the anal fin in a canal among the muscles of the abdomen to the anus, which opens just behind the edge of the branchiostegal membrane. Air-bladder large, simple, with round ends. Milts communicating with the anal opening by a long canal which follows the intestine. One species. Lake Pontchartrain.

FAMILY III. CLUPEIDÆ, Valenc.

Scaly fishes, without an adipose fin. Body generally elongated and very much compressed; belly thin and trenchant, frequently denticulated by the edges or points of a series of dermal bones. Scales always present on the body, but easily detached. No spinous rays in the fins; ventral fins nearly in the middle of the body; dorsal fin always solitary; moderately long *pre-maxillary bones* conjoined with the *maxillaries* to form the *upper border of the mouth* (this character they possess in common with the *Salmonidæ*); *maxillary composed of three pieces* easily separated.

Gill-openings very large; rakers of the branchial arches long, and projecting towards the mouth; no accessory gills present. Ribs long, and with their epipleural spines very slender; the latter diverging from the parapophyses and neurapophyses of the vertebræ, as well as from the ribs; points of the ribs connected with the dermal osseous scales on the edge of the belly. Stomach cæcal, often fleshy; pyloric cæca numerous and long. Ova (roe) very numerous, and,

Classification—Malacopteri.

near spawning time, occupying much space in the belly, as do also the male organs (melt). The air-bladder is always large, and has a slender tube by which it communicates with the apex of the cæcal cone of the stomach, or in some species with the dorsal side of the stomach or œsophagus; sometimes the air-bladder divides into two long conical processes posteriorly, but this is rare; in all, its anterior end is simple and generally pointed, and does not pass before the centre of the first spinal vertebra, nor are there any ossicles intervening between its point and the acoustic capsule, as in the Carps; neither has the air-bladder of the *Clupeidæ* any communication with the interior of the skull.

ANALYTICAL TABLE OF THE *CLUPEIDÆ* (Dum.)

Mouth large.		
Anal separated from the caudal.		
Ventrals conspicuous	Encrasicholus or Engraulis	12.
Ventrals none, or scarcely visible	Odontognathus	14.
Anal coalescent with the caudal	Coilia	13.
Mouth of moderate size, or small.		
Teeth visible on the jaws.		
Teeth on all the oral bones	Rogenia	6.
Teeth on the *upper jaw and mandible only*	Clupea	1.
Teeth on the upper jaw, mandible, and pterygoids	Kowala	9.
Teeth on the tongue only	Meletta	10.
Teeth on the tongue and palatines	Spratella	8.
Teeth on the tongue and pterygoids	Clupeonia	7.
No teeth on any of the oral bones.		
Dorsal with all the rays connected	Alausa	11.
Dorsal with one isolated ray	Chatoessus	15.
No teeth on the vomer, nor jaws, but on the other bones	Sardinella	2.
No teeth on the vomer only.		
Anal short, far back	Harengula	3.
Anal long.		
Ventrals none	Pristigaster	5.
Ventrals present	Pellona	4.

Genus I. Clupea, Cuv. Small pre-maxillary teeth; crenatures on the maxillary so fine as to be discoverable rather by the touch than by the sight; fine teeth also on the symphysial portion of the mandible which projects farther forward than the upper jaw; a longitudinal band of larger teeth on the vomer; a similar one on the tongue; two or three very small deciduous teeth on the external edge of the palatines. Body elongated; back rounded; belly more or less compressed or trenchant according to the size the roe or melt has attained. Sixteen species.

Genus II. Sardinella, Valenc. Teeth on the palatines, entopterygoid, and tongue; none on the vomer, pre-maxillaries, maxillaries, or mandible. Specific characters derived from the forms of the gill-cover or other external part. Seven species.

Genus III. Harengula, Valenc. Teeth on the jaws, tongue, palatines, and entopterygoids; no vomerine teeth. Ten species.

Genus IV. Pellona, Valenc. Dentition of *Harengula*. Body very much compressed. Ventrals before the dorsal; anal long and low; edge of the belly strongly denticulated. Pectorals pointed, their first ray strong, though jointed, and long. Sixteen species.

Genus V. Pristigaster, Cuv. Apodal *Pellonæ*. Air-bladder various: large and forked behind in some species. Four species.

Genus VI. Rogenia, Valenc. Teeth on the vomer, palatines, entopterygoids, and tongue; teeth also on the jaws, but scarcely visible.

Genus VII. Clupeonia, Valenc. Teeth on the tongue and entopterygoids only; jaws, vomer, and palatines edentate. Five species.

Genus VIII. Spratella, Valenc. Teeth on the palatines and tongue only. Two species.

Genus IX. Kowala, Valenc. Teeth on the jaws and entopterygoids only; none on the tongue, vomer, or palatines. Form of *Spratella*. Two species.

Genus X. Meletta, Valenc. A rough band on the tongue; no other teeth. Ten species.

Genus XI. Alausa, Valenc. Teeth on the jaws deciduous and very small; no other teeth; a notch in the upper jaw. Air-bladder simple, pointed at both ends, and not extending before the third vertebra; air duct entering the conical point of the cæcal stomach. Twenty-two species.

In the preceding genera the mandible is longer than the upper jaw.

Genus XII. Engraulis, Valenc. Mouth large, snout projecting. Nasal bone advancing before the jaws, concealing the small pre-maxillaries; maxillaries slender, not prolonged behind the mouth; vomer, palatines, and entopterygoids narrow, sustaining teeth sometimes very small. Gill-openings large. The species may be divided into two groups, by the elongation of the upper ray of the pectoral, or by the absence of that character. Twenty-three species.

Classification—Malacopteri.

Genus XIII. Coilia, Gray. Maxillaries large, their posterior ends passing the gill-opening. Dorsal far forward; upper rays of the pectoral prolonged into slender filaments, and divided nearly to their base. Tail generally much compressed and tapering to a point, with a long low anal united to the caudal: there is an exception to this character in a species which has the tail abbreviated, and the caudal wide and rounded. In other respects the genus corresponds with *Engraulis*. Six species.

Genus XIV. Odontognathus, Lac. (*Gnathobolus*, Schn.) Body greatly compressed: belly trenchant and very strongly denticulated, from the throat to the anus. No ventrals; dorsal very small, far back on the tail; anal very long and low, extending to near the forked caudal; pectorals moderately long. Mouth small; mandible passing the upper jaw, which is truncated, with the small pre-maxillaries lying transversely; maxillaries long, wide in the middle, projecting backwards beyond the mandibular joint. Teeth on the jaws, palatines, entopterygoids, and tongue; none on the vomer. One species.

Genus XV. Chatoessus, Cuv. Mouth small, edentate; pre-maxillaries small, with a medial notch which receives the symphysial apex of the mandible and a fibrous lip, that runs backwards from it along the whole edge of the maxillary, the latter articulated to the nasal behind the pre-maxillaries; first branchial arch uniting above the pharynx with its fellow, and sending a curious pectinated branch forwards beneath the roof of the mouth. Body in general high, oval, and short; belly strongly denticulated. Pectorals and ventrals small; first ray of the dorsal frequently prolonged. Stomach muscular; pyloric cæca very numerous, united by cellular tissue into a glandular mass, which fills great part of the belly; ova not inclosed in a sac, but dropping into the general cavity of the abdomen. Twelve species.

Genus XVI. Amblogaster, Bleeker. Small pre-maxillaries; the maxillaries constituting most of the upper half of the mouth. Body elongated, compressed; belly rounded, without serratures. No teeth. Head naked above; eyes half covered by a membrane; cheeks venous; five branchiostegals. Indian Ocean.

SALMON FAMILY.

The progress of Ichthyology in the last half century has been rapid, as might be expected of a science which had been previously greatly neglected, but whose importance was at length acknowledged. The old generic groups of fishes were first characterized as families, and afterwards having, by the discovery of new forms diverging more or less from the characters of the typical species, and having, moreover, been found in many instances, by the more correct investigations into their structure that were instituted, to include heterogeneous assemblages, were broken up into several genera, families, or even into groups of a higher order. The genus *Salmo* of Artedi is an example of this. That ichthyologist included in this group all fish which have from twelve to nineteen branchiostegals, teeth on the jaws, and a dorsal standing over the ventrals, with an adipose fin on the tail. Linnæus modified this classification somewhat, and at length three great families have grown out of the single genus Salmo, one including all the Salmonoids, with the cheeks or the whole head covered with scaleless integument, being the group comprised in our table under the name of *Salmonidæ*. The *Characini*, a second family of fishes formerly associated with the Salmon, is characterized by the small number of its branchiostegals, a very small mouth, great variety of dentition, almost always in many rows, but rarely with any on the tongue, and with a divided air-bladder. The *Scopelidæ* is the third family of this stock, being distinguished from the others by the maxillaries not forming part of the orifice of the mouth. Some smaller detachments have also been made, as the *Erythrinidæ* and *Macrodons*.

Salmo, Cuv. The fishes which constitute this genus are of great importance, and are by far the most esteemed and valuable of all those which inhabit the fresh waters. The value of the fisheries, with the number of men engaged in them, is very great, and the expense of the mate-

Classification—Malacopteri.

rials which are employed in the capture of one or two species is immense. In Britain they are mostly consumed in the great towns, either in a recent or prepared condition. In the north of Europe and America numbers are salted or otherwise cured for exportation.

The male fish has the nose elongated and the under-jaw hooked during the breeding season. The silvery colours change to gray and red. The species inhabit the sea and fresh waters. Some migrate at the breeding season; all spawn in shallow streams, and both sexes assist in forming the spawning bed. They inhabit Europe, Asia, and America. At the commencement of the genus stands,—

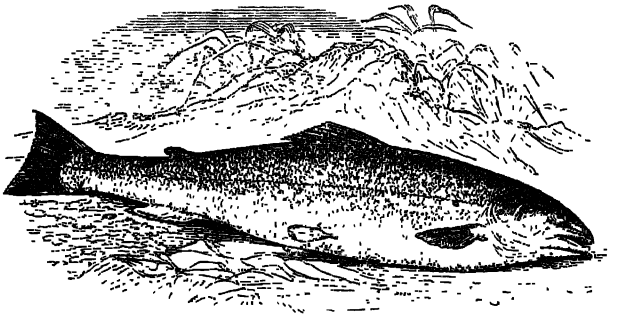


Fig. 70.
Salmo salar.

Salmo salar, or common Salmon, a species which likewise occupies the foremost place in the estimation of both sportsman and epicure. The Salmon is a fish of great elegance, combining a form fitted alike for strength and swiftness; and its depth and thickness, while in good condition, are so proportioned to its length as at once to convey the idea of a pleasing symmetry. The body above is of a rich bluish or greenish gray, changing below to silvery, sprinkled above the lateral line with rather large sub-cruciform black spots, a few of which at the shoulders generally extend below the line. The characters which distinguish it from its British congeners are the different form of the opercular bones, which show a rounded outline to the posterior edge of the gill-covers, the longest diameter of which to the nose would be in a line through the eye, while in all the other British migratory species the same line would pass much below the eye. The black inner surface of the pectoral fin is nearly a constant mark. The tail is forked in the young state, but fills up to a nearly square outline in the adult.

The common Salmon inhabits the seas around Great Britain, and extends to the north of Europe and to Asia. It generally delays entering the rivers in great numbers until the streams become somewhat swollen by rains, although in the larger rivers there may be said to be a limited daily run. When the flood has fairly mingled with, and to a certain extent has saturated the estuaries, the rush of fish is often very great, especially if there has been a continued tract of dry weather. In the latter case they collect at the mouths of rivers, and are seen and often taken in vast numbers; but they do not then attempt an ascent, deterred perhaps by the clearness of the stream, or by some instinctive feeling that the water would yet be deficient to carry them through. As the *fresh* approaches, however, an increased activity may be perceived; and, as far as we can judge, the change is probably indicated by the nostrils receiving a sense of the mixture of the waters, by means of the large ramification of nerves with which they are supplied; and to this same sense may perhaps be attributed the singular fact of the greater proportion of Salmon returning to the very streams in which they were spawned. The fish, on entering the river, rush forward as long as the flood continues, seldom resting in their course during the time that the water continues discoloured. From ten to twenty-five miles daily is the rate, as far as can be ascertained, at which they are supposed to travel.

Classification—Malacopteri.

In their more lengthened courses, where the rivers are deeper and the interruptions less frequent, the rate at which Salmon travel is probably more rapid. Our common kind (*Salmo salar*) makes its way by the Elbe into Bohemia, and through the Loire as far as the environs of Puy, in the ancient Velay. We also know that it works its way up the Rhine, and visits a portion of the rivers of Switzerland, although the irresistible torrent of the Falls of Schaffhausen prevents its ingress to any part of the basin of the great Lake of Constance. It is an entire mistake to state its occurrence in the Persian Gulf, and equally absurd to say that, unrepelled by the gloomy terrors of a subterranean journey, Salmon from the Gulf, adorned by the fanciful Persians with rings of gold and silver, find their way into the Caspian. The non-existence of the supposed communication, is of itself a pretty sufficient barrier, even did no other exist in the laws of nature, and were light and atmospheric air dispensable. M. Valenciennes states that it belongs not only to France, England, and Germany, but to Schleswig-Holstein, Mecklenburg, Scandinavia, Iceland, and Greenland. It exists also in Labrador and Canada, and down the American coast to the Connecticut River, in latitude 41½°; and either it, or a species so nearly allied to it as not to be distinguishable except by close comparison, abounds in the Arctic Seas washing the northern shores of the American continent. It does not frequent the rivers falling into the Mediterranean, though Dr Davy informs us, on the authority of an intelligent observer, the clerk of the market at Malta, that a stray Salmon was once caught at that island, and brought to the market for sale. During nine months residence at Constantinople Dr Davy paid frequent, almost daily visits to the well-supplied fish market of that city, but never saw either Salmon or Trouts among the great variety of other fish that were there for sale.

In our lower and clearer waters, however, they travel at a much slower rate than that above alluded to—resting for some time in the pools by the way, and now and then taking a regular *lie* in some chosen spot, which they will return to daily as long as the river continues unfitted for their progress. Upon the least accession, however, to the water, either directly or from some swollen tributary, they are again upon the alert; and it is often felt by them several hours before the quickest or most experienced human eye can perceive a rise upon the river. Having ascended to a considerable height, they remain more stationary, and proceed more slowly with the subsequent floods, till the spawn increases in size. This increase, if not influenced by, is at least so connected with, the commencement of the colder weather, as then to proceed at a more rapid rate. As the spawn advances, the symmetry of the form is disfigured; the female becomes disproportionately large, the colours lose the brightness of their silvery tints, and become dull and gray. The male becomes thin upon the back, the nose elongates, and the under jaw turns up in a large and strong hook, which enters a hollow in the nose before the pre-maxillary bones. The colours and markings become brown and red, those on the head and gill-covers being particularly brilliant, and disposed in lines almost like the marking of a *Sparus*. In this full breeding dress the male and female seek some ford or shallow stream, and commence to excavate a trench or furrow (chiefly by the exertions of the female). In this the spawn is deposited, and impregnated at the same time, and finally covered with gravel by the exertions of the fish. The furrow is generally from six to nine inches in depth; and when the spawn has appeared to be covered beyond that depth, this has occurred from some other circumstances—such as the stream or floods having carried downward additional masses of gravel, &c. After this great effort has been accomplished,

Classification—Malacopteri.

both sexes are reduced to a state of remarkable emaciation. The elongated nose, and hooked jaw, and brilliant colours, are almost immediately lost; the old scales are cast, and the fish retire to some pool to regain their strength and complete their new clothing. They finally redescend to the sea by easy stages, where their former condition and silvery lustre are regained, their strength invigorated, and all their functions so repaired as to enable them ere long to renew their visit to the flowing streams, again to multiply their race.

The ova continue covered by the gravel during the winter, and begin to vivify from about the end of March to the commencement of April. The fry remove from under the gravel when nearly an inch in length, with the ovum still attached; and at this period, if the spawning bed or furrow be turned up, it will appear in motion. We refer to the article FISHERIES for the details of Mr Shaw's observations, which prove that the young fish or *Parr* may remain a full year in the fresh water. On the eve of descending to the sea, the Parr assumes a more brilliant dress and becomes a *Smolt*. At this time it is from four to six inches in length, of a greenish gray above, silvery below, the scales extremely delicate and very deciduous. From the time the Smolts reach the sea, for two months or ten weeks, we lose sight of them, and can only infer their growth from the fact, that after the lapse of that period we find them again ascending the rivers with a weight of from two and a half to four pounds. They are then known under the name of *Gilse* or *Grilse;* and their size, as they ascend from the sea, increases with the advance of the season. The Grilse which thus ascend spawn during the ensuing winter, and are then entitled to the name of *Salmon*. Descending in a weak state (as before mentioned), they return again in the summer of the following year, as fish of from ten to fifteen pounds weight, according to special circumstances. A third year would still increase their weight, as would several ensuing seasons, till the attainment of an enormous size. Pennant, for example, mentions a Salmon which weighed seventy-four pounds; and although we now regard with something of wonder a fish which weighs even the half of that amount, yet there is no doubt that not many years ago Salmon of forty pounds were much more frequent than in these degenerate days. The absence of Salmon of the largest class from many of the Scottish rivers, where they formerly abounded, is in fact owing to the injudicious perfection of our fisheries, which occasions the constant capture of the species in the state of Grilse, or other early condition; and the chances are by consequence greatly against any individual escaping the various dangers by which it is environed, for such a succession of years as is likely to admit of its attaining to its full dimensions. The destruction by poachers, in the higher parts of the rivers, of the large enfeebled *Kelts*, or fish which have completed their spawning operations, is also extremely prejudicial; for these individuals (almost utterly useless as food at the time alluded to) would, if allowed to descend to the salubrious sea, ere long revisit their native streams, greatly increased in size, and full of health and vigour. A Salmon above fifty pounds weight was taken, in 1835, at the mouth of the Leven in Dumbartonshire. The general capture that season was very great in Scotland. Nearly 800 were taken at one haul in a bay of the island of Islay; and our calculation, from accurate data, is, that for some time, about a *hundred thousand Salmon* (including Grilse) were then shipped in Scotland *weekly* from our eastern ports alone. A friend of our own lately saw a Salmon of sixty-one pounds weight on a fishmonger's stall in London; and as these sheets are before us, we read in the *Times* of July 15, 1856, that a Salmon was caught at Chanonry Point, Moray Firth, Fortrose, on the 10th, which weighed sixty-two pounds. It was sent to London, and purchased by Mr Barton, fishmonger, of Bishopgate Street. Similar causes have diminished the Salmon in the northern parts of the United States of America. Hudson, in 1609, when sailing up the river that bears his name, "saw great store of Salmons." Now a solitary Salmon straying thither is a rarity.

Dr Davy has for some years been in the habit of recording his observations on the *Salmonidæ*, and has made, with his usual accuracy, a series of important experiments likely to throw much light on the distribution of species. From these, he concluded "that the ova of the Salmon, in an advanced stage, can be exposed to the open air, if dry, but a short time, at ordinary temperatures, without loss of vitality; but for a considerable time, if the temperature be low and if the air be moist; the limit in the former case not having exceeded an hour, whilst in the latter it has exceeded many hours. The vitality of the ova was as well preserved in air saturated with moisture, as it would have been had they been kept in water. It was also preserved even when the ova were included in ice, but if they were exposed to a temperature many degrees below the freezing point, probably effecting their congelation, they were deprived of their vitality. Both the ova and young fish were capable of bearing a temperature of about 80° or 82° in water for a moderate time with impunity, but not without a loss of life at a higher temperature than 84° or 85°. A degree of saltness of water nearly equal to that of sea-water proved speedily fatal to the ovum of the Salmon and to the young fish; the same effect was produced on the young fish by brackish water of specific gravity 1016, but in a longer time; and when the solution is so diluted as to be reduced to the specific gravity of 1007, the advanced ovum may be hatched in it, and the life of the young fish may be sustained in it for many days but with diminishing power."[1]

From Dr Davy's excellent paper, the fact of temperature having a still higher influence on the distribution of species of fish than on the higher animals is apparent. An anadromous fish must have its range restricted not only by the temperature and suitableness in other respects of the affluents of a river in which it deposits its roe, but also by the nearness to the equator of the mouth of that river. We may, therefore, find Salmon in the streams flowing down the northern side of a great watershed while they do not exist on the southern side, though the feeders of both river systems interlock at their sources. This Dr Hooker found to be the case with the Trouts, which are confined to the northern face of the Himalaya range. Dr M'Clelland has described a species, *S. orientalis*, which inhabits the affluents of the Oxus. The parallel of 45° N. Lat. may be roughly considered as the southern boundary of the common Salmon in Europe, overlooking the feeders of the Atlantic rivers which rise to the southward of that latitude; and the parallel of 41° may be taken as the limit in America, adverting to the fact that the mean annual heat in a given parallel of the latter continent in the temperate zone, is from 8° to 15° of Fahrenheit lower than the parallel in Europe. The mean temperature of the year on these parallels lies between 45° and 52° Fahrenheit, and the mean heat of the hottest month between 60° and 68° Fahrenheit. The heat of the waters of the rivers frequented by the Salmon will, of course, vary much less than that of the atmosphere, and fall far short of the hottest months.

Ausonius, in his poem on the Moselle, which we have already had occasion to quote, says of the Salmon—

"Nec te puniceo rutilantem viscere Salmo transierim,"

contrasting it with the characters of two other members of

[1] *Phil. Trans.*, March 1855.

Classification—Malacopteri.

the family, the *Fario* and *Salar*, by equally descriptive lines which will be quoted when these fish are noticed.

Fario argenteus of Valenciennes, "Truite de mer ou Truite argentée," is stated by him to be identical with the *Salmone Cumberland* of Lacépède, and with the Salmon-Trout of Yarrell, the *S. trutta* of British ichthyologists. It is also according to the last-named author, the "White Trout" of Devonshire, Wales, and Ireland, but is more abundant in the rivers of Scotland, where it is named the Sea Trout. In the Nith it is taken in quantities, associated with young of other species, and sold, together with them, under the name of "Hirling;" but on attaining the larger size of several pounds weight, it is distinguished as the Sea Trout. Its head and dentition are correctly figured in plate 92, fig. 1, A and B of the *Fauna Boreali Americana*. The Hirling has been named *Salmo albus*, and locally, "Whitling." In its largest state, or as known under the specific title of *S. trutta*, it enters the rivers from two and a half to six pounds weight in the end of May. It is of an elegant form, and possesses all the symmetry of the Salmon. The head is small, the back remarkably broad when viewed from above; the tail slightly forked, and wide at the extremity of the web; the colour above greenish, inclining to bluish-gray, lower parts of the clearest silver; body above the line spotted, as in *S. eriox*, with large, deep-black spots, but generally much fewer in number. The flesh is pink, richly flavoured, and much esteemed for the table. It ranks next to that of the Salmon, and by many is esteemed more delicate than even that prized species. The *S. albus*, or smaller and younger state in which it is found, is very nearly of the same proportion, form, and colours. They approach the mouths of the rivers in the end of July and commencement of August, in immense profusion, and immediately enter the fresh waters, where an angler may take almost any quantity without the exercise of great skill. In the North they form a perquisite to the taxmen or kayners of the Salmon fisheries—above a thousand being sometimes taken at a sweep of the net. In the Solway they are taken in equal abundance in houses of the stake-net, covered for the purpose with net of a small mesh, and are then carried to the various country markets, and during the height of the run, to the villages, in cart-loads, for sale. The flesh of this smaller fish (whether species or variety, as the case may be) is also pink, and delicately flavoured. Its food is likewise the same as that of the larger kind; in the sea small Crustacea (*Talitrus locusta* being a favourite and common food); in fresh water, aquatic insects, worms, minnows, or other small fish. They appear also to spawn rather earlier than the Salmon, and after the same manner. The colours of both sorts during the breeding season are deep-grayish black, slightly tinted with brown in the males; and at this time they offer a most marked contrast (being black and lean) to the symmetrical form and brilliant silvery tints of their perfect condition. It is of this fish that Ausonius, in his poem on the Moselle, already quoted, says,—

> Teque inter species geminas, neutrumque, et utrumque,
> Qui necdum Salmo, nec jam Salar, ambiguusque
> Amborum medio *Fario* intercepte sub œvo?

thus well expressing the doubts still entertained after a lapse of fifteen hundred years.

Salar griseus aut cinereus, Willughby and Ray. We have adopted these names as not subject to the same misapprehension with *eriox*, which our modern British ichthyologists have borrowed from Linnæus, but M. Valenciennes, after much investigation into the synonyms of the *Salmonidæ*, says that it is altogether impossible to discover at this day the species which the Swedish naturalist had in view when he characterized *eriox*; and M. Valenciennes has not recognised the *S. griseus* in the French rivers. The English fish is named the Bull Trout, the Gray Trout, the Whitling, and the Round-tail, according to the district in which it is taken. In Wales it is called the Sewin; and Donovan has given it the specific appellation of *Cambriscus*, but it is often confounded in the markets, and even by fishermen, with the *Fario argenteus*. The same thing occurs in Dumfriesshire, the young of the two species on their first return from the sea being sold under the name of "Hirling." They come up the river Nith from the Solway Firth with the tide, and are very plentiful for a short time. The best flavoured Hirlings of the two are the yearlings of the *Fario argenteus*; but the flesh of the *Salar griseus* is also red on coming from the sea, and seems to be more juicy and rich than that of older Bull Trouts. The *Salar griseus* reaches a weight of twenty-five pounds. It is thicker in proportion to its length than the Salmon; the fins are much more muscular; the tail particularly so, and perfectly square at the end in all the stages of growth, while the distance between the two extremes of the web is smaller proportionally than in any of the other species. The head is larger in proportion than that of the Salmon of a similar weight, and the opercular covering is more lengthened. The toothing is very strong. The general colours are—above, greenish gray; the lower parts silvery white; the body above the lateral line being thickly covered with large cruciform black spots. In the breeding dress they assume a much blacker tint than the Salmon, and want much of the red markings. All the under parts, jaws, and cheeks, become blotched with deep blackish gray. The flesh is of a yellowish tint, and is coarse, except in the young state; it has the least flavour, and is consequently less esteemed in the market than any of the other species. The hook of the under jaw of the male does not become so elongated as in the Salmon. The old fish commence to enter the rivers about the end of July, and appear to deposit their spawn and return to the sea about a month earlier than the Salmon. The young fish, of from two to three pounds weight, and in this state known as *Whitlings*, enter the rivers about the beginning of June. In all its states it is a very powerful fish, and feeds voraciously and indiscriminately. When hooked it springs repeatedly from the water, and runs (to use an angler's expression) with extraordinary vigour to free itself. The River Tweed and its tributaries, and the Nith, the Annan, and Esk, which fall into the Solway, are the principal Scottish localities for this fish.

Salmo hamatus, Cuv., is described at length in the *Histoire des Poissons*, and reasons assigned for dissenting from the opinion of Agassiz who holds that it is the male of *Salmo salar*. *Salmo hucho* is the Salmon of the Danube, where it attains the weight of 30lbs, and it is reported, even of 60lbs. Gesner says that its flesh is white, and less agreeable than that of the common Salmon; while Cornide says that it has a good flavour, but is a little dry. The *hucho* spawns in June, in hollows excavated in the gravelly bottoms; the male and female working together and hiding themselves in these hollows from the nets of the fishermen. Mr Reissinger has verified these observations in Hungary. In Galicia this fish is named "Reo." It is a mistake to suppose that it is an inhabitant of the British waters. *S. umbla*, a fourth species, is common in the eastern parts of France, in Switzerland, and the Tyrol. It is the *L'Ombre chevalier* of the French, and M. Valenciennes considers it to be identical with the Charr of England, the *S. carpio* of the *Fauna Danica*, and the "Kebleriksoak" of the Greenlanders and of Otho Fabricius; and he quotes, with commendation, Mr Yarrell's figure of the Northern Charr, as enabling him to recognize the species. M. Valenciennes rejects the Linnean name of *alpinus*, applied by most English ichthyologists to this species, as he says that referred to a different species. He retains, however, the name of *S. salvelinus* for the other English Charr, though that also was differently used by Linnæus; but it is the fish

Classification—Malacopteri.

so named and figured by Bloch, as he has ascertained by an examination of specimens from the same locality where Bloch procured his.

Salmo umbla is abundant in the English lakes, and in the greater number of those in the north of Scotland, when of any considerable extent; but more seldom seen there, from the absence of the practice of *netting*, and the general unwillingness of Charr to take a fly or bait. This fish is of great repute in the Lake of Geneva, and is also found in many of the alpine lakes of northern Europe. The common Charr reaches a considerable size, being sometimes taken in Britain above 2 lbs. in weight, although the more usual weight is under three quarters of a pound. When in full condition, it is a fish of very great beauty, above of a grayish green, shading into the most delicate white on the lower parts, and tinted with a blush which is comparable to that seen on the breasts of some of the gull tribe when newly shot in spring. The body is sprinkled over with pale spots of a considerable size. In this state they remain in the deeper parts of the lakes, and are not frequently taken, although we doubt not they might be so were the practice adopted of hanging a herring-net in the deep water, instead of trying only the *winter* practice of hauling in shore. We ourselves caught them by the former method, in their prime *silvery* state, in Sutherland, during the month of June. On the approach of the breeding time, they seek the mouths of the small tributaries, and are taken in vast numbers at the very period when their preservation ought to be most strictly attended to, and when, in truth, they begin to fall off in their condition. At this season the colour of the upper parts is darkened, the fins are very rich, and the sides and belly become of a beautiful and brilliant red, the whole spotted with small marks of a paler tint.

S. salvelinus occurs in Wales; and we have already mentioned (in the article ANGLING of this work) that both kinds occur in Windermere, to wit, the Charr or Case Charr (*Salmo umbla*), and the Torgoch or Red Charr (*Salmo salvelinus*). These are usually thus distinguished—the former, by having the first rays of the ventral and anal fins white; the latter, by having those parts plain, that is, of the same colour as the other rays. A remarkable distinction is also observable in their natural habits,—the Case Charr ascending rivers, and spawning about Michaelmas; the Red Charr depositing its ova along the shores of the lake, and not till the end of December, or the beginning of the year.

The chief feeder, or head stream of Windermere, is composed of two branches, the Brathay and the Rothay, which meet a short way above the lake, into which they speedily pour their united waters. The Brathay is the left-hand branch (as we ascend from the lake), and draws its sources from the mountain vales of Langdale, reaching Windermere without any resting-place; while the Rothay has previously formed and flowed from two consecutive lakes, Grassmere and Rydal. The Charr, in ascending from Windermere to spawn, invariably turn to the left, and ascend the Brathay (though to no great distance), and as invariably avoid the lake-descended waters of the Rothay. They also spawn lower down the lake of Windermere, at the mouth (or a short way upwards) of the stream called Troutbeck, which is also derived from the flow of mountain tributaries, without any lesser or intermediate lake.

Although the art of angling is not immediately connected with the science of Ichthyology; it is, at the same time, evident that the successful practice of that art necessarily illustrates the *food* of fishes, and therefore makes us acquainted with an important portion of their natural history. For this reason we insert the following memoranda, transmitted to us by Mr John Wilson, jun.:—"The season for fishing Charr (with rod and line) in Windermere and Coniston commences about the end of May, and, I should say, is over by the first or second week in July. Trolling with a smallish minnow is by far the most successful mode of angling for this fish. It may, however, be taken with the artificial fly, the green and gray drake being the favourites. I killed three, one day in May last, with a small red *professor*. A Bowness fisherman, on the same day, trolling without intermission from six in the morning till six in the evening, killed *six and twenty*, being the greatest number that has been taken in Windermere, in a single day, by one person, for many years. In Coniston, where this fish is more abundant, I believe it is by no means uncommon to kill three or four dozen in a day. With regard to the size of Charr in Windermere, I should say they average three to the pound. I never saw one that was a pound. Billy Balmer told me that he once saw one that was a pound and a quarter, and that it was the largest ever taken in Windermere." In relation to the same subject, in a different locality, we may also add the following extract from another hand:—"A small red Charr is found in Loch Achilty, Ross-shire, on the property of Sir George Mackenzie. It takes the fly greedily in warm still weather, and, what is singular, during all the summer and autumnal months. I have captured eighteen in a forenoon in July—raising many more. My flies were of various sorts, from a midge to one as large as a sea-trout fly. The water of Loch Achilty is singularly deep and transparent; the soil is rich and loamy, and contains large quantities of imbedded wood—black oak especially. It is supplied by numbers of minute streams, but has no visible outlet, being supposed to discharge itself subterraneously. The Charr found in it average eight or nine inches in length; we, however, caught one much larger. They rise with less velocity than the Trout, and on missing the fly, unless injured, will return to the hook. In Strathglass there is a Loch Bruiach, where Charr are caught of a much larger size, but chiefly with the net: except in the month of October, when, as our informant, the Rev. Mr Chisholm, told us, they may be taken in the shallows with the rod, but at no other season."

On dissecting the Charr which we killed last summer in Sutherland, with a view to ascertain their food, we found the stomach usually empty, but the lower part of the intestine filled with green vegetable residuum. This we found to be the remains of the *cases* of aquatic larvæ (*Phryganidæ*), a few of which we discovered in a half-digested state in the upper portion of the intestinal canal.

The true *S. alpinus* of Linnæus is, according to M. Valenciennes, a Salmon which corresponds perfectly with the figure of the *Roëding* by Ascanius, and the only species that agrees with the description given in the *Fauna Succica*. It inhabits the Norwegian and Swedish waters, and also the rivers of Siberia which fall into Lake Baikal. For the other species of Salmon we must refer to the pages of the *Histoire des Poissons*.

Professor Nilsson of Lund has investigated the Scandinavian Salmon, and compared them with the original specimens of Linnæus, still in the museum at Lund.

I. TRUTTÆ, "Lachs" Suecis.

(*a.*) Teeth in the front only of the vomer.

1. *Salmo salar*, L.; "Blanklachs" Suecis. (*Fauna Bor. Amer., pl. 91, fig. 1.* Salmon from the River Urr in Galloway.)

2. *Salmo eriox*, L.; "Graulachs" Suecis. (*Fauna Bor. Amer., pl. 91, fig. 2.* Head of a Trout from Glamorganshire, in Mr Yarrell's possession, said to be the Sewin.)

(*b.*) Teeth in one row down the mesial line of the vomer.

3. *Salmo trutta*, of which the following are varieties:—*S. ocla*, Nilss; *S. truttula*, Nilss.; *S. fario*, L.; *S. punctatus*, Nilss.

Classification—Malacopteri.

II. SALVELINI, "Rothfohren" Suecis; Charr. Anglis.

4. *Salmo salvelinus*, L.; of which *S. pallidus*, Nilss., *S. alpinus*, L., are varieties.

5. *Salmo carbonarius*, Str., of which *S. ventricosus* is a variety. (*Arch. für Naturg. von Trosch*, 1849, 310.)

Fario Lemanus, or the Salmon-Trout of the Lake of Geneva, is another fine species of this genus, fully described by M. Valenciennes, and beautifully figured by M. Agassiz.

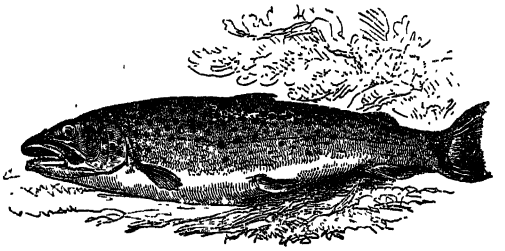


Fig. 71.
Fario Lemanus.

Salar Ausonii. Under this new appellation, M. Valenciennes, treats of the well-known *Salmo fario* of authors, the river Trout of England, and the burn Trout of Scotland. Having adopted the word *fario* for the appellation of a generic division of the family, he has taken a specific name from the author who has so briefly, yet so well, characterized the three members of the family that are the most remarkable for the frequency of their occurrence in the rivers of Europe. The propriety, however, of setting aside a specific name so long established as *fario*, and so little mistaken, may be questioned.

"Purpureisque *Salar* stellatus tergore guttis."

This line which, with others, from the same author, we found in the *Histoire des Poissons*, and have quoted in preceding pages, gives a neat description of the Trout. One of our own poets says:—

"The springing *trout* in speckled pride,
The *salmon*, monarch of the tide,
The ruthless pike intent on war,
The silver eel and mottled *parr*."

thus singling out three of the salmon tribe that frequent the Leven, flowing over its smooth, round-pebbly bed.

This lovely Trout is most extensively distributed over the whole of Northern Europe, being found in every burn and tarn, in every lake and river. It may be also said to be one of the most pleasing in its appearance; and, when newly taken in "golden glory" from some translucent stream, is exquisitely beautiful. The variation of the tints of the ground colour is infinite; yellow, however, is the most predominant, varying to the most brilliant orange; while at other times the ground colour of the body runs from a dark-greenish black to violet, in most instances numerously spotted with black and red. Sometimes, however, the black is alone present in the form of large round spots, placed in a pale circle, but in all cases beautifully relieved, and breaking up the uniformity of the other colours. In a few instances the spots have been observed to be wanting altogether. One cause of the variation in the Trout, is the difference of food; and, according to every information we possess, those which feed on fresh-water shells and *Gammari* (screws, or fresh-water shrimps, as they are sometimes called), are of the most brilliant tint, and also of the finest flavour, with a decided pinkness in their flesh. Those feeding on the ordinary water insects are next in brilliancy and flavour, while such as live chiefly upon aquatic vegetables are dull in colour, and of soft consistence. This is further confirmed by the Trout in *stews* being always finished, or *fed off* as it is called, on the foresaid *Gammari*, collected often from a distance. It is only in this way also that we can account for the variation in the appearance and flavour of Trout found in two adjoining bays of the same lake. The individuals, in fact, do not appear to stray to any distance, but seem to be satisfied with whatever food is found within a limited district, and which of course will be in many instances of a peculiar and local kind. It is also true, that the colours of Trout accommodate themselves to the tint of the water, and to the prevailing *tone* of the bottom, whether of rock or gravel, or of softer substance; and so constantly is this the case, that an experienced and observant angler has little difficulty in accurately predicating the general aspect of the fish of any lake or river. The presence of moss, so frequent in alpine districts, has invariably the effect of deepening the tints, particularly the shades of green and yellow.

In form this fish, when in perfect condition, may be said to be nearly symmetrical; the head only being sometimes rather large in proportion to the body, when considered in relation to what we regard as the *beau ideal*. The fins are of moderate strength, those of the body assuming a variation of form, from a rounded to a lengthened extremity. The tail is almost always forked; the fins are always coloured, that is, never of the transparent whiteness observable in the migratory species, and their tints are generally of a paler shade than those of the corresponding parts of the body. The anal fin is often bordered on its lower surface with white. The scaling is proportionally less than in the migratory kinds. The toothing is in general strong, and very prominent on both the tongue and vomer.

The average growth of the common Trout, taking the species generally, may be stated at about a pound, and certainly not more than a pound and a half. In almost all rivers, fish weighing beyond this may certainly be found; but they are comparatively uncommon. Individuals from two to six pounds weight are occasionally taken, even in what may be termed a "wild state." In ponds or stews, again, they reach a much greater size, but cannot be said to be in the natural condition of uninclosed fish. The Thames Trout seem to reach most frequently the largest size, being short compared to their length, but of great thickness and well flavoured. Two were lately taken, the one of eleven, the other of fifteen pounds weight. The lakes in the north of England produce Trout of very fine quality, and which are often passed off for Charr. Loch Leven, too (of which the barren isle and now dismantled castle are famous in history as the prison-place of the beautiful Queen Mary), has long been celebrated for its breed of Trout. These, however, have fallen off of late considerably in their general flavour and condition, owing, it is said, to the partial drainage of the loch having destroyed their best feeding ground, by exposing the beds of fresh-water shells, which formed the greater portion of their food. Farther north (as in Sutherlandshire) the immense multitude of lochs produce a corresponding abundance and variety of Trout. Of these, however, only a few are of superior quality; but these few may assuredly vie with the Trout of any country in the world. Another large species, occurring in the British waters, and not yet distinctly known elsewhere, is the—

Salar ferox, Jardine. This species reaches a weight of twenty-eight pounds, and is of very great power compared with its size. The characters which distinguish this fish from *S. Ausonii* are the great size which it attains in a natural state, the large proportional size of the head, the square extremity of the tail in all the stages of its growth, the relative position of the fins, and the number of rays in the dorsal, which vary from 2–11 to 4–11. The external skin or covering of the scales is also extremely tough; and there is a difference in the form of the scales of the lateral line. In colour the upper parts are generally of a deep purplish brown, shading into purplish gray, and finally, on the lower parts, to greenish or grayish yellow, more or

Classification—Malacopteri.

less tinted with orange. The spotting is large and not numerous, and consists of black spots placed in a pale circle, and of large pink spots with a similar light area. These extend over the gill-covers, upper fins, and often over the tail itself. A variety occurs in Loch Loyal, in Sutherland; above, purplish brown; beneath, blackish gray; the whole body spotted over with dark sepia coloured spots, of a smaller size on the lower portions. *Salmo ferox* appears to be entirely confined to the lakes, seldom ascending or descending rivers, or wandering in and out of them, and never migrating to the sea. When spawning, it ascends for a short way up the rivers or streams which run into the lakes, but never, as far as yet known, descends those which run out of them. It inhabits, among the English lakes, Ulswater; but does not there reach a size above ten or eleven pounds. In Ireland, as far as we can yet learn (specimens having not yet reached us on this side of the water), it is found in Loch Neagh and some other large lakes; and in Scotland we have taken it in Loch Awe, Loch Laggan, the upper end of Loch Shin, and Lochs Loyal and Assynt. It is a fish of remarkable ferocity, and as great an enemy to its smaller companions as the Pike. It may be taken by night lines, or by strong trolling tackle, baited with a small Trout, and will return a second and third time to the bait, even after it has been dragged for forty or fifty yards.

The *Salmonidæ*, though they take so important a place among the fresh-water fishes of Europe, are still more abundant in the northern Siberian rivers, and in the great lakes and rivers of North America. On the Pacific coast, indeed, of British North America some populous tribes of natives subsist chiefly throughout the year on the Salmon and Trout, which they take at the beginning of the spawning season, and preserve by drying. Descriptions of some of the species are given in the *Fauna Boreali Americana*, and the *Fauna Rossica* of Pallas contains accounts of the numerous interesting Asiatic *Salmonidæ*. The common Salmon, we have said above, frequents the Atlantic and Arctic coasts of British North America; but there is a Trout in the great lakes and interior rivers which equals the Salmon in size, and is at least equal to it in flavour and excellence as an article of diet. This is the *Salar namaycush* (Pennant), which is very commonly taken of a size varying from twenty to forty pounds, and is reported to grow to sixty and upwards, though fish of that weight are as rare as a Salmon equally heavy. The *Namaycush* is taken in considerable numbers for the American markets at the fisheries established on Lakes Huron and Superior for the capture of another member of the family of still greater excellence, the *Coregonus sapidus* of Agassiz, or the *albus* of the *Fauna Boreali Americana*. This *Coregonus*, the well known "White Fish" of the fur traders, is found in every lake and river from the United States northwards, and it descends even to the mouths of the rivers that fall into the Arctic Sea. In flavour, and all the qualities that a fish can possess as an article of food, it surpasses, we believe, every other, whether fresh-water or marine; and Europeans previously accustomed to a sufficient variety of diet, have lived almost solely upon it for a year or more without tiring of it. To the native population it is of vital importance, and it is only in the Buffalo prairies that they can subsist without its aid; while to many tribes it forms the chief food. Within a few years fisheries, employing a large fleet of ships, chiefly belonging to the United Sates, have been established for the capture of this fish on Lakes Huron and Superior. Several other species of *Coregonus*, known locally by the name of "Herring Salmons," exist in the American waters, but they are much inferior in quality, and resemble the European species more nearly as articles of diet. Even they, however, are delicate food, and would be esteemed were they not so much surpassed by the "White Fish." It may be remarked here that M. Agassiz, who is now in a position to investigate the ichthyology of America thoroughly, has already perceived that every lake, basin, and river system in that country possesses peculiar species of fish, though some species are common to several watersheds. He found this to be the case with *Lepidosteus* and *Coregonus;* and if his observations prove the fact in that continent, we may expect to perceive that the same law exists elsewhere, though the European lake and river systems, being comparatively very small, it may not be so apparent with us. M. Valenciennes describes many European *Coregoni*. Of the British species, he says that the *Coregonus pollan* of Thomson (Yarrell, *Supp.* 24) is very similar to his *C. sikus*, which inhabits Norway, in the vicinity of the North Cape, but that its head is smaller and its jaws more equal. The *Pollan* inhabits Loch Neagh, and Mr Thomson says that 17,000 were taken there at either three or four draughts of the net in September 1834. It is a fish that is brought in quantities to Belfast market during its season. Of the Powan (Yarrell), the *C. Cepedei* of Parnell, he says that he has found the original description of Noël de la Mariniere, on which Lacépède founded his *C. clupeoides*,, in which the fish is called also "Span" or "Pollock." Noël had gone to Loch Lomond to see what were said to be sea Herrings naturalized in the fresh-water lake, and thus the species was introduced into our systems. Pallas had already used the specific name of *Clupeoides* for another *Coregonus*, and the name given by Dr Parnell will therefore remain as the scientific appellation of the fish. At Loch Lomond *Shelley* is one of its local names. M. Valenciennes thinks that this species has not yet been discovered on the Continent. *C. Pennanti* is the Welsh Gwyniad of Yarrell (*Brit. Fish.*, ii., 85); but, according to M. Valenciennes, very different from the *fera*, with which Pennant confounded it, and equally so from the Lavaret of Switzerland. The specific name of *Pennanti* is therefore employed in the *Histoire des Poissons* to distinguish it. The species which inhabits Lochmaben, a piece of water that bathes the ruins of Bruce's Castle, is locally known as the *Vangis*, *Vendace*, *Juvangis*. According to the traditions of the place, it was originally imported thither from the Continent by Queen Mary. Sir William Jardine was the first who correctly described the Lochmaben fish under the name of *C. Willughbii*, but recognizing at the same time its close resemblance to the *S. albula* of Linnæus. M. Valenciennes, by a comparison of specimens, has decided it to be in fact the *albula* of the *Fauna Suecica*, and has therefore described it under that specific name in the *Histoire des Poissons*. It is the *Blitka* of Lake Siljan in Dalecarlia, and the *Vemme*, or, when its resemblance to the Herring is referred to, the *Land-sild* of the inhabitants bordering on Lake Miæs. According to Bloch, it exists in Silesia, Brandenbourg, Pomerania, and Mecklenbourg; and M. Martens found an extremely similar *Coregonus*, if not actually the same, at Kamtschatka. Artedi mentions *Sik-loja* and *Strut* as its Swedish names, *Blieta* as its Silesian one, and *Moiku* and *Räpis* as those by which it is known to the Fins. The *Vendace* of Lochmaben, whatever scientific name it may ultimately receive, is one of the most elegant of the *Coregoni*, though of a small size, reaching from four to ten inches in length. The head is of an angular shape, and small compared with the size and depth of the body. The crown of the head is very transparent, and the form of the brain, which is heart-shaped, is seen through the integuments. This peculiarity is one of the first things pointed out to the stranger naturalist who visits Lochmaben to see this species. The eye is large and brilliant; the body rises gracefully to the back fin, and recedes with a gradual curve to the tail; the under line is nearly straight from the gills to the ventral fin. The upper parts are of a delicate greenish-

Classification—Malacopteri.

Classification—Malacopteri.

brown, shading gradually into a clear silvery-white; the dorsal fin greenish-brown, the anterior edge much lengthened and pointed; the lower fins all blush-white; the tail much forked. They spawn about the commencement of November. The roe is minute and abundant, and of a bright orange colour. The flesh is white and rich, and highly prized as food; but as it requires almost to be *eaten on the spot*, it is not useful as a market commodity when transmitted to any considerable distance. The lochs of Lochmaben are the only authentic British habitat for this species.

The Grayling (*Thymalus vulgaris*) is a local fish in England, being chiefly found in the Test, the Avon, the Dove, the Lug, the Wye, the Irvon, the Teme, and the Clun, in the southern counties; in the Trent, the Dove, and Dee, in the midland districts, and in the Wiske, the Wharfe, the Ure, the Ribble, and the Derwent, in the northern counties. In America the Graylings have not been detected south of the 61st parallel of latitude, but two or more species abound in the clear affluents of the Mackenzie, issuing from granitic and other primitive rocks. One, the *Thymalus signifer*, is the most beautiful known species; and the Eskimos, seizing on its most characteristic feature, name it "*Hewlukpowak*" or the "fish with the wing-like fin." It affords fine sport to the angler, tugging like a bull-dog when it feels the hook.

Stenodus Mackenzie, the *poisson inconnu* of the canoemen who accompanied Mackenzie in his voyage down the great river which bears his name, is still so called by the fur-traders who frequent the district. It ascends the Mackenzie from the Arctic Sea as high as Great Slave Lake, a course of 500 miles, but shuns clear water, and has not hitherto been discovered in any other river than the Mackenzie. M. Valenciennes, having seen no specimen, has not introduced it into his great work, but it is nevertheless a very distinct generic form, not liable to be confounded with any other. When obtained soon after its ascent from the Arctic Sea it is agreeable food, but people who feed solely on it tire of it sooner than either of the "Namaycush" or "White Fish;" and after it has been for some time in fresh water its flesh becomes soft and oily. Its weight varies from five to fifteen pounds, but it has been taken of a considerably greater size.

The preceding pages contain as full an account as our limits will permit of the typical *Salmonidæ* with fleshy cheeks, and, on account of their importance to man, and the general interest felt in their history, we have devoted more space to them than we can give to other groups of fishes. M. Valenciennes has separated the Salmonoids which have the cheeks cuirassed by an enlargement of the sub-orbitar scale bones so as to cover, in great part or wholly, the muscles which move the mandible. These present a great variety of forms, which he has subdivided into lesser assemblages of genera. The *Characini* and *Scopelini* of Müller nearly comprehend this division, but the group is not exactly the same.

Some of the genera belonging to this division, and named in the table, are vegetable eaters, and have long intestines doubled up in the belly; others are fierce devourers of flesh. Some of the most curious, from their habits, live in the great rivers of South America. The *Myletes paca* of Humboldt is said to be a fish of exquisite flavour, but with its flesh full of ribs. It is an inhabitant of the Amazon and its affluents. The species of *Serrosalmus*, so voracious and so expert in carrying away a mouthful of flesh, bitten off with their cutting teeth, are dreaded by the natives of the districts in which they abound. Any animal falling into the water is immediately attacked and cut in pieces by swarms of these fish. Known to the Indians by the names of *Caribe* or *Caribito*, on account of their thirst for blood, they assail bathers the instant they plunge into the water, and inflict dangerous wounds before the sufferers are able to escape. Their haunt is at the bottoms of the rivers, but a single drop of blood thrown into the water will bring them in thousands to the surface.

A very curious white and translucent fish is the *Salanx Reevesii*, known to the Europeans at Canton by the name of "Whitebait," and eaten as a delicacy, served in the same way that the fish of the same name is cooked at Blackwall. One group, the *Scopolini* of authors, is remarkable for the extreme metallic brilliancy of round spots, placed generally in rows along the body, or for other brilliant places about the head and elsewhere; many are nocturnal, coming to the surface at night, and some have luminous eminences on the head visible in the dark. They abound in the Mediterranean and China seas, but they comparatively rarely appear in northern latitudes.

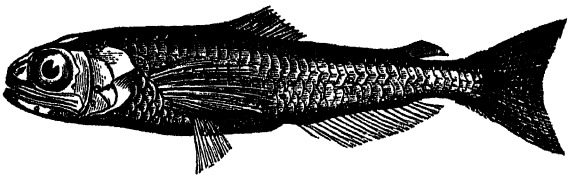


Fig. 72.
Scopelus or *Myctophum boops.*

One species only has been detected on the British shores. The *Scopelus Pennanti* was first noticed by the naturalist whose name it bears, but was mistaken by him for the Atherine. It has been taken at the island of Sheppy, on the coast of Flintshire, at Exmouth, and in the Orkneys. The *S. borealis* (Nilss.) is a Norwegian fish, different from the British one. Fig. 24 represents a scale of *Scopelus resplendens*, an Atlantic fish, and *Chauliodus Fieldii* is represented by fig. 2.

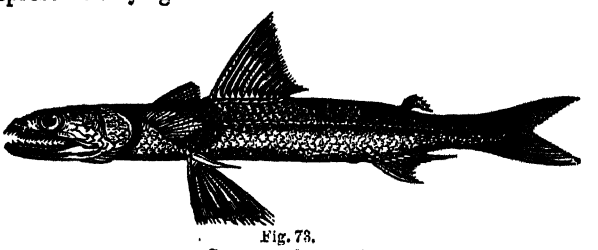


Fig. 73.
Saurus undosquamis.

The Saureys are curious from the forms of the teeth; in some species long, slender, and barbed at the points. The dentition of the *S. nehereus* (Hamilton), *S. ophiodon* (Cuvier), is of this kind, and on that account Lesueur proposed *Harpodon* as a generic name for it. It is a fish of voracious habits, and at certain seasons its body is brilliantly phosphorescent, like some of the Scopelines. It is rich food, though delicate when newly taken. When salted and dried it gets the singular appellation of "Bombay ducks" in commerce, or of *Bummaloti*, and is exported in large quantities from Bombay and the Malabar coast to other parts of India. Fig. 41 shows the form of a scale from the lateral line of *Saurus undosquamis* (Richardson).

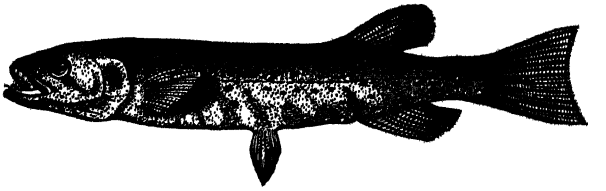


Fig. 74.
Galaxias truttaceus.

The *Galaxidæ*, though they want the adipose fin of the Trouts, yet have much the aspect of these familiar fishes, and represent them in the southern hemisphere, where no

Classification—Malacopteri.

true Trouts are found. They are inhabitants of fresh water, and are named "Trouts" by the settlers of New Zealand and Australia. As an article of food they are softer and more oily than the northern Salmonoids.

Family IV.—SALMONIDÆ, Müll.

Scaly fishes, with an adipose fin. Upper half of the orifice of the mouth formed by the pre-maxillaries and maxillaries; numerous branchiostegals. A large, simple air-bladder, without contractions; supplementary branchiæ, and numerous pyloric cæca. They possess most of the characters of a Clupeoid that has not the acute and denticulated belly. Their teeth are often absent, or small; often all the pharyngeal bones are armed with them; they are conical and in one row, and when they exist on the jaws and palatines the tongue also is furnished with teeth. The distribution of the vomerine teeth furnishes M. Valenciennes with generic characters for the subdivision of this most important but difficult family.

(A.)

Genus I. Salmo, Valenc. A few teeth at the end of the vomer, but no prolonged row on the mesial line. Body fusiform. Head moderately large; throat well armed, often wide; pre-maxillaries short, and rather on the sides of the mouth than across its upper edge; maxillaries articulated to the ends of the pre-maxillaries, and not compound; mandible strong, often with the symphysis rising into a small tubercle, but in some species the tubercle is much developed. Strong conical teeth on the jaws; a small group at the end of the vomer; one row on the palatines, entopterygoids, and on each side of the tongue; some have two rows on the tongue. An adipose fin on the tail. Thin small scales covering the body. A short intestinal canal; a siphonal stomach; ova, when detached from the ovary, falling into the cavity of the abdomen before they are excluded in spawning. A large air-bladder, simple, with thin coats, and opening anteriorly into the pharynx, almost directly or without the intervention of an air-tube. With the exception of the peculiarity of the vomerine dentition, many of these characters are common also to the two genera which immediately follow. Twenty-five species.

Genus II. Fario, Valenc. Salmons with a single mesial line of teeth running down the vomer. Four species.

Genus III. Salar, Valenc. Vomer armed with two rows of teeth, without any remarkable group on the chevron of the vomer, as in the preceding two genera. Eight species, besides about twelve doubtful ones hitherto imperfectly described.

Genus IV. Osmerus, Cuv. Pre-maxillary teeth small and hooked; vomerine teeth big, conical, and so far forward that they appear to belong to the jaws; a row on the outer edge of the palatines, and one on the internal border of the entopterygoid; big teeth also on the tongue. In other respects the Spirlings resemble the other *Salmonidæ*. They have a small adipose fin; ventrals situated under the anterior rays of the dorsal. Gill-openings widely cleft; air-bladder having within silvery walls, and communicating with the upper part of the œsophagus. Four species.

Genus V. Mallotus, Cuv. Mouth rather less widely cleft than that of *Osmerus*, armed with very small, slender, or conical teeth in a single row on the jaws; more numerous on the palatines and vomer; small teeth also on the tongue. Eight branchiostegals. Intestines of the Trouts. One species.

Genus VI. Argentina, Cuv. *Salmonidæ*, in having an adipose fin, and the upper half of the orifice of the mouth formed by the very short pre-maxillaries and the maxillaries. Mouth small; no teeth on the jaws; on the chevron of the vomer a curved band of uniform teeth, prolonged on each side by a dental stripe on the palatines; lingual teeth of variable size in different species. Gill-openings wide; branchiostegals six. Stomach moderately large, cæcal; numerous short pyloric cæca; ova falling into the abdominal cavity as in the Salmons. Air-bladder covered by a coat of silvery fibres, which tear off, and is used in the fabrication of artificial pearls. Four species.

Genus VII. Thymalus, Cuv. Mouth small, the orifice horizontal under the snout; teeth small, conical, uniserial on the jaws, chevron of the vomer and fore part of the palatines. Intestines like those of *Salar*. Air-bladder large, communicating with the œsophagus by a very small tube. The disposition of the scales under the throat is peculiar in some species. Eight species.

Genus VIII. Coregonus, Cuv. Pre-maxillaries crossing the upper part of the mouth, thin, and of variable depth; maxillaries on the sides of the mouth also thin and attached to the ends of the pre-maxillaries, generally of an oval or oblong form. Teeth small or none. Dorsal fin farther forward than the ventrals. Forty species.

Agassiz retains the name of *Coregonus* for the species which have the mandible shorter than the upper jaw; and gives the name of *Argyrosomus* to those which have it longer.

Classification—Malacopteri.

Genus IX. Stenodus, Rich. Pre-maxillaries crossing the upper part of the mouth, giving a truncated appearance to the snout, each armed by a narrow linear-lanceolate band of small raduliform teeth; maxillaries articulated to the palatine bones, long and broadish, with a posterior, ovate, accessory piece as in the *Coregoni*, and forming the sides of the mouth; toothless; vomerine teeth in a transversely oval disk on the chevron (but not down the mesial line), uniting with the crescentic bands of teeth of the same kind on the palatines. These palatine bands have the hollow of the crescent facing the sides of the mouth, and taper to a point posteriorly. On the tongue, the teeth are rather coarser, and cover its surface. Mandible rather shorter than the upper jaw, the part opposed to the pre-maxillaries transverse with a knob at the symphysis, and armed there by a very narrow band of villiform or raduliform teeth; limbs of the bone longitudinal, with rather acute perfectly toothless edges. The whole orifice of the mouth is nearly quadrangular. In general aspect the *Stenodus* rather resembles a *Coregonus* than a Salmon, but bears no strong likeness to either. The ventrals are under the anterior part of the dorsal, and the adipose fin corresponds to the posterior half of the anal, which commences with the last third of the fish, caudal included, and does occupy above a ninth of the entire length of the fish. Branchiostegals nine to eleven, often one more in number on the left side. Stomach but slightly cæcal, the upward turn which ends in the pylorus being short, with the œsophagus longitudinally folded within. Pyloric cæca numerous, and crowded for an inch below the pylorus, but after the insertion of the gall-duct confined to one side of the intestinal tube; lower part of the gut furnished with valvulæ conniventes. Air-bladder communicating with the œsophagus by a wide tube. Only one species known, the *Stenodus Mackenzii*, Richardson (*Back's Voyage down the Great Fish River in* 1834 and 1835, p. 521).

(B.)

M. Valenciennes makes a second division of the Salmonoid fishes by grouping together those in which the sub-orbitar scale bones are large, and conceal almost the whole, or at least a great part, of the interval between the orbit and the ascending limb of the preoperculum. This division includes the *Characini* and *Scopelinæ* of Müller; but from the former, M. Valenciennes separates his *Erythrinidæ*.

Family V.—CHARACINIDÆ.

Characini, J. Müll. Malacopterygian fishes with abdominal ventrals; adipose fin; scaly bodies; scaleless head; no accessory branchiæ; upper half of the orifice of the mouth formed by the pre-maxillaries and maxillaries; villiform pharyngeal teeth above and below; cæcal stomach; numerous pancreatic cæca. Air-bladder divided by a transverse strangulation into two, and connected with the acoustic organs by a chain of ossicles as in the *Cyprinidæ* and *Siluridæ*. Branchiostegals four or five; numerous pancreatic cæca. South American or African fluviatile fish.

M. Müller includes *Erythrinus* and *Macrodon* among his *Characini*, but these fish want the adipose fin of the Salmon family, and are placed by M. Agassiz near the *Clupeidæ*. M. Müller's genera *Catoprion*, *Myletes*, *Myleus*, *Serrasalmus*, *Pygocentrus*, and *Pygopristis*, have the belly serrated. The other genera are *Anodus* (*Curimatus* Valenc.), *Hemiodus*, *Xiphostoma*, *Xiphoramphus*, *Hydrolycus*, *Anostomus*, *Leporinus*, *Schizodon*, *Chilodus*, *Hydrocyon*, *Citharinus*, *Piabuca*, (including *Schizodon*, Valenc.), *Gasteropelecus*, *Epicyrtus*, *Raphiodon*, *Pacu* (*Prochilodus*, Agass.), *Distichodus*, *Exodon*, *Salminus*, *Brycon*, *Chalceus*, *Alestes*, *Tetragonopterus*.

ANALYTICAL TABLE OF THE *CHARACINIDÆ* (Dum.)

Teeth, none..... { Anodus, M. / Curimatus, V. } 1.

Teeth, none on the tongue, present elsewhere in the mouth.

Teeth elsewhere uniserial.

Pre-maxillary teeth stronger, *tricuspid*...Gastropelecus 14.

Pre-maxillary teeth stronger, *conical with canines.*

Belly rounded.....Epicyrtus 3.

Belly keeled..... { Raphiodon, M. / Cynodon, V. } 29.

Pre-maxillary teeth not stouter.

Dorsal opposed to the ventrals.

Pre-maxillary teeth wide, entire.....Leporinus 2.

Pre-maxillary teeth fissured..... { Piabuca, part. / Schistodon, M. } 8.

Classification—Malacopteri.

Pre-maxillary teeth narrow, round	CITHARINUS, sp. / CHILODUS, M.	7.
Pre-maxillary teeth narrow, conical	HYDROCYON	27.
Dorsal not opposed to the ventrals.		
Dorsal before the anal	CITHARINUS	7.
Dorsal above the anal	PIABUCA	8.
Teeth elsewhere pluriserial.		
Dorsal above the ventrals.		
Teeth feeble, slender; labial ones biserial	PACU / PROCHILODUS	6.
Teeth firm, fissured, biserial,	DISTICHODUS	15.
Teeth large; anterior ones conical	EPICYRTUS, sp. V. / EXODON	3.
Dorsal between the ventrals and anal.		
Teeth conical, triserial above, biserial below	SALMINUS	5.
Teeth flat, pointed, triserial on the mandible	CHALCEUS, sp. / BRYCON	21.
Teeth flat, pointed, biserial above.		
Belly keeled	CHALCEUS	21.
Belly round		
Mandibulars uniserial	TETRAGONOPTERUS	11, 12, 13.
Mandibulars biserial	ALESTES	16.
Teeth present on the tongue.		
Teeth on both jaws.		
Palatine teeth, conical, uniserial; canines	XIPHORAMPHUS	30.
Palatine teeth granular, crowded; canines	HYDROLYCUS	29.
Palatine teeth none	XIPHOSTOMA	32.
Teeth on the mandible; none on the upper jaw	HEMIODUS	9.

GENUS I. CURIMATUS, Valenc. Resembling the Graylings (*Thymali*) in the smallness of their mouth, and feeble dentition, often wholly absent on the jaws. Mouth toothless; jaws with trenchant edges, without lips, the superior one notched to receive a symphysial tubercle of the mandible. Ascending branch of the stomach thick and muscular. Pyloric cæca numerous (amounting to eighteen). Branchiostegals four. Species seven.

GENUS II. LEPORINUS, Spix. Body elongated; belly rounded. Mouth small; lips fleshy; teeth few in number on the pre-maxillaries and mandible; the mesial pair above and below longer than the rest and almost horizontal. Pharyngeal teeth in transverse bands; each tooth having a long laterally compressed crown, terminating in two hooked points of unequal length. Branchial aperture small, from the union of the membrane to the scapula. Branchiostegals four. Pyloric cæca from ten to eighteen. These fish are vegetable feeders. Eight species.

GENUS III. EPICYRTUS, Müll. Conical teeth on the pre-maxillaries and maxillaries, some of them projecting from the surface of the jaw like the canines of some Labroids (*Calliodon*, for instance, figure 56). Pyloric cæca, six or seven. Intestines short. Two species, which include *Exodon*.

GENUS IV. PARODON, Valenc. Teeth planted in the walls of the upper lip, moveable and slightly curved, their crowns small triangular disks with denticulated edges; mandibular teeth on the side lips only, and not opposed to the pre-maxillary ones of the upper jaw. Four branchiostegals. One species, unknown to Müller.

GENUS V. SALMINUS, Agass. Teeth in several rows on the jaws. Body elongated like that of a Trout, and the mouth also similar, except that the tongue and roof of the mouth are smooth as in most Characins. Pre-maxillary teeth conical, in two rows; one row on the maxillaries; mandibular teeth in two rows, and the interior ones remarkable for their small size, their equality, and their oblique insertion into the limbs of the jaw. Five species.

a. M. Valenciennes forms a group of *Prochilodus*, *Citharinus*, *Hemiodus*, and *Piabuca*, which have the teeth curiously crenated, and no denticulated keel to the belly, but with an adipose fin, as in the other *Salmonidæ*.

GENUS VI. PROCHILODUS, Agass. (*Pacu*, Müll.) Mouth small, protractile, situated at the extremity of the head, and surrounded by very thick lips, supporting under their edges a row of excessively small teeth like hairs, which, when viewed under a lens of considerable power, are seen to have a disk at the extremity, often denticulated or crenated. Farther back towards the middle of the lips there is a second series of similar teeth in a crescent with the hollow towards the interior of the mouth. Body elongated and somewhat compressed, but clumpish like that of a Carp. Four branchiostegals. Ascending branch of the stomach fleshy, but not so much so as in *Curimatus*. Pyloric cæca very numerous, so as to deter one from counting them. Thirteen species.

GENUS VII. CITHARINUS, Cuv. (Including *Chilodus*, Müll.) Body elevated, compressed, rhomboidal; mouth horizontal at the extremity of the head, the upper arch of the orifice almost entirely formed by the pre-maxillaries, the maxillaries lying behind, but covering the corner of the mouth; teeth extremely small, implanted in the lips, and resembling hairs; none within the mouth. Two species, Nile.

GENUS VIII. PIABUCA, Cuv. Salmonoids, with uniserial, trenchant, and compressed teeth, denticulated on the cutting edge, implanted in the lip, and very moveable, the row corresponding to the pre-maxillaries and mandible. It comprises the *Schistodons* of Agassiz and Müller. Three species.

GENUS IX. HEMIODUS, Müll. Small labial teeth, implanted close to one another in a row on the upper lip; the pre-maxillary and maxillary teeth moveable to the touch like the keys of a piano. There are none on the lower lip. Each tooth is compressed, rounded in front, with denticulated crown or disk. Pre-maxillaries very small and concealed beneath the lip. Mouth very small; body elongated; belly rounded. Branchiostegals four to five. Two species.

GENUS X. PLECOGLOSSUS, Schl. Teeth on the pre-maxillary six; on each maxillary between the bone and the lip fourteen moveable ones in one row; they are somewhat compressed and pointed; a band of card-like teeth on each palatine, and the tongue also covered with teeth; three pockets formed by a membrane attached before the tongue. Branchiostegals four.

GENUS XI. TETRAGONOPTERUS, Artedi. Body elevated, rhomboidal or orbicular, passing in some species into oval or lengthened forms. Mouth small; two rows of teeth in the upper jaw, one in the lower one. Twenty-one species.

GENUS XII. BRYCINUS, Valenc. Separated from *Tetragonopterus*. Body elongated as in *Chalceus*; teeth crenulated and standing close as in *Tetragonopterus*. The interval between the two rows is greater in the upper jaw, and a distinctive character exists in the presence of a spur on the crown of the teeth, which resemble those of *Chalceus*, but may be readily distinguished; dorsal and anal high. Senegal.

GENUS XIII. PIABUCINA, Valenc. Separated from *Tetragonopterus* and *Piabuca*, on account of a combination of characters; body elongated like *Piabuca*, with fixed crenulated teeth as in *Tetragonopterus*, but differing from those of the latter in that the double row is on the mandible; on the upper jaw there is only one row. One species resembling *Erythrinus*. Maracaibo.

GENUS XIV. GASTEROPELECUS, Pall., Gronov. Pre-maxillary teeth in two rows, tricuspid; maxillary teeth conical, much pointed, uniserial; pharyngeal teeth villiform, densely crowded. Body excessively compressed and high in the pectoral region. Dorsal far back. Gill-openings large; branchiostegals four. Scales. Intestine remarkably short; seven pancreatic cæca. Surinam.

GENUS XV. DISTICHODUS, Müll. Teeth on both jaws in a double row; small, close together, with a slightly compressed forked crown. Body elongated and compressed, belly rounded; caudals and adipose fin scaly like the rest of the body, naked only at the border. Stomach long, ascending branch long and very muscular. Pyloric cæca numerous and elongated like small intestines, extending along one side of the duodenum. A vegetable feeder. One species, the *nefasch* of the Arabs.

GENUS XVI. ALESTES, Müll. Pre-maxillary teeth in two rows, those of the exterior row having three trenchant points, while in the interior row the crowns are more obtuse; but there are some projecting points among them; no maxillary teeth; mandibular teeth biserial, the disk channelled, with crenated crowns; behind the symphysial ones, some small conical ones; pharyngeal teeth very small. Ten to fourteen pyloric cæca. Voracious insectivorous fishes. Air-bladder prolonged posteriorly on the right side of the interhæmal spines, whereas in most other fishes when the air-bladder is extended back out of the abdomen it is forked, and sends a horn on each side of these bones. Three species.

GENUS XVII. MYLETES, Cuv. Pre-maxillary teeth having truncated crowns and standing in two rows; for the most part there are only two conical teeth in the inner row behind the symphysis, but in some species there are seven. The teeth are mostly prismatic with rounded ribs, the crowns of the anterior row being slender, cutting, and feebly denticulated; in the second row the posterior edge is more elevated, and the middle somewhat pointed. Body compressed; belly keeled and often strongly denticulated. First interneural of the dorsal lying horizontally, with its spinous point directed forwards. Intestines long; cæcal stomach, with a short, thick, pyloric branch. Vegetable feeders. Seventeen species.

GENUS XVIII. TOMETES, Valenc. A row of pre-maxillary teeth with sloping or chisel-formed cutting crowns like the hu-

Classification—Malacopteri.

man incisors; behind which there is a second rank in which the teeth near symphysis have their crowns somewhat truncated, but the lateral teeth are all incisorial, the slopes of the two rows being on different sides, so that they form a furrow which receives the points of the mandibular teeth. At the symphysis of the mandible there are two interior, very small, compressed, and sharply pointed teeth. No maxillary teeth. Three species, unknown to Muller.

Genus XIX. Myleus, Müll. Pre-maxillaries armed with two rows of teeth; the exterior ones compressed and incisorial; the interior ones truncated like molars, but with the posterior edge elevated and cutting; mandibular teeth in one row, pointed and incisorial on the anterior part of the jaw, but with no conical ones behind them. Body compressed; belly keeled and denticulated; these dermal ossicles forming two rows near the anus. Branchial openings large; pharyngeal teeth villiform; dorsal with its pointed interneural spine in front, placed over the interval between the ventrals and anal. Three species.

Genus XX. Mylesinus, Valenc. Dorsal and anal fins as in *Myleus;* pre-maxillary teeth five, sharply cutting, standing closely side by side, with their crowns a little dilated, and having a little cusp on each side, so that they may be called tricuspid, though the middle lobe forms most of the cutting edge; the neck of the tooth is narrower; a little behind the two mesial teeth, though in the same row or nearly so, there are three teeth with truncated or sloping cusps, which are rather notched than tricuspid; mandibular teeth twelve on each limb, in a single row, tricuspid, with the middle cusp oval and elongated; no conical teeth forming a second row at the mandibular symphysis. Lips thick, fleshy, and densely papillose. One species.

Genus XXI. Chalceus, Cuv. (*Brycon*, Müll.) Pre-maxillary teeth triserial, multicuspid; the anterior ones the smallest, and seeming conical from the smallness of their lateral cusps; mandibular teeth biserial, the front ones large and multicuspid, the lateral ones and those of the anterior rows conical; behind the symphysis two stronger conical teeth, as in *Myletus*. Body elongated, compressed; belly rounded like that of a Trout, but covered with large scales like a Carp. A great number of pyloric cæca. Eleven species.

Genus XXII. Chalcinus, Müll. Pre-maxillary teeth small, crenulated, multiscupid, biserial; mandibular teeth, biserial like those of *Chalceus*, multicuspid, and strong anteriorly; two small conical ones behind the symphysial ones, and an interior lateral row of very small conical ones towards the angle of the mouth. Body compressed; edge of the belly trenchant but not serrated. Dorsal far back; anal very long; and pectorals long and pointed. Three species.

The genus *Alysia* of Lowe (*Zool. Tr.* 1839) probably belongs to some of the preceding genera of *Characini*, but the teeth are not described with sufficient minuteness to determine its proper place.

b. M. Valenciennes makes a small group of *Serrasalmus, Pygocentrus, Pygopristis*, and *Catoprion*.

Genus XXIII. Serrasalmus, Lacép. Teeth triangular and trenchant, in a single row on the pre-maxillaries, palatines, and mandibular; maxillary not entering into the composition of the orifice of the mouth, but lying under the edge of the pre-orbitar, and behind the pre-maxillary. Body compressed, for the most part rhomboidal, the first dorsal and anal ray proceeding from the most prominent points of the upper and under profile; belly keeled and serrated with a double row of dermal spines before the anus; first interneural of the dorsal projecting one pungent point anteriorly and two posteriorly; branchial openings pretty large; four branchiostegals; stomach a very large conical sac; from thirteen to twenty-one pyloric cæca. Voracious carnivorous fishes. Ova not dropping into the cavity of the abdomen.

Genus XXIV. Pygocentrus, Müll. No palatine teeth; pre-maxillary and mandibular bones carrying a single row of triangular, trenchant, feebly-crenulated teeth. Maxillary bone as in *Serrasalmus*, almost hidden behind the pre-maxillary. Body compressed; belly trenchant and serrated, the points near the anus being doubled; branchiostegals four; cæcal stomach; cæca varying from ten to fifteen; air-bladder divided into a small globular anterior one, and a very large second one, which communicates with the œsophagus by a very short canal. Ova not dropping into the cavity of the abdomen. Four species.

Genus XXV. Pygopristis, Mull. Separated from *Pygocentrus* by the edentate and smooth roof of the mouth, but the jaw teeth are crenulated, and strongly denticulated. Two species.

Genus XXVI. Catoprion, Müll. and Trosch. Salmonoids, with a serrated belly, having two rows of conical pre-maxillary teeth, and one row of trenchant triangular mandibular ones. One species.

Genus XXVII. Hydrocyon, Cuv. Salmonoids, with large and strong teeth implanted in a single row on both jaws; these teeth are conical, slightly compressed, and have cutting edges; roof of the mouth smooth. Body elongated; sides flattened in the middle; belly rounded like the back; intestines very short, with a considerable number of pancreatic cæca (thirty-five to forty). Branchiostegals four. One species. Classification—Malacopteri.

Genus XXVIII. Cynopotamus, Valenc. Differ from *Hydrocyon* in having two rows of pointed pre-maxillary teeth, those of the exterior row very short; interior row containing four large canines; maxillary on the side of the orifice of the mouth like that of a trout, edged by a row of very small conical teeth; mandible armed at the end by eight canines; and a second interior row is composed of very small teeth; palate destitute of both teeth and granular eminences. Branchiostegals five.

Genus XXIX. Cynodon, Spix. Salmonoids, with granular teeth on the palate; pre-maxillaries, maxillaries, and mandible armed by a single row of pointed conical teeth, among which there are enormous canines, the largest being near the symphysis, those of the mandible entering corresponding holes in the palate. Body much compressed at the pectorals; belly frequently compressed; anal very long and scaly. Pectorals pointed and laid along the body, descending to a right angle with the longitudinal axis when they act. Stomach remarkably large. Carnivorous. Three species. *Cynodon scomberoides*, Val., is the genus *Hydrolycus* of Müller.

Genus XXX. Xiphorynchus, Agass. Differs from *Cynodon* in having a single row of pointed teeth on the palatines, as well as on the jaws. Carnivorous fish. Twelve pancreatic cæca or thereabouts. Five species.

Genus XXXI. Agoniates, Mull. Intermediate between *Hydrocyon*, which is remarkable for long canines, and *Tetragonopterus*, which has two rows of pre-maxillary teeth, some of them tricuspid. This dentition distinguishes *Agoniates* from *Cynopotamus*. One species.

Genus XXXII. Xiphostoma, Spix. Snout conical and elongated by the extension of the pre-maxillaries, palatines, nasal and prefrontal, and the dorsal aspect of the skull wholly covered by a granular engraved casque. The elongated pre-maxillaries and the mandible are furnished with numerous minute teeth, set closely side by side in a single row, their points recurved like a small fishing-hook; palatines wrinkled and rough, with odontoid granulations. Body slender, elongated, and round. Dorsal very far back beyond the ventrals. Pancreatic cæca very considerable in number. Five species.

Genus XXXIII. Salanx, Cuv. (*Leucosoma*, Gray.) Body slenderly fusiform, the thin end of the spindle being the anterior one; jaws equal, the cleft of the mouth horizontal, slightly arched in the middle; maxillary curving over the corner of the mouth, and sending a slip in front of the end of the pre-maxillary, forming a considerable part of the border of the orifice; pre-maxillaries armed with a single series of small teeth, with four tall, subulate, recurved canines among them on each bone, the space nearest the symphysis have only a row of small ones; maxillary edged with a pectinated row of short teeth; mandibular teeth on the sides of the bone smaller and more numerous than those of the upper jaw; tip of the mandible toothless, but close to it there are three strong teeth, whose points when the jaws are close pass through a rhomboidal membranous space near the point of the snout; palatine bones set with a row of fine teeth, but there are no teeth on the vomer, which does not project. Ventrals about the middle of the fish; dorsal in the middle of the posterior half, the anal still nearer the caudal fin, and the adipose fin corresponding to the posterior part of the anal. One species.

Genus XXXIV. Hydropardus, Reinh. Teeth on the pre-maxillaries, elongated maxillaries, and mandible, uniserial, canines and conical ones intermixed; the anterior mandibular teeth received into pits in the palate; palatine teeth minute, granular; pharyngeal teeth villiform. Body elongated, compressed; belly keeled. Scales small. Gill-openings extremely large; five branchiostegals; internal rakers of the branchial arches having the form of small osseous tubercles, studded with the finest spines; *ventral fins none*; dorsal fin over the anal, which is exceedingly long, and has a scaly base. (An. 1850.)

Genus XXXV. Gonostoma, Rafin. Pre-maxillaries short, not passing the eye; the maxillary completing the upper half of the mouth, as in the *Clupeidæ* or *Salmonidæ*; teeth large, conical, and sharply pointed, widely set on the jaws, with very small ones in the intervals; palatines and entopterygoids covered with minute raduliform teeth, and there are rough spots on the tongue; pharynx very narrow, the superior pharyngeal teeth resembling the teeth of a harrow, in two groups, the anterior group composed of three teeth larger and longer than the rest; fourteen branchiostegals, suborbitar very delicate; dorsal placed far back; free recurved spines on the sides of the tail. Ovarian sacs shut. One species.

Genus XXXVI. Chauliodus, Bloch. (*Astronesthes*, Richardson. *Phænodon*, Lowe, *Ann. Nat. Hist.*, x., p. 52.) Mouth formed nearly

Classification—Malacopteri.

as in *Gonostoma*, but the dentition differs; the teeth are slender pointed, compressed, and curved, adhering to the bone, the mandibular ones being the largest; maxillary teeth arranged in a pectinated manner on the edge of the bone, inclining backwards; palatine teeth shorter; tongue armed on the sides with teeth; pharyngeal teeth harrow-like. Branchiostegals fifteen to seventeen; pectoral fins attached low down; gill-openings large; dorsal far back, anal still more posterior, its last rays opposite to the thin adipose fin. *Astronesthes niger*, R., fig. 2, p. 132.

Mr Ayres, in the *Journal of the Boston N. H. Society* for 1849, describes a fish which seems nearly allied to *Chauliodus*, but if the symphysial mandibular barbel and branchiostegals have not been overlooked, it can not be the same. The generic characters given of it are as follows:—

Genus XXXVII. Malacosteus, Ayres. Scales small; mouth very deeply cleft, its upper border chiefly formed by the maxillaries; pre-maxillaries short; pre-maxillary and maxillary teeth small, sharp pointed; mandibular teeth very long, somewhat curved, smaller ones behind them; no teeth on the palatines, vomer, or gill-arches; a double row on the tongue; and a tuft on each pharyngeal; small fins; dorsal far back over the anal; gill-cover membranous without ossification, and no branchiostegals perceptible. All the bones unusually soft. One species, *M. niger*, found in the North Atlantic. Could the bones have been softened by spoiled spirits?

Genus XXXVIII. Aplochiton, Jenyns. Characterized by a peculiar fold or longitudinal pouch in the integuments of the belly; wholly without scales; uniserial small teeth on both jaws; two rows on the tongue and vomer; none on the palatines; branchiostegals three. Elongated form of a Grayling, but thicker. Magellan's Straits.

The last six genera are scarcely members of this family.

Family VI.—SCOPELIDÆ.

Scopelini, Müll.; *Sauridæ*, Valenc. Scaly or scaleless fishes with an adipose fin, whose mouth is bounded above from corner to corner by the pre-maxillary, the maxillary lying behind; accessory gills. Swim-bladder absent in most. Genus *Aulopus*, Cuv.; *Saurus*, Cuv.; *Scopelus*, Cuv.; *Maurolicus*, Cocco; *Ichthyococcus*, Bonap.; *Chloropthalmus*, Bonap.; *Odontostomus*, Cocco; *Paralepis*, Risso; *Sudis*, Raf. not Cuv.; *Sternoptyx*, Herm.; *Argyropelecus*, Cocco.

They are separated from the *Salmonidæ* by the structure of the mouth, and by the ova being discharged by a proper canal, and not falling into the general cavity of the abdomen. The maxillaries in some genera approach the corner of the mouth, and form a portion of its orifice, and in *Argyropelecus* they are formed of three pieces, one of which is dentiferous. This genus and *Sternoptyx* belong, by the structure of the mouth, to the *Characinidæ*.

Genus I. Argyropelecus, Coc. Body greatly compressed, high, with an irregular polygonal outline; tail narrow at its commencement, and generally very thin near the caudal fin; mouth nearly vertical, formed above by the pre-maxillaries and maxillaries, the latter in some species occupying but a small part of its orifice, in others nearly the whole upper half; maxillary composed of three pieces, one of them dentiferous; curved, unequal teeth on the jaws; smaller ones on the palatines; branchiostegals nine; the scapular chain of bones largely developed; thin nuchal osseous crest; four pancreatic cæca. Four species.

Genus II. Sternoptyx, Herm. Body high, compressed, with long ribs seen through the silvery integument; mouth cleft almost vertically, bordered above with very short pre-maxillaries, and on the sides by the maxillaries, as in *Salmo* or *Salar*; pluriserial teeth on the jaws, the shorter ones placed in an exterior row, and the larger ones more interiorly; palatines armed with two or three longer curved teeth anteriorly; vomer edentate; branchial arches and inferior pharyngeals rough with small teeth, but the extremity of the tongue smooth. The dentition of the jaws is like that of *Saurus*, and the palatine teeth resemble those of *Chauliodus*. Gill-openings wide; branchiostegals five, of different forms; coracoid bones forming a keel with an anterior point under the throat; pubic bones also having a sharp point; a triangular osseous crest before the dorsal, with one large projecting spinous point. Adipose fin pretty long. One species.

Genus III. Odontostomus, Coc. Upper half of the mouth formed entirely by the pre-maxillaries which carry the teeth, the maxillary lying posteriorly and being toothless; mandible, palatines, and chevron of the vomer armed with moveable teeth, which rise by their elasticity when pressed down; no teeth on the tongue; eye large, with an adipose fold. One species.

Genus IV. Scopelus, Cuv. (*Myctophum*, *Maurolicus*, *Lampanyctus*, Bonap. Upper half of the mouth bordered by the pre-maxillary, the toothless maxillary supporting it behind; teeth of the jaws small, and differing little in size; on the palatines the teeth are minutely raduliform; no teeth on vomer, in which the genus differs from *Odontostomus*. Twenty species.

Genus V. Saurus, Cuv. Elongated body, wide mouth, long, rounded pre-maxillaries, ending in a point; the toothless styloid maxillary being hidden under the integuments. Teeth numerous, conical, somewhat curved, and often with a hastate or barbed point, forming harrow-like bands on the jaws, the palatines, tongue, and pharyngeals; the small teeth being in the exterior ranks, and the larger ones interiorly. First rays of the ventrals shorter than the posterior ones, as in *Platycephalus* and *Callionymus*, and also in the united ventrals of *Gobius*. Branchiostegals sixteen; sub-operculum large, also frequently the inter-operculum. Cæcal stomach large, with a short pyloric branch; pancreatic cæca few. Ovaries in a shut sac. No air-bladder. Seven species.

Genus VI. Saurida, Valenc. Differ from *Saurus* in having an internal band of acute teeth surrounded by minute ones, as well as the band of longer palatine teeth which *Saurus* possesses; internal ventral rays not so much prolonged as in that genus. Two species.

Genus VII. Farionella, Valenc. Resembling a Trout. Dorsal standing over the space between the ventrals and anal; an adipose fin above the end of the anal; caudal small. Upper half of the moderate-sized orifice of the mouth formed by the pre-maxillaries, the very small toothless maxillary lying behind. Teeth simple and conical on the pre-maxillaries, palatines, and mandibular, also along each side of the tongue. One species.

Genus VIII. Aulopus, Cuv. Maxillary dilated posteriorly, with supplementary pieces, but bordered in front by the pre-maxillaries, which form the upper border of the mouth. Teeth small, crowded, nearly of equal size, forming a narrow band on both jaws, on the palatines, and on the chevron of the vomer; two dental plates of very fine teeth on the entopterygoids, and the pharyngeals above and below bristle with pretty strong heckle-formed teeth. Large gill-openings. Bones of the head cavernous, with spinous points on the hinder part. Thick jointed inferior rays on the pectoral, as in some *Sclerogenidæ*, with which in other respects the genus presents many analogies. It has also somewhat of the external aspect of a *Gadus*, but is allied more closely to *Saurus* by dentition, and the presence of an adipose fin. Two species.

Genus IX. Paralepis, Risso. (*Sudis*, Rafin.) Malacopterygian abdominal fish, with an adipose fin, slender fusiform bodies, elongated jaws, and the upper half of the orifice of the mouth formed by the pre-maxillaries, which pass before the maxillaries. Dorsal and ventrals opposite to each other and very far back; adipose fin radiated, but the rays not articulated like true rays. Teeth trenchant, much like those of *Sphyræna*. In the *Hist. des Poiss.* the first dorsal was considered to be spinous, but Reinhardt has shown that its rays are articulated, and Müller assigns it a position among the *Scopelinidæ*.

Genus X. Alepisaurus, Lowe. Body elongated, tapering, much compressed, acute-edged posteriorly above and below. Jaws elongated, with a wide mouth, which is bordered above from corner to corner by the pre-maxillaries, armed with small subulate teeth; lanceolate teeth on the palatines and sides of the mandible, with long subulate ones on the fore part of the latter bone. The dentition has much resemblance to that of *Sphyræna* or *Lepidopus*, and the bones have great similarity in structure to those of the *Scomberidæ*. No teeth on the vomer. A long anterior dorsal extending backwards from the nape; posterior one adipose; ventrals abdominal. Neither air-bladder nor pyloric cæca. Lowe. Three species in the Atlantic and Australian seas.

Family VII.—GALAXIDÆ.

Shape of a Trout, but with no adipose fin, and the dorsal far back. No scales. Moderate-sized, uniserial pointed teeth on the pre-maxillaries and mandible, sometimes three canines at the curve of the latter; stronger curved styloid teeth in one row on the palatines and each side of the tongue; pre-maxillaries not reaching the corner of the mouth, but the maxillary is excluded from the edge of the orifice by the thick lip. Inhabit fresh waters in Australia, Van Diemen's Land, New Zealand, the Falklands, and Patagonia, where they represent the Trouts.

Genus I. Galaxias, Cuv. Seven species.

HYODONTS.

This small family group was instituted by M. Valenciennes to comprehend three genera, which have the greatly compressed sides of the Herrings, but not the serratures on the lower edge of the belly exhibited by all the typical members of that family: the presence of pancreatic cæca separates them from *Chirocentrus* with which they would

Classification—Malacopteri.

otherwise associate. They are fresh-water fishes, interesting to ichthyologists from their characters, but of no great importance to man. The Hyodons, from which the group derives its appellation, are small fishes of North America, known locally by the name of Gold Eye, and having a resemblance to the Trouts in feeding on insects and taking the artificial fly freely. They, as well as *Osteoglossum*, are among the fishes which have the interior of the mouth most fully armed, since they possess strong teeth far back on the palate as well as on the tongue and jaws.

Family VIII.—HYODONTIDÆ.

Hyodontes, Valenc. M. Valenciennes places in this group *Osteoglossum*, *Ischnosoma*, and *Hyodon*, which have compressed bodies, and a keeled belly, without denticulations, but with *pancreatic cæca*, the presence of which, he says, alone separates them for *Chirocentrus*, though the suborbitar scale bones are more developed than in the latter. Their intestinal canal resembles that of the *Mormyri*.

Genus I. Osteoglossum, Fereira. Body and head compressed like the blade of a sabre; head bony above, and the cheeks protected by the suborbitars and opercular pieces; mouth much cleft; small conical teeth on the premaxillaries and slender maxillaries, which move little, and are partially concealed by the preorbitar; lower jaw armed like the upper one with two fleshy barbels under the symphysis; minute crowded teeth cover the vomer, the palatines, entopterygoids, presphenoid, lingual bone, and body of the hyoid bone. Gill-openings very large, overlaid by the wide membranous border of the gill-cover; branchiostegals ten. Anal long, but separated from the small caudal; ventrals ending in a filamentous point. Belly trenchant, but without denticulations; stomach rounded, without any cæcal projection; two pancreatic cæca; air-bladder large, simple, without either partitions or horn-like prolongations, but communicating with the upper part of the œsophagus by a tube having an excessively small mouth. Two species, one in the Amazon, the other in Borneo.

Genus II. Ischnosoma, Spix. An *Osteoglossum*, with the anal and caudal united.

Genus III. Hyodon, Lesu., Rafin. Body scaly, greatly compressed, thickest above the lateral line; back acute, belly more so; profile suboval. Dorsal short, over the long anal. Eye large, preorbitar scale bones covering the whole of the cheek; mouth wide, premaxillaries and maxillaries forming equal portions of its upper border. These bones have uniserial conical teeth, largest towards the symphysis; the mandible has two rows with their points inclined backwards, and the interval between the rows covered with minute teeth; the vomer is similarly armed, but the dental surface widens gradually as it approaches the gullet; the palatines are armed by a single row of conical teeth, with a small oval plate of very minute ones within the middle of the row; tongue strongly armed by a marginal row of hooked teeth bigger than the others, and the rest of the surface covered with minute card-like teeth, having their points reflexed. Stomach siphonal; one pancreatic cæcum; air-bladder large, communicating with the œsophagus. Fresh-water North American fish.

CLUPESOCIDÆ.

This family was indicated by Müller in his treatise on the Natural Families of Fish, and was considered by him to be distinct from the true Herrings by having no pseudobranchiæ, which the Clupeoids all possess. On subsequently examining some examples of the genus *Megalops*, he found the pseudobranchiæ present, though evanescently small; and he also discovered that *Gnathobolus*, a genus closely related to *Notopterus*, has pectinated pseudobranchiæ. He therefore ceased to consider the *Clupesocidæ* as a separate family, and referring them all to the *Clupeidæ*, enumerates as members of that family, *Clupea*, *Pristigaster*, *Alepocephalus*, *Gnathobolus*, *Notopterus*, *Engraulis*, *Thryssa*, *Megalops*, *Elops*, *Lutodeira*, *Hyodon*, *Butirinus*, *Chirocentrus*, *Stomias*, *Chauliodus*, *Heterotis*, *Arapaima*, and *Osteoglossum*. Neither *Amia* nor *Chauliodus* have pseudobranchiæ. M. Valenciennes has treated of the genera here enumerated as intermediate between the *Clupeidæ* and *Esocidæ*, and considers several of them to be types of distinct families, some of which have been named by him. After abstracting these, the remainder are here placed under the head of *Clupesocidæ*, as a convenient term indicating their position between the natural families of the Herrings and Pikes. When their anatomy has been more perfectly investigated, they will be distributed by ichthyologists to their proper places in the system. One part of the structure of a fish is much attended to by Müller in his searches after the natural affinities of the various genera he examines, viz., the investments of the ovaries, or the organs which hold the roe or eggs. In the Salmon tribe the eggs are not contained in a separate sac, but drop off from the ovary as they come to maturity, into the general cavity of the abdomen, and are expelled from thence; in the *Galaxidæ* and in various groups that have been separated from the *Salmonidæ*, the ovaries are inclosed in a sac, which has a canal of its own, through which the eggs pass in the process of spawning. A too rigid adherence to a single character often separates fish that are connected by many natural affinities; and some of the *Clupesocidæ* would associate well with the *Scopelidæ* did they possess an adipose dorsal; the absence or presence of teeth on the palate has also been occasionally made of too much importance by systematists.

Classification—Melacopteri.

The genus *Notopterus* is peculiarly interesting to systematic naturalists on account of the combination of characters of very different orders of fish which it presents. With the compressed body of a Clupeoid, it has the denticulations of the preorbitars, suboperculum, and mandible, and the cranial crests observed in several families of *Acanthopteri*, together with a Gobioid union of the ventrals, in which also it agrees with *Gonorhynchus*; the dentition, especially the existence of spheroidal teeth, allies it to *Butirinus*, while the armature of the tongue brings it near to the *Hyodontidæ* or to *Mormyrus*. The eggs are not shut up in a sac, but fall freely into the abdominal cavity as in the *Salmonidæ*.

The genus *Arapaima*, so named by Müller, and since called *Vastres* by Valenciennes, was termed *Sudis* by Cuvier; but Rafinesque having previously used the word *Sudis* to denote a fish of a totally different kind, the name has been necessarily dropt as an appellation of this genus. The species are of much interest not only from the peculiarities of structure which they exhibit, and their encasement in strong, bony, compound scales, but from the great size which they attain, exceeding that of almost all other fresh-water fishes, and also from the excellence of their flesh as an article of food. Sir R. Schomburgk mentions, that in the Rio Negro some are taken which measure fifteen feet in length, and weigh four hundredweight. They are harpooned, or taken with a baited hook, and are the objects of considerable fisheries. They fetch a high price, and are excellent when fresh, especially the belly part which is very fat. When salted they are exported in large quantities to Para, and are there preferred to the salted fish from the banks of Newfoundland.

Butirinus and *Heterotis* are also interesting, but more from peculiarities of their structure than from their utility to man, though, as articles of food they rank among the more highly prized fishes.

Family IX.—CLUPESOCIDÆ, Müll.

No adipose fin; no accessory gills; premaxillaries bounding the orifice of the mouth in the middle above, and the maxillaries the sides. Some have a simple swim-bladder; pyloric cæca in a few, in others absent. Distinguished from the *Clupeidæ* by the absence of accessory gills. They include the following genera: *Stomias*, *Chirocentrus*, *Notopterus*, *Osteoglossum*, *Heterotis*, and *Sudis*, Cuv. (or *Arapaima*, Müll.)

These genera were either associated with *Esox* by M. Valenciennes, or considered as types of peculiar families; and at a later period Muller ceased to consider these fish as forming a proper family, but we have placed them together until appropriate positions are found for them

Classification—Malacopteri.

GENUS I. STOMIAS, Cuv. Elongated scaly fish, having somewhat of the form of *Scomberesox*, but with a short high head and a barbel depending between the limbs of the mandible. Dorsal and anal opposite near the caudal; ventrals in the posterior quarter of the fish before the vertical fins. Scales thin, forming hexagonal divisions in the skin, not imbricated. Mouth cleft far past the eye, which is near the end of the very short snout; upper border of the mouth formed by the premaxillaries and maxillaries; mandible projecting beyond the snout; strong conico-subulate curved teeth on the premaxillaries and mandible, with very small teeth on the part of the maxillary, which passes beyond the premaxillary; small teeth exist between the tall ones; the tongue is toothed in the same manner, and the branchial rakers are in the form of long, hooked teeth. Branchiostegals seventeen; pretty large gill-openings. Alimentary canal a long straight tube, without a stomachal dilatation; no pancreatic cæca; ovaries, two long sacs; a long, slender air-bladder. One Mediterranean species.

The want of an adipose fin seems to be the only character that separates this fish from *Chauliodus*, and other *Scopelini*.

GENUS II. MICROSTOMA, Valenc. General form of *Stomias*, but less elongated, with a small head and a very small mouth, wholly anterior to the proportionally enormous eye. The anal behind the dorsal, and neither of them so far back as in *Stomias*. Upper half of the orifice of the mouth formed by the small premaxillaries and maxillaries, both without teeth; a few vomerine teeth, none on the palatines, nor on the tongue or pharyngeals, but the branchial rakers are long and pointed. Branchiostegals four. Intestine and air-bladder as in *Stomias*; pseudobranchiæ crested. One Mediterranean species. The specimen in the Paris Museum is the same with Risso's, but the imperfect descriptions of the latter giving it an adipose fin, led Müller to believe them to be different.

The *Chirocentres*, says M. Valenciennes, approach *Esox*, and even *Cyprinus*, by the absence of pancreatic cæca, but they depart from these families to place themselves near the Clupeoids by the junction of the premaxillaries and maxillaries. It is a family of only one species, forming the

GENUS III. CHIROCENTRUS, Cuv. Body compressed, elongated; belly trenchant, not denticulated. Dorsal far back on the tail, opposite to the anal; pectorals pointed with a long styloid bone in the axilla covered with scales; ventrals excessively small. Pharyngeal teeth strong and curved; two mesial premaxillary teeth horizontal; upper jaw formed of small premaxillaries soldered to dentiferous maxillaries which have two supplementary pieces as in *Clupea*, one of them hidden under the preorbitar scale bone, the other extending beyond the corner of the mouth; teeth very fine and short on the palatines, two pterygoid bones, the tongue, the branchial arches, and the pharyngeals. Stomach cæcal; intestine short, with the interior mucous coat forming a long spiral valve; no pancreatic cæca; swim-bladder long, slender, with interior imperfect transverse partitions, and an air-tube going to the stomach. Branchiostegals eight.

GENUS IV. NOTOPTERUS, Valenc. Body greatly compressed, very thin towards the tail. Snout obtuse, with little projection, the nasal bone scarcely passing the turbinal; two small premaxillaries placed transversely at the extremity of the nasal, and suspending the free maxillaries, the latter a single bone (not of several as in the *Clupeidæ*); limbs of the maxillaries having a deep, oblong, dorsal cavity, with two trenchant edges carrying teeth; jaws armed with minute raduliform teeth, also the palatines; a small spot on the end of the vomer, an oval surface on the presphenoid; and very long crooked ones on the edges of the tongue. The foremost two suborbital scale bones are serrated on their edges, and also the edges of a large hollow on the inferior limb of the preoperculum, which hides entirely the smooth interoperculum; operculum large, and *suboperculum wanting as in the Siluri*. Large muciferous cavities in the cranium, on which there are five longitudinal ridges, namely, a mesial interparietal one and two lateral ones on each side; the suprascapula is also cavernous, and pierced for the passage of mucoducts. Dorsal very small; anal very long and united to a small caudal; ventrals united to one another, but scarcely perceptible from their minuteness. A genital papilla behind the anus. Belly very much compressed, and edged by a *double series of denticulations*. Scales small, covering the body, the gill-covers, and part of the cheeks; lateral line straight. Branchiostegals seven, erroneously stated in the "*Regne Animale*" to be only one. Stomach compressed, globular, with the cardia and pylorus in front, one over the other. Ova not shut up in an ovisac, but dropping into the abdominal cavity. Air-bladder multilocular, having numerous interior partitions, and some exterior contractions, with two long posterior horns; and two little horns that, proceeding from the fore-part of the bladder attached to the cranium, *pass under the acoustic sacs which contain the otolite, onwards to the third tubercle of the brain*—a unique circumstance in fishes. Three species.

Notopterus is considered by M. Valenciennes to be the type of a peculiar family.

Classification—Malacopteri.

GENUS V. ARAPAIMA, Müll. (*Sudis*, Cuv.; *non* Rafin.; *Vastres*, Valenc.) Body more or less rounded, covered by a mosaic work of osseous scales, which extend over the vertical fins. Anal and dorsal short, and far back. Head formed of deeply sculptured bones, with mucous cells, clothed in a thick skin; large cheek bones; mouth pretty large, bordered above by the premaxillaries and maxillaries, both carrying teeth, and below by the mandible, toothed in the same way; small raduliform teeth cover the palatines, the pterygoids, the vomer, the presphenoid, the lingual bone, and all the body of the os hyoides; and there is a plate of teeth on the internal surface of the mandible; the presphenoidal and palatine teeth vary with the species. Air-bladder said to be cellular like the lungs of a fowl; two valves at the arterial orifice of the ventricle, and no muscular bulb. About six species in the rivers of South America.

GENUS VI. HETEROTIS, Ehren. A large cuirassed head, clothed in mucous skin, and hard mosaic scales on the body, give this genus a resemblance to *Sudis*, but the vertical fins are not scaly. The teeth stand in a single row on the jaws, they are recurved with a rounded point; no teeth on the palatines, vomer, or presphenoid, but there are groups of straight conical teeth on the pterygoids and dilated part of the hyoid bone. Two long, thick, pancreatic cæca. A cellular air-bladder enters into rings formed by the parapophyses of the caudal vertebræ, as in the *Exocœti*. Two species, Africa.

GENUS VII. BUTIRINUS, Com. (*Albula*, Gronov.) Has the general aspect of some of the Indian Cyprinoids. Body regularly fusiform, with a conical head, and pointed snout, passing the end of the mandible a little. Dorsal in the middle of the length, its hinder third opposite the ventrals, the anal half-way between the latter and the largely-forked caudal. Head naked. Body covered with large, hard, firm scales; furrows on the cranium perceptible through the skin. Fine card-like teeth on the jaws, palatines, front of the vomer, and pharyngeals; and what is characteristic of the genus are small, cup-shaped, hemispheric patches of teeth, covering a part of the presphenoid, and another on each pterygoid. The convex tongue fits into the canal formed by these three bones, and its surface is also covered with granular teeth. Intestines like those of the *Clupeidæ*. Stomach large, cæcal; pancreatic cæca twenty-two; hexagonal cells in the mucous coat of the rectum; ovarian sacs opening on each side of the anus. A long air-bladder, having its thin membrane enveloped in an exterior fibrous sac, communicates with the stomach by a short tube. Nine species.

The Butirines, says M. Valenciennes, are undoubtedly allied to the Clupeoids by their large air-bladder and numerous pancreatic cæca, and the want of teeth on the maxillary, but they are kept apart from that family by the absence of a keeled denticulated belly.

ERYTHRINIDÆ.

A small family established by M. Valenciennes of several genera whose true place in the system has been much canvassed. *Erythrinus* is stated by the ichthyologist just named, to present in its skeleton a resemblance to the *Salmonidæ* in the adjustment of the bones of the face, to the *Cyprinidæ* in the size of the lateral occipital foramina, to the *Clupeidæ* in the parieto-occipital foramina, and in the form of the basi-occipital, which differs totally from that of the Cyprinoids in wanting that vaulted dilatation to which the median pharyngeal plate is attached in that family; but again it possesses Cyprinoid characters in the union of the first vertebræ and in the existence of the Weberian ossicles, connecting the air-bladder with the auditory organs, though not exactly in the same way as in the *Cyprinidæ*.

FAMILY X.—ERYTHRINIDÆ.

Erythroïdes, Valenc. Body moderately thick; back and belly rounded; head large; snout obtuse; upper arch of the mouth formed of the small premaxillaries, with the maxillaries articulated to their extremities, both crowded with small conical teeth, as is also the mandible. Villiform teeth cover the palatines and pterygoids, and form an arched plate on the roof of the mouth, separated from its fellow on the other side by a smooth vomerine line; pharyngeal teeth also villiform. Entire cheek covered by bony suborbitar scales, followed by *two temporal plates* which are characteristic of the family. Stomach conical, siphonal; pancreatic cæca numerous;

ovarian sacs not communicating with the cavity of the abdomen; air-bladders two, united by a neck, the anterior one roundish and covered by a thick fibrous coat as in the *Catastomi* and other *Cyprinidæ*, and inserted into the third and fourth vertebral processes, but not communicating with the ear; the second is subcellular anteriorly, without extensive partitions, but with recesses formed by longitudinal and transverse bridles in the walls of the viscus, which project inwardly in thin folds. A tube runs from the second air-bladder to the top of the œsophagus.

Erythrinus, says Müller, belongs decidedly to the *Characini*.

Genus I. Erythrinus, Cuv., Müll. Simple, card-like teeth on the palatines; the bigger canines among the mandibular teeth are proportionally short. Swim-bladder cellular. Six species.

Genus II. Macrodon, Müll. A row of bigger conical palatines in place of the card-like teeth of *Erythrinus*; on the mandible isolated very large canines. Swim-bladder not cellular. Six species.

Genus III. Lebiasina, Valenc. Having the aspect of a *Cyprinodon* and the tricuspid teeth of that family, but with the suborbitars cuirassing the cheek; numerous pancreatic cæca, and a double air-bladder, partially cellular as in *Erythrinus*.

Genus IV. Pyrrhulina, Valenc. In some of its characters this fish approaches the *Cyprinidæ*. A scaly, fusiform fish, with the mandible projecting, and the upper lobe of the caudal elongated. Snout very short; eye rather large; mouth formed above by the short premaxillaries carrying minute crowded teeth, and on the side by oval edentate maxillaries, which fit into pits in the mandible; the mandible has large limbs, with small conical teeth, and moves after the manner of the jaw of *Mugil*; the second and third suborbitar scale bones cover the cheek. Stomach roundish; six pancreatic cæca; a double air-bladder, like that of *Macrodon*, without cellular walls, but with a tube from the posterior conical half, which communicates with the upper part of the œsophagus. One species, Surinam.

Genus V. Umbra, Kram. Small premaxillaries, articulating at their extremities with the maxillaries, both carrying teeth; vomer and palatines also studded with teeth. Branchiostegals five; œsophagus short and globular. Stomach long, cylindrical, siphonal; no pancreatic cæca; air-bladder simple, pointed behind, rounded before, and communicating with the pharynx by a wide opening. A thickly fusiform fish, with a short-conical, smooth head, large scales on the body, and a dorsal rather posterior to the middle of the fish, and opposite to the small ventrals and anal. Caudal fin cuneate at the end.

This genus is one which ichthyologists find a difficulty in assigning to any family that has as yet been characterized. It combines the characters of several groups. Müller remarks that it does not belong to the Pœcilian genus *Cyprinodon*, since, in addition to the premaxillary teeth, it has teeth on the vomer and palate bones; and a mouth bounded anteriorly by the premaxillaries, and externally by the maxillaries, as in *Esox*, with which it agrees also in having no cæcal projection of the stomach, and in the intestines and the covered pseudobranchiæ. (*Arch. fur Naturg.*)

Genus VI. Dussumiera, Valen. This fish, having the aspect of a *Clupeoid*, but, being without denticulations on the belly, is one of the species whose combinations of characters mock at our attempts at arrangement. It has teeth on the jaws, palatines, pterygoids, and tongue, but the vomer is smooth. There are raduliform patches of teeth on the palatines and pterygoids as in *Elops*, but it cannot enter the *Elopidæ* family, because it wants the sublingual bone of *Elops*. It ought to be placed, M. Valenciennes thinks, between *Butirinus* and *Elops*. One species, *D. acuta*.

Genus VII. Etrumeus, Bleek. Separated from *Dussumiera* because it has vomerine teeth. (*Clupea micropus*, Schlegel.)

ELOPIDÆ.

The existence of a bone between the limbs of the lower mandible is one of the characters of this family, and the want of it in *Butirinus* (left among the somewhat heterogeneous *Clupesocidæ*) is the reason why M. Valenciennes did not place that genus with his *Elopiens*. *Amia* is another genus in which this sublingual bone is present, but Müller has adduced various arguments founded on its structure for considering it to be one of the few living Ganoids, and we shall accordingly mention it under that order along with the *Lepidostidæ* which are more unequivocal Ganoids.

The figure No. 75, represents the *Elops saurus*, or Silver-fish of Garden, a fish which has been introduced into our systematic works under four different specific names and three generic ones. It is the only representative of the genus *Elops* yet discovered, and is one of the few fishes which are

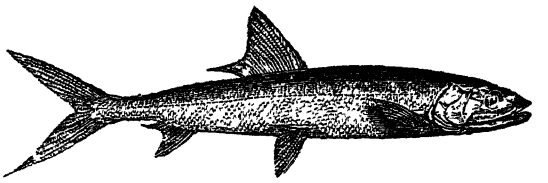


Fig. 75.
Elops saurus.

common to the warmer parts of both the Atlantic and Pacific Oceans. It has been captured at New Orleans, Surinam, and on the coast of the Brazils; also on the opposite African coast at Senegal. In the Red Sea also, at the Isle of France, in the Indian Ocean, and, lastly, on the North Australian coasts and in the seas of Polynesia, westward to Japan and China.

There is a likeness between the genera *Lutodeira* and *Elops*, but the great number of branchiostegals which the latter possesses at once distinguishes them.

Family XI.—ELOPIDÆ.

Elopiens, Valenc. Separated by M. Valenciennes on account of the presence of a sublingual bone from the *Butirinidæ*, to which they are nearly allied. This bone exists in *Amia*, but that genus has another kind of dentition. These fish are remarkable among their allies for the *number of their branchiostegals*, and the *median bone* under the branchiostegal membrane, between the limbs of the mandible, is also an unusual part of their structure. The mouth is, like that of the *Clupeidæ*, bordered above by small premaxillaries, and long free maxillaries on the side. Teeth so fine on the premaxillaries, maxillaries, mandible, palatines, entopterygoids, vomer, presphenoid, and tongue, that they appear merely to be slight asperities. Body long and rounded; no denticulations whatever on the belly. Dorsal medial, with no prolongation of the last ray. An enlarged and indurated scale on the dorsal and ventral edge of the base of the deeply-forked caudal; long scaly appendages in the axillæ of the ventrals and pectorals. Head naked; a diaphanous, waxy-looking, adipose eye-membrane. Stomach conical, with an ascending fleshy branch; numerous pyloric cæca; a large air-bladder communicating with the digestive canal, and forked anteriorly, but not entering the cranium.

Genus I. Elops, Linn. Character of the family as above. Two species.

Genus II. Megalops, Commer. Body elongated, of moderate height and elegant form. Mouth bordered above by the small premaxillaries, and by the large, moveable, compound maxillaries on the sides, with the edges of both rough with minute teeth: there are teeth also on the mandible, the palatines, the pterygoids, the front of the vomer, the presphenoid, the lingual and hyoid bones, and on the pharyngeals. Wide gill-openings; branchiostegals numerous (twenty-two to twenty-five). A sublingual bone between the limbs of the mandible. An adipose eye-lid to the pretty large eye. Small dorsal, with the tip of the last ray filamentous and long. A large conical stomach; numerous slender, filiform, pancreatic cæca; air-bladder large, forked anteriorly, with an air-pipe from it opening into the pharynx. Three species.

MORMYRIDÆ.

A small family of fishes which abound in the rivers of both sides of Africa, the Nile, Senegal, and Congo. They are timid fish, of nocturnal habits, that frequent rocky basins in the rivers, and would be seldom taken but for the high price they command, which renders the fishermen very assiduous. They are caught with lines to which many hooks baited with worms are affixed, and one fisherman rarely succeeds in taking more than two or three in the course of the night. Their flesh has an excellent flavour, and is greatly esteemed by the epicures of Egypt. These fish seem to have been objects of as great attention to the ancient Egyptians as they are to the present inhabitants of that country. In the Egyptian museum of Paris there is a small bronze representation of one of the sharp-nosed

Classification—Malacopteri.

Mormyri surmounted by the mythic horned circle emblematic of the divinity Athor; and mumified *Mormyri* are not rare. Sir J. Gardner Wilkinson says, that the name of these fish in modern Egypt is *Mizdeh;* and in page 250 of the second volume of the second series of *Ancient Egypt*, he gives two very recognisable representations of a *Mormyrus* taken from bronzes, one of them crowned by the emblem in question. A third figure is copied from a representation of the fish in the temple of the Great Oasis, where it is coupled with the name of the goddess, and shows, Sir Gardner thinks, that the fable of the metamorphosis of Venus into a fish was of Egyptian origin. The ancient Egyptians appear to have made the *Mormyrus* an object of veneration, but to have abstained from eating it, according to Plutarch, because it was one of three different kinds which devoured a part of the body of Osiris, and which Isis therefore was unable to recover when she collected the rest of the scattered members of her husband. The *Mormyrus longipinnis* of Rüppell, or *M. caschive* of Hasselquist and Valenciennes, has been ascertained to possess electric organs, which probably exist in other species also, and may be one reason for the veneration of the whole genus by the ancient Egyptians. The long-finned species represented by one of the bronzes figured by Sir Gardner Wilkinson is either this *M. caschive* or the *M. oxyrhinchus* which has also a long dorsal. Müller found the premaxillaries of the *Mormyri* to be united so as to form a single bone.

FAMILY XII.—MORMYRIDÆ, Müll.

Mormyri, Cuv. Longish compressed bodies, with a tail slender at its origin, but swelling out at the attachment of the caudal. Head encased in a thick, naked skin, which envelopes the gill-cover and branchiostegals, and leaves only a perpendicular slit for a gill-opening. Branchiostegals six. Mouth small, and bounded above mesially by a single bone formed of the coalescent premaxillaries as in *Diodon;* laterally the maxillaries enter into the composition of the orifice. Dentition various. The post-frontal or temporal apparatus is simpler than in other fish, therein resembling the *Siluridæ*. The cranium has a peculiar canal closed by the skin, leading to the interior hollow of the skull, and the acoustic labyrinth. Accessory gills absent; stomach globular; intestine long and slender; two pyloric cæca; swim-bladder simple.

GENUS I. MORMYRUS, Müll. A row of slender teeth, curved at the tips on the premaxillaries and mandible, and in the young a stripe of raduliform teeth on the hinder parts of the vomer. *M. cyprinoides, oxyrhynchus, dorsalis, longipinnis.*

GENUS II. MORMYROPS, Müll. Conical teeth on the jaws in place of curved tipped ones. *M. anguilloides, labiatus.*

M. Valenciennes does not adopt these genera of M. Müller, as he says that conical and slender teeth exist on the jaws of the same species. He describes twenty species, in two groups, characterized by the length of the dorsal fin. Since the publication of the *Histoire des Poissons*, Peters has discovered six new ones on the Mozambique coast. Most of the species described by M. Valenciennes have two minute lateral cusps to the teeth, separated by a *notch* as in *Crenidens.*

CYPRINODONTS.

The typical forms of this family are small fishes, formerly considered to be Cyprinoids, but, as their name denotes, differing from the true Carps in possessing teeth, and, moreover, in having protractile jaws; they want also the kind of pharyngeal grinding apparatus which is peculiar to the Carps. Species exist both in the Old and New Worlds; and some inhabit indifferently fresh, brackish, or salt water. We have seen specimens procured in a brine spring and salt marsh on the shores of the Dead Sea, on the supposed site of Sodom, probably from one of the slime pits of Siddim of which the valley was full in Abraham's time. In one member of this family, the *Guapucha* (*Pœcilia bogotensis*), which inhabits the little river of Bogota on the plateau of Santa Fe, 8840 feet above the sea level, Humboldt found a double air-bladder; and, on examining the contained air, ascertained that 93 parts in 100 were azote, the rest being carbonic acid and oxygen. The *Orestias* are found at a still greater altitude, being inhabitants of Lake Titicaca and other elevated sheets of water on the Cordilleras of Peru and Bolivia, between the 14th and 19th degrees of latitude, and from 13,000 to 14,000 feet above the sea. The flesh of these fishes is a great delicacy; and they are sought for during the winter season, when they can be transported without spoiling.

Classification—Malacopteri.

Anableps is a genus which excites the attention of the dullest of observers by a conformation of the eyes which no other vertebrated animal possesses, in the cornea being divided into two somewhat unequal elliptical parts by a bridle of the conjunctiva, giving to each eye the appearance of being double. This very peculiar structure has most likely a connection with the habit the fish has of swimming with the eyes partly out of the water. *Panchax* and *Vandellia* were considered by M. Valenciennes to have affinities with *Pœcilia*, but owing to their possessing teeth on the palate he places them after *Esox*. Neither has *Diplopterus* been enumerated among the *Cyprinodonts* by Müller, but no other more convenient place for these three genera occurs than just before the *Esocidæ*.

FAMILY XIII.—CYPRINODONTIDÆ, Agass.

Cyprinodontes, Agass. This is a very precise family, with prominent characters. Its members resemble the *Cyprinidæ* in habit, but they do not possess the large pharyngeal tooth, nor the bony process of the basi-occipital. Upper and under pharyngeal teeth card-like; maxillary as in the *Cyprinidæ*, and the premaxillaries forming alone the upper half of the mouth, but they are armed with teeth; jaws protractile. Swim-bladder simple, and unfurnished with a chain of acoustic ossicles. No supplementary gills. Stomach siphonal; no pancreatic cæca. Some are viviparous.

GENUS I. PŒCILIA, Valenc. Jaws depressed, horizontal and protractile, the upper border of the mouth formed solely by the premaxillaries; moveable and curved teeth on both jaws in an exterior row, with a stripe of villiform teeth behind; roof of the mouth edentate, soft; many rows of hooked teeth on the pharyngeals. Five branchiostegals. A single, simple air-bladder. Long, simple intestines; viviparous. Eight species.

GENUS II. MOLLIENESIA, Lesu. Having the dentition, branchiostegals, and intestines of *Pœcilia*, they differ in the position of the anus, advanced to between the ventrals, which are rather far back. A large and long dorsal and expanded caudal. One species, Lake Pontchartrain.

GENUS III. XIPHOPHORUS, Heck. Teeth bristly, short, surrounded by a row of stouter ones. Ventrals as in *Mollienesia;* anal in the male close to the ventrals, the front rays thickened, connected together by a long plate, whose extremity is used as a prehensile organ; the posterior rays very short. Three Mexican species.

GENUS IV. CYPRINODON, Lacép. (*Lebias*, Cuv.) Viviparous fishes, with the jaws rather less depressed than in *Pœcilia*, the teeth in a single close row, compressed and tricuspid. Branchiostegals five. Intestines and air-bladder of *Pœcilia*. Small fishes resembling a Minnow. Eight species.

GENUS V. FUNDULUS, Lacép. Characterized by the presence of fine card-like teeth on arched premaxillaries, the upper half of the orifice of the mouth being semicircular. Head flat beneath; and the jaws not depressed as in *Pœcilia*. Branchiostegals five. Eight species.

GENUS VI. HYDRARGYRA, Lacép. Teeth of *Fundulus*. Six branchiostegals. Four species.

GENUS VII. GRUNDULUS, Valenc. Body compressed, oval; the flat upper jaw shorter than the mandible; numerous teeth on the jaws. Dorsal far back, opposite to the anal. Branchiostegals five. Air-bladder double, the posterior one much the largest. One species, seen only by Baron Humboldt.

GENUS VIII. ORESTIAS, Valenc. Thickly fusiform, apodal, scaly fishes. Dorsal and anal opposite to each other, behind the middle of the body, on the commencement of the tail. Mouth rather small at the extremity of a muzzle which bulges beneath by the projection of the mandible; teeth fine and hooked; pharyngeal teeth card-like. Five branchiostegals. Scales of the fore part of the fish hard horny bucklers, with occasional intervals of naked skin; posteriorly they are ordinary cycloid scales like those of a Carp. Lower part of the belly destitute of scales, shining and metallic in lustre. Nine species, Andes.

M. Gervais has instituted a genus which he names *Tellia*, for an

Classification—Malacopteri.

Algerine fish which is distinguished from *Cyprinodon* by the want of ventrals. We know it only by a brief notice in the *Archiven fur Naturgeschichte*, and are not told in what respect it differs from *Orestias*.

Genus IX. Anableps, Bloch. Elongated scaly fishes, with a flattish, rounded back, and depressed head. The maxillaries carry no teeth, and do not enter into the composition of the border of the mouth, which is formed above by the premaxillaries alone. On these there are teeth, the outer row being moveable like those of *Pœcilia*, and the inner ones minute, in a crowded band; roof of the mouth smooth, edentate; tongue a very small tubercle; pharyngeal teeth two plates above and below, conical pointed, villiform, crowded; lips thick; eyes prominent under a scaly arch, having the cornea and iris divided by a longitudinal band, so as to give them the appearance of being double. Branchiostegals five. In the male the excretory canal of the organs of generation, common also to the urinary bladder, is carried along the front of the anal beyond the tip of its first ray, in a tapering, scaly appendage, with the orifice at the extremity. The female is viviparous, but seldom produces more than seven or eight young at a time. Air-bladder pretty large, with a pneumatic duct in the fœtal state, which is obliterated as the fish attains maturity. Four or five species.

Genus X. Diplopterus, Gray. (*Luciocephalus*, Bleeker.) Is placed by its affinities between *Cyprinodon* and *Esox*; the existence of vomerine teeth brings it near *Panchax*, which it resembles in the position of the ventrals under the pectorals. A single anacanthous dorsal opposite the anal. Upper half of the mouth composed of the very protractile premaxillaries, which have moreover a tuft of teeth on their ascending pedicels, and uniserial teeth on their labial limbs; mandibular teeth pluriserial in front; vomer rough, with minute teeth; four complete branchial arches; no pseudobranchiæ; inferior pharyngeals widely separated, armed with conical teeth. Gill-openings large, coming forward under the eye. Branchiostegals five. Nostrils two in the preorbitar space. Scales Ctenoid on the body, Cycloid on the head. Stomach cæcal, intestine short; no pancreatic cæca.

Genus XI. Panchax, Hamilt. Buch. Thickly fusiform scaly fishes, highest in the middle, and tapering rather more towards the head than posteriorly. Dorsal far back over the posterior part of the larger anal; abdominal ventrals before the middle of the fish. Upper arch of the mouth formed by the premaxillaries, behind whose descending limbs the maxillary lies and does not touch the edge of the orifice, which is garnished all round by a narrow band of teeth as fine as hairs. Teeth on the palatines; branchiostegals five.

Genus XII. Vandellia, Valenc. Body elongated, rounded, slenderer anteriorly; snout depressed, prominent; mouth small, situated on the ventral aspect; lips thick, with a fleshy barbel at the corners of the mouth on each side; teeth on the vomer; none, or little visible teeth on other parts of the mouth. Ventrals small, on the posterior third of the body; dorsal standing over the interval between the ventrals and anal. One species, India.

ESOCIDÆ.

By the abstraction of groups formerly included in the Pike family, only a single genus remains to represent it, and of this there is only one European species, viz., *Esox lucius*, Linn. (the common Pike). During the earliest stage of its life it is of a greenish hue, but in the second year it becomes gray with pale spots, the latter ultimately acquiring a yellowish colour. Its markings, however, are very variable, and instances have occurred of its being perfectly white. It is one of the largest of fresh-water fishes, and indeed, if the accounts which some writers give are not exaggerated, it occasionally attains a size not greatly inferior to the gigantic inhabitants of the ocean. Individuals are recorded as measuring from 5 to 9 feet in length. They frequently weigh above 30 lb. in the lakes of the north of England; and Dr Grierson mentions one taken in Loch Ken, in Galloway, which weighed 61 lb. Pallas states that the lakes in the government of Tobolsk in Siberia nourish multitudes of Pikes which attain the size of between 30 and 40 lb. In North America, which seems to be the headquarters of the family, since not only the common European species, but several others exist in the great lakes of that country, 30 lb. is considered a large size, though doubtless some individuals attain a greater weight. Most authors have cited the accounts of one said to have been caught at Kaiserslautern, near Manheim, in 1497, which was nearly 19 feet in length, and weighed 350 lb. The skeleton of this extraordinary specimen was for a long time preserved, and bore a brass ring with an inscription to the effect that the fish was put into a pond by the hands of the Emperor Frederick II., the 5th of October 1262. From this it is inferred that it was upwards of 235 years old. M. Valenciennes enters at some length into a critical examination of the truth of this story. Gesner, who lived soon after the time assigned to the capture of this remarkable fish, and who might have known eye-witnesses of the event, says that it was caught near Heilbronn, in Suabia; and in 1592 Lehman saw a painting of the Pike and a sketch of the ring kept in a tower on the road from Heilbronn to Spires, and the piece of water whence it was taken was still named *Kaiserwag*, or the Emperor's Lake, in 1612. There seems to be no doubt but a fish of great size and great age was taken about the time mentioned, but there are discrepancies enough in the various accounts that are given of it by authors to make the details doubtful; and a celebrated anatomist having examined the skeleton of the said Pike, then kept in the Cathedral of Manheim, found the vertebræ to be more numerous than those of a single Pike, and in fact that the skeleton had been lengthened to fit the story, which had itself undergone the same process from that love of the marvellous which is common to every age. The common Pike is not only an inhabitant of most of the larger waters of Europe and northern Asia, but it is certainly one of the native fishes of North America. This is a question of interest to those who are engaged in tracing the distribution of animals, and some pains were taken to ascertain the identity of the species in the two hemispheres. A specimen brought from Lake Huron was examined by Baron Cuvier and M. Valenciennes, and found to be the same with the European one; and Sir John Richardson carefully compared the European and American fishes with each other without detecting any specific difference. Some American ichthyologists have questioned the accuracy of these examinations, but they do not appear to have given sufficient weight to the fact of there being more than one species in the great lakes of their country, and the chance of the specimen they commented on being one of these. *E. estor* inhabits Lake Huron, as well as *E. lucius*, and most likely there are others in that lake or in the fresh-water seas that communicate with it. M. Yarrell gives some interesting facts respecting the value of this fish at different periods of English history. Edward the First fixed the price of a Pike higher than that of fresh Salmon, and ten times greater than that of the best Turbot or Cod; and in the reign of Henry the Eighth a large one was sold for double the price of house-lamb in February, and a Pickerel or young Pike for more than a fat capon. These facts are sufficient to show the error of some writers on British ichthyology, who have fixed upon the reign of Henry the Eighth as the epoch of the introduction of the Pike into the British isles; which Albin says

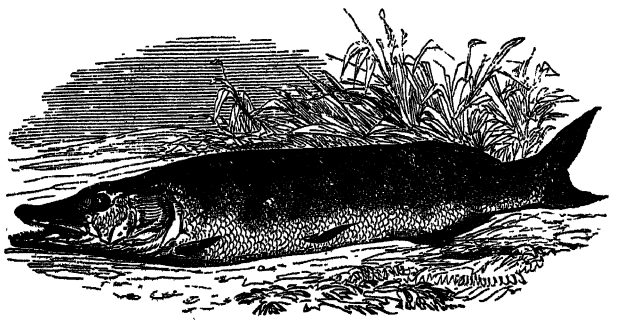


Fig. 76.

Esox lucius.

Classification—Malacopteri.

was in 1537. Leland mentions that a Pike of great size was taken in Ramesmere, Huntingdonshire, in the reign of Edgar. Pikes are proverbially voracious. There seems, indeed, to be no bounds to their gluttony; for they devour indiscriminately whatever edible substances they fall in with, and almost every animal they are able to subdue. "It is," says M. de Lacépède, "the Shark of the fresh waters; it reigns there a devastating tyrant, like the shark in the midst of the ocean; insatiable in its appetites, it ravages with fearful rapidity the streams, the lakes, and the fish-ponds that it inhabits. Blindly ferocious, it does not spare its species, and even devours its own young; gluttonous without choice, it tears and swallows, with a sort of fury, the remains even of putrified carcasses. This bloodthirsty animal is also one of those to which nature has accorded the longest duration of years; for ages it terrifies, agitates, pursues, destroys, and consumes the feeble inhabitants of the waters which it infests; and as if, in spite of its insatiable cruelty, it was meant that it should receive every advantage, it has not only been gifted with strength, with size, with numerous weapons, but it has also been adorned with elegance of form, symmetry of proportions, and variety and richness of colour." A singular instance of its voracity is related by Johnston, who asserts that he saw one killed which contained in its belly another Pike of large size, and the latter, on being opened, was found to have swallowed a water-rat! Its flesh is well flavoured and easy of digestion, and is consequently much sought after as an article of food, especially for convalescents, and others of weakly habit. It is most tender and nutritive in young individuals, but full-grown Pikes are occasionally found in which the flesh on the back and near the vertebral column acquires a greenish colour, which is held in high repute, and often purchased at a great price. Sibbald, writing in the reign of Charles the Second, says that the heart of the Pike is a remedy against febrile paroxysms, that the gall is of much use in affections of the eyes, that the dried jaws reduced to powder are a remedy in pleurisy, gravel, and stone in the bladder, and that the ashes of the fish are used to dress old wounds. These and the rest of his statements on medical subjects have the formal approbation of the President and Censor of the Royal College of Physicians of Edinburgh.

Even the names of the Pike is a subject not without its interest. It is the *Lucio* or *Luzzo* of the Italians, an appellation evidently descended from the Latin *lucius*. Ausonius, in using this term, says that it was a despised fish on the Moselle, very contrary to the estimation in which it was held in England ten centuries later—

> "Lucius, obscuras ulva cænoque lacunas
> Obsidet. Hic nullos mensarum lectus ad usus,
> Fervet fumosis olido nidore popinis."

In Sweden it is named *Gädda*, and in Denmark *Giedde*, *Gedde*, *Gede*, or *Gei*, names differing little from the appellation of the fish in the lowlands of Scotland, "Ged," and showing, with many other instances of Scandinavian words relating to maritime affairs and fisheries, the origin of the population that displaced the Celtic races from the country lying to the south of the Firth of Forth, and on the east coast of Scotland still farther north. M. Valenciennes has printed a long list of the names which the fish bears among the Sclavonic and Tartar peoples, none of which seem to have any relation to those by which it is known on the western coast of Europe. The Scandinavian name had probably its origin in the sharpness of the teeth of the Pike, and the consequent danger of injury to those who attempted to handle it, for we find a similar word, *Gede* or *Geede*, used to designate a goat in Danish (also lowland Scottish "Gait"), and *Gedehams*, to signify a hornet. The English names Pike and Pickerel are evidently sprung from the Saxon *Piik* (sharp-pointed), and the French Canadians term the *Lucioperca* of that country the *Piccarel*, which it well merits, as its teeth are no less formidable than those of the *Esox lucius*.

Classification—Malacopteri.

FAMILY XIV.—ESOCIDÆ, Müll.

Scaly fishes without an adipose fin, and possessing covered glandular accessory branchiæ. Orifice of the mouth formed above in the middle by the premaxillaries, and on the sides by the maxillaries. A simple swim-bladder. Diffuse vascular ramifications exist on the inner surface of the skin, which are peculiar to this family. Stomach siphonal; no pancreatic cæca. Type of form the common Pike; inhabitants of fresh waters only, in the northern hemisphere.

GENUS I. ESOX, auct.

GONORHYNCHS.

The members of this small family are more interesting from the peculiarities of structure that they exhibit, and which are briefly denoted in the generic characters, than by their importance in an economical point of view. The *Chanos*, however, has been named Milk Fish, from its delicacy as an article of food.

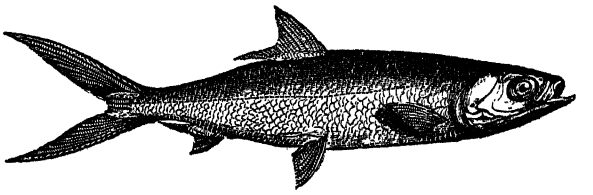


Fig. 77.

Chanos or *Lutodeira salmonea*.

A scale of this fish has been represented on a preceding page (fig. 40), and the following woodcuts give the portrait of *Gonorhynchus Greyi*, a fish of Western Australia, and of one of its scales.



Fig. 78.

Gonorhynchus Greyi.

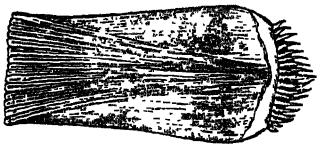


Fig. 79.

Scale of *Gonorhynchus Greyi*.

On the *Alepocephalidæ*, we have no remarks to make.

FAMILY XV.—GONORHYNCHIDÆ.

Gonorhynques, Valenc. This small family was constituted by M. Valenciennes for the reception of two genera which want oral teeth, and thus have some affinity with the *Cyprinidæ*.

GENUS I. CHANOS, Lacép. (*Lutodeira*, Van Hass., Rüpp.) The *Chanos* have an affinity to the *Clupeidæ* without actually belonging to that family, and are separated from the characteristic Herrings by the belly being rounded and not carinated, nor denticulated. They resemble the *Butirinidæ* and *Gonorhynchi* in their fatty eyelids, toothless jaws, and scaly appendages in the axillæ of the pectorals and ventrals; they have, moreover, a lanceolate scaly fillet above and below the lateral line on each side, extending longitudinally over the caudal, dividing the long acute lobes of the forked caudal from a small central portion. *Chanos* is further character-

ized by a peculiar hollow behind the gill-opening, which communicates with the gills through an aperture, and lodges an accessory gill that has cartilaginous supports. The intestinal canal is very long, being doubled upon itself many times, and in the interior of the œsophagus there is a complete spiral valve, of numerous turns, and with fringed edges, which have been observed in no other genus. Pancreatic cæca numerous. Air-bladder double, communicating with the œsophagus. Upper half of the mouth formed partly by the premaxillaries, partly by the maxillaries. General aspect that of a *Coregonus*. Species eight.

GENUS II. GONORHYNCHUS, Gronov. (*Rhynchæna*, Rich.) Body elongated, with a slenderly conical head, ending in an acute snout, which has a small median barbel beneath. Dorsal and anal fins opposite, very far back; long scaly processes in the axils of the pectorals and ventrals; branchiostegal membrane uniting with the surface of the throat, and leaving merely a vertical slit for a gill-opening. Branchiostegals four; lips fringed and lobed. Scales small, pectinated on the edge by a row of long and strong teeth. Pharyngeal teeth cylindrical, truncated; pyloric cæca six to nine; no air-bladder. Two species.

FAMILY XVI.—ALEPOCEPHALIDÆ, Valenc.

This family consists of a single species, of which M. Valenciennes says "the genus *Alepocephalus* is separated from all others, and forms the type of a peculiar family." The upper jaw is that of the Pikes (*Esox*), with an alimentary canal like that of the Clupeoids, and a spiral valve in the rectum like *Amia*, but with many pancreatic cæca and no air-bladder, whereas *Amia* and *Chirocentrus* have remarkable air-bladders and no pancreatic cæca. No denticulations on the belly like those of the Clupeoids. Body compressed, rounded beneath; long scaleless head. Short premaxillaries bearing teeth, forming the upper half of the mouth; toothless maxillaries lying behind them; palatine and mandibular teeth small. Siphonal stomach with numerous pancreatic cæca; spiral valve in the rectum. One species.

GENUS I. ALEPOCEPHALUS, Risso.

CYPRINOIDS.

This large family is a very natural one, but the great conformity of structure exhibited by its very numerous species is a source of difficulty to ichthyologists who have attempted to divide it into genera, and other subordinate groups. It is wholly a fresh-water family, and among the least carnivorous in the class of fishes.

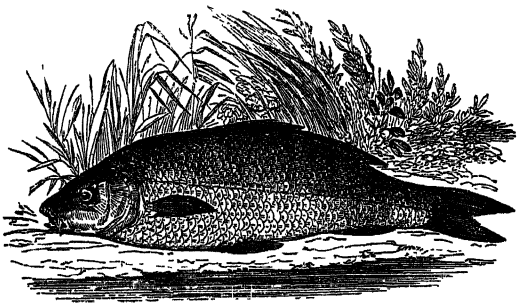


Fig. 80.
Cyprinus carpio.

Cyprinus carpio, the common Carp. This well-known fish is of an olive-green, yellowish beneath, having the anal and dorsal spines strong and denticulated, and the barbels short; the pharyngeal teeth are flat and striated on the crown. It is a native of the central countries of Europe; but, owing to its value as an article of food, it was early distributed by human agency over the whole of that Continent. The ease with which it can be transported from one place to another, and its speedy growth and propagation in ponds and artificial reservoirs, afforded great facilities for its rapid dispersion. The year 1614 is assigned as the date of its first introduction into England; but it was naturalized in Germany and Sweden nearly half a century before that period. It delights in tranquil waters, preferring such as have a muddy bottom, and the surface partially shaded with plants. Its food consists of the larvæ of aquatic insects, minute Testacea, worms, and the tender blades and shoots of plants. The leaves of lettuce, and other succulent plants of a similar kind, are said to be particularly agreeable to them, and to fatten them sooner than any other food. Although the Carp eats with great voracity when its supply of aliment is abundant—to such a degree, indeed, as sometimes to produce indigestion, which occasionally proves fatal—it can subsist for an astonishing length of time without nourishment. In the winter, when the Carps assemble in great numbers, and bury themselves among the mud and the roots of plants, they often remain for many months without eating. They can also be preserved alive for a considerable length of time out of the water, especially if care be taken to moisten them occasionally as they become dry. Advantage is often taken of this circumstance to transport them alive, by packing them among damp herbage, or wet linen; and the operation is said to be unattended with any risk to the animal, especially if the precaution be taken to put a piece of bread in its mouth *steeped in brandy!* In a similar way, the Dutch preserve them by suspending them from the roof of a damp apartment in a bag-net filled with moss, which is continually kept moist, and they are fed with vegetables and bread steeped in milk—a mode of treatment by which they are not only kept alive, but actually thrive and fatten.

The fecundity of these fishes is very great, and their numbers consequently would soon become excessive, but for the many enemies by which their spawn is destroyed. No fewer than 700,000 eggs have been found in the ovaria of a single Carp, and that too by no means an individual of the largest size. Their growth is very rapid, more so perhaps than that of any other fresh-water fish, and the size which they sometimes attain is very considerable. In certain lakes in Germany and Prussia, individuals are occasionally taken weighing thirty or forty pounds; and Pallas relates that they occur in the Volga five feet in length, and even of greater weight than the examples just alluded to. The largest of which we have any account is that mentioned by Bloch, taken near Frankfort-on-the-Oder, which weighed seventy pounds, and measured nearly nine feet in length. M. Valenciennes commends the small figure of the Carp in Mr Yarrell's *British Fishes*, as being the very best representation of the fish that he had seen.

Cyprinus auratus (Gold Fish). This beautiful species, the most brilliantly adorned of all our fresh-water fishes, and scarcely surpassed even by the more richly ornamented inhabitants of the ocean, is well known to be a native of China, although it is now domesticated, so to speak, in almost every country, both of the old and new world. Like the Carp, it has the dorsal and anal spines denticulated. When young it is of a blackish colour, and it gradually acquires the fine golden red by which it is characterized; but some examples are of a silvery hue, aud others are variegated with three different shades of colour. Like most other animals that have been long estranged from their natural habits, and subjected to artificial influences, this species presents a great many varieties, extending even to some important parts of structure. Individuals occur without a dorsal, others with a very large one, others with the caudal greatly enlarged, and divided into three or four lobes; and in some instances the eyes are enormously dilated. The Golden Carp is said to have been originally confined to a lake near the mountain Tsienking, in the province of The-kiang, in China, about N. Lat. 30. It was first brought to England in 1691, but was very scarce till 1728, when a considerable number were imported, and they soon became generally known. They do not flourish in rivers and open ponds, not, however, because such places are uncongenial to them, but because they are exposed to many enemies, against which they have no means of de-

Classification—Malacopteri.

fence. When kept in confinement they ought to be nourished with fine crumbs of bread, small worms, flies, and yolks of eggs dried and powdered, and the water ought to be frequently changed. The ordinary length of this species is from four to six inches; but they have been sometimes known to reach a foot. Although natives of a warm climate, they can sustain a great degree of cold uninjured. An individual, which was accidently exposed during the night, was completely frozen up in the centre of its glass jar; but as the ice thawed it recovered its vigour, and seemed to suffer no further inconvenience.

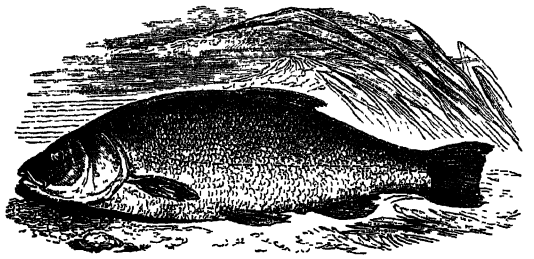


Fig. 81.
Tinca vulgaris.

The Tench (*Tinca vulgaris*) is of a deep yellowish brown, sometimes, however, assuming a fine golden colour. Its usual length is from 12 to 14 inches; but instances are on record of its having reached 3 feet. It inhabits stagnant waters with a muddy bottom; and in the winter conceals itself among the mud, and seems to undergo a kind of torpidity. In May and June it deposits its ova among aquatic plants; these are very minute, of a green colour, and so numerous that 297,000 have been reckoned in one female. The Tench is very extensively distributed, appearing to occur throughout Europe and Northern Asia.

"Quis non et virides vulgi solatia Tincas norit."
AUSONIUS.

Its flesh is not much esteemed, as it is soft, insipid, and difficult of digestion.

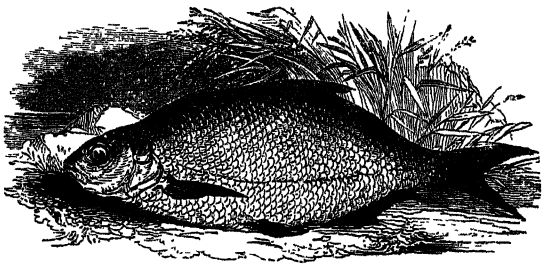


Fig. 82.
Leuciscus brama.

The Bream (*Leuciscus brama*, Valenc.) is common in slow-flowing rivers and lakes in most European countries. It sometimes acquires 2½ feet in length, but its ordinary dimensions may be stated to be about 1 foot. Worms, confervæ, and aquatic plants are its usual food; but like many allied species, it often swallows mud, which renders its flesh unsavoury. "There exists in the River Trent, in the neighbourhood of Newark, two species or varieties of Bream. The common Bream is known there by the name of Carp Bream, from its yellow colour, and has been taken of nearly eight pounds weight. The other species or variety, which I believe to be a nondescript, never exceeds a pound in weight. It is of a silvery hue, and goes by the name of White Bream."

Leuciscus rutilus (Valenc.) is the *Gardon* of French fishermen, and the *Rödskalle* (Red-scale), or *Rödfisk* (Red-fish), of the Danes. In some parts of Germany it is named

Classification—Malacopteri.

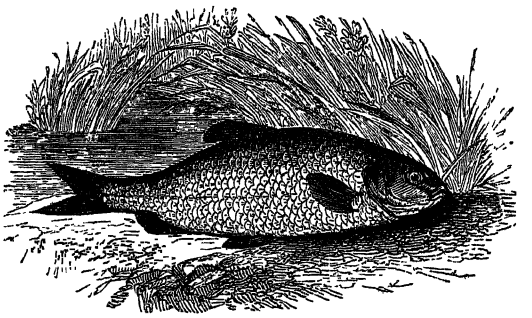


Fig. 83.
Leuciscus rutilus.

Röthauge, but in general it is called in that country *Roche*, an appellation evidently identical with its English one.

The Chub, named in Cumberland Skelly, is a well known English fish, and has received its northern appellation (*quasi* Scaly) from the size of its scales.

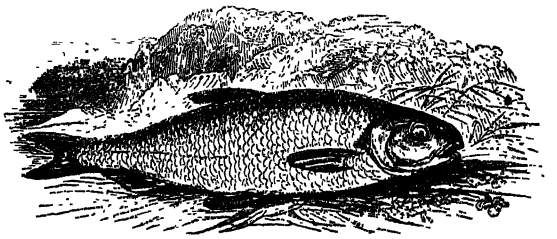


Fig. 84.
Leuciscus cephalus.

English ichthyologists have all given it the specific name of *cephalus*, but M. Valenciennes remarks that the term *cephalus* was applied by Linnæus to an assemblage of an *erythrinus* with the tenth species of Artedi, which itself comprehends several European *Cyprini*. He therefore employs the specific name of *Jeses*, also Linnæan, to denote the Chub of England, which is the *Jentling* or *Bratfisch* of the Danube, and the *Jeses* or *Jese* of the Oder. *Leuc. phoxinus* (common minnow) is familiar to all. It is the smallest species of the genus found in Europe, the greatest length which it attains seldom exceeding 3 inches. It first makes its appearance in March, and disappears in October, passing the winter beneath the mud. It is well known to be a gregarious species, and small shoals are to be found in almost every shallow stream, especially in clear weather, as they seem to delight in warmth and sunshine. They usually spawn in the month of June, but their ova are often found at a much later period. The flesh of the minnow is delicate and well-flavoured, but its size is too small to admit of its being of much value as an article of food. It is principally used as a bait for the capture of larger kinds.

FAMILY XVII.—CYPRINIDÆ.

Cyprinoidei, Agass. A small, soft, toothless oral orifice, the upper half formed by the pre-maxillaries only, the maxillaries lying behind them; no teeth except on the bones circumscribing the posterior aperture of the mouth; under pharyngeals armed with one large tooth; upper pharyngeal wanting. On the base of the cranium, or basi-occipital, and opposed to the under pharyngeals, there is a projecting process covered for the most part by a horny plate. Most have scales (*Aulopyge*, Heck., is an exception). No adipose fin. Siphonal stomach; no pancreatic cæca; swim-bladder in most divided into a fore and hinder part, and connected with the acoustic organs by a chain of ossicles. The presence or absence of supplementary branchiæ varies with the genera. *Cobitis* and *Acanthopsis*, having bony coverings to the swim-bladder, ally themselves to the other *Cyprinidæ*, as *Clarias*, *Heterobranchus*, *Heteropneustes*, and

Classification—Malacopteri.

Ageneiosus, which have a bony capsule to the swim-bladder, do to the *Siluridæ*. This structure does not exist in all the *Cyprinidæ* allied to *Cobitis*; and in *Schistura* there is a thick-skinned swim-bladder behind the enlargement of the vertebræ. Both M. Agassiz and M. Valenciennes restrict the genus *Cobitis* to the species which want teeth.

This great family, as now restricted, comprises fresh-water fishes only. It contains a great number of species in all parts of the world, and no one has as yet made a satisfactory arrangement of them, and characterized the groups so that they can be easily distinguished. We follow M. Valenciennes in the primary grouping.

Genus I. Cyprinus, Lacép. A long dorsal, with three stiff pungent rays, the third and longest one being often denticulated on its hinder edge, resembling the rays of some Siluroids; anal with two strong solid rays. The under pharyngeal teeth are five, one being very large, with curved, seemingly concentric edges, and three somewhat wavy parallel enamelled ridges, separated into two by a longitudinal furrow: farther back on each side of this principal tooth there are two others, not half as big, having flat and worn crowns; before the large mesial tooth there is another rounded one, without eminences; and behind all, a fifth very small tooth. This is the dentition of the *Cyprinus carpio*, or common Carp, but the number of teeth varies with the species. Body thick, more or less high, with flat sides, and thick scales. One group (*Cyprinus*) has small barbels at the corners of the mouth; another wants them (*Cyprinopsis*, Fitzing.) Twenty species in the *Histoire des Poissons*.

Genus II. Barbus, Flem. Body fusiform. Dorsal short, with three small simple rays in front, and a fourth very strong one, like that of *Cyprinus*, sometimes denticulated, in other species smooth; two barbels in front of the maxillary joint, and two labial ones from the corners of the mouth; four in all. Pharyngeal teeth conical, elongated, and a little curved. Sixty-two species, subdivided by the smooth or denticulated rays, and the projecting or non-elongated snout.

Genus III. Labeobarbus, Rüpp. Body elongated. Lips thick, the inferior one having a single symphysial thick barbel, making five barbels in all, including the pair of maxillary, and pair of labial ones. A firm ray not denticulated in the dorsal, and a short anal. Three species.

Genus IV. Schisothorax, Heck. Cyprinoids with a maxillary and labial barbel on each side. Dorsal and anal short; three dorsal osseous rays, the third one denticulated. Scales small; a cutaneous fold on the posterior part of the belly, clothed with larger scales, concealing the anus and greater part of the base of the anal, like a slit sheath. Mouth various, giving rise to subdivisions founded on its several kinds of form. Ten species.

Genus V. Racoma, M'Clell. Differs from *Schisothorax* in the projecting maxillaries; the premaxillaries form a moveable appendage to the mouth.

Genus VI. Oreinus, M'Clell. Head fleshy; mouth vertical; mandible shorter than the premaxillaries; snout muscular and projecting. Dorsal preceded by a serrated ray. Scales small. Intestinal tube five or six times as long as the body, capacious. Mountain fish.

Genus VII. Schisopyge, Heck. Separated from *Schisothorax*, by the acute cartilaginous-edged mandible, and the bony ray of the dorsal, standing either before or above the ventrals.

Genus VIII. Dangila, Valenc. Remarkable for the length of the dorsal, without the anterior osseous ray, differing in the latter character only from the dorsal of *Cyprinus*: another peculiar character is the conical papillæ on the border of the upper lip, resembling small teeth; a labial and a maxillary barbel on each side.

Genus IX. Lobocheilos, Bleek. Between *Labeo* and *Barbus*. Border of the mouth threefold; lips smooth, not fringed, the inferior one forming a square fleshy lobe; snout prominent, fleshy. Four maxillary and labial barbels. No toothed dorsal or anal spine. *Labeo falcifer*, Cuv. and Valenc., and three others.

Genus X. Crossocheilos, Bleek. Mouth inferior, with a threefold border, the orifice a parallelogram; lips crenated or fimbriated with papillæ; snout fleshy, very prominent, with two barbels. No toothed dorsal or anal spine. *Labeo oblongus*, Cuv. and Valenc.

Genus XI. Devario, Heck. Pharyngeal teeth knife-edged; mouth subinferior; lips round. Two barbels at the corners of the mouth, or none. Dorsal and anal fins elongated, each with a smooth osseous ray having a flexible tip. Intestine between four and five times the length of the body. Seven species.

Genus XII. Nuria, Valenc. Cyprinoids with the dorsal far back like that of a Pike, short and without spines. No maxillary barbels, but a pair of labial barbels at each corner of the mouth, keeping up the number four. Thin lips. Two species.

Genus XIII. Rohita, Valenc. Four barbels round the mouth; thick fleshy lips, with their edges fringed more or less. A thick fold of skin inclosing the lips, forming above a sort of muzzle; and below a veil covering the closed mouth. Premaxillaries small, and attached to beneath the point of the nasal, so that the mouth is protracted like a cupping-glass. When the lips are retracted they retire within the second lip or fold of skin. Intestinal canal very long. Herbivorous. Twenty-three species.

Classification—Malacopteri.

Genus XIV. Capoeta, Valenc. Intermediate between *Barbus* and *Gobio*, and containing species with a barbel at each angle of the mouth, or two in all; some with a denticulated ray in the dorsal: others with a solid ray, not denticulated; and a third group again with the ray soft.

Genus XV. Cirrhinus, Cuv. Maxillary barbels, two in all; no labial ones. A moderate-sized dorsal without spines, all the rays being flexible. Lips thin; snout not elongated beyond the mouth.

Genus XVI. Gobio, Cuv. Dorsal and anal short, without spines. Barbels labial, *i.e.*, at the corners of the mouth. Pharyngeal teeth conical, slightly curved at the tip, and in two rows.

Genus XVII. Tinca, Cuv. Thick and broad body, covered with small scales, and a labial barbel at each side of the mouth. Pharyngeal teeth clubbed.

Genus XVIII. Labeo, Cuv. Snout thick and fleshy, projecting over the mouth, which is furnished with triple lips, one emanating from the preorbitar and extending over the two others, a second from the maxillary, and a third the true lip below, detached so as to make a mandibular velum; a small barbel at the corner of the maxillary. Anterior dorsal rays slender and simple, the others branched and very flexible. The *Labeos*, therefore, are Cyprinoids, with the dorsal of *Gobio* or *Tinca*, but with lips approaching those of *Rohita*, and differing merely in their disposition. These fish belong entirely to the old world.

Heckel makes a group of the Cyprinoids which have these double or triple rows of lips, which he names *Pennochitæ*; and includes in it the genera *Labeo*, *Rohita*, and three characterized by himself, *Pylognathus*, *Discognathus*, and *Cyrene*.

The following genera want barbels.

Genus XIX. Leuciscus, Valenc. The length of the anal has been given as a distinctive character of *Abramis*, and its shortness of *Leuciscus*; but M. Valenciennes, finding that there was an imperceptible gradation in the length of this fin among the species, ranges them all under *Leuciscus*, and considers generally as mere specific characters those derived from the form of the pharyngeal teeth by which Agassiz, Bonaparte, and Heckel have sought to define the numerous groups they have formed. *Leuciscus* is to be known, then, chiefly by negative characters. Short dorsal without spines; anal short or long, also without spines, and no particular conformation of the lips. In the *Histoire des Poissons* one hundred and forty species are described in eleven groups.

The following genera have been characterized by the authors whose names are given, and Dr M'Clelland, in his account of the Indian Cyprinidæ, has named and described numerous groups, but a revision of the entire family is needed before the proper places of these proposed genera can be found. The Prince of Musignano's *Catalogo Metodico dei Cyprinidi d'Europa* may be consulted with advantage by those who wish to master the arrangement of the Cyprinoids.

Genus XX. Gila, Baird and Girard. Body fusiform, compressed, with the back more or less arched in the older fish. Head depressed, uncommonly small, its upper profile concave; snout elongated; no barbels. Pharyngeal teeth oblique, compressed in two rows, hooked at the point. Four gills.

Genus XXI. Chondrostoma, Agass. A horny cartilaginous plate covering the lower lip, easily detached in dead fish, but leaving the soft keel on which it was implanted. Some have labial barbels, and others maxillary barbels, and there is much variety in the pharyngeal dentition. Ten species.

Genus XXII. Catla, Agass. Maxillaries dilated, and forming thin laminæ, which advance over the equally thin premaxillaries, forming a snout shorter than the mandible, whose limbs are likewise so dilated as to encase one another, and give a prominent, rounded form to the throat; when depressed the lower jaw looks like the bowl of a large spoon. The lower lips are thick and fleshy, but without barbels; and the branchial rakers are long and hair-like, and very flexible, resembling the same organs of a Clupeoid rather than of a Cyprinoid. One species.

Genus XXIII. Aspidoparia, Heck. Mouth small; no barbels. Suborbitar scale-bones covering the cheek. Short base of the dorsal fin standing over the interval between the ventrals and longer anal; ventrals with seven divided rays; lateral line much decurved.

Genus XXIV. Catastomus, Forster, Lesu. Resembling the European Barbel in general form, but having neither maxillary nor labial barbels, and no bony or denticulated rays in the dorsal. Mouth under the snout, without teeth; lips large, lobed, and variously

Classification—Malacopteri.

furrowed and papillated according to the species. The pharyngeal bones, large and semicircular, are armed with a pectinated row of compressed teeth, whose crowns are wider than their bases; and whose size decreases gradually from below upwards. Gill-covers large. Scales varying in size with the species. The intestine is long, and the air-bladder is divided into two in some, into three or even four parts in others, the foremost division having an exterior, thick, fibrous outer coat, which the others want. Twenty-two species.

Genus XXV. Rhinichthys, Agass. Distinguished from other *Catastomi* by the conical elongation of the snout.

Genus XXVI. Sclerognathus, Valenc. Mouth not quite terminal, but the snout advances less beyond it than in the *Catastomi*. The premaxillaries are suspended, as in that genus, under the cartilaginous extremity of the nasal, have long pedicels, and very short transverse processes, the rest of the orifice being formed by a fibrous ligament within a thin upper lip. The maxillary is a broad solid bone, under which the lip retires, and it is itself hidden by the broad preorbitar. Lower lip narrow and thin. The structure of the mouth is that of *Catastomus*, without the fleshy development of the lips. Mucous pores as in the *Catastomi*, and also a pectinated row of pharyngeal teeth, but not so large. Air-bladder divided into two, with two small lobules behind the second. Two species.

Genus XXVII. Exoglossum, Rafin. Body elongated, little compressed. Small scales. Anus far back. Head without scales, flattened beneath; mouth terminal; mandible short, divided into three or five lobes, and resembling a tongue. Ventrals nine-rayed, opposite to the dorsal. Pharyngeal teeth hooked, without denticulations, with a small flat crown, and in two rows. No pores on the head. Species five.

Genus XXVIII. Cobitis, Artedi. Mouth small, edentate, surrounded by from four to eight barbels; gill-opening a vertical slit, high up; branchiostegals three. Preorbitar hidden entirely by the skin, or in some prolonged into a spine, seldom followed by the other suborbitars, which are absent in most *Cobites*. No solid dorsal ray; no superior pharyngeals. Scaly fishes like all the *Cyprinidæ*. M. Agassiz separates the species with spinous preorbitars under the name of *Acanthopsis*, and M'Clelland calls the group which have forked caudals *Schistura*; but M. Valenciennes does not consider these divisions as natural or established on important peculiarities of structure. Forty-six species are described in the *Histoire des Poissons*, in four groups.

Genus XXIX. Balitora, Gray. (*Platycara*, M'Clell.; *Homaloptera*, Kuhl et Van Hasselt.) Allied to *Cobitis* by the edentate mouth, furnished with small barbels, but differing in their flatly depressed head, and in the size of the pectorals and ventrals, the bones which sustain these fins forming large plates, from which the fins spread horizontally like those of *Callionymus*. Body scaly above, naked on the ventral aspect. A short, simple, intestinal canal, with a globular stomach; no air-bladder. Seven species.

SILUROIDS.

This very large family brings up the rear of the Malacopterygians which have an air-tube to their swim-bladder (*Physostomi*, Müll.), and in fact some of the rays of their fins are firmer, stouter, and nearly as hard as the spinous rays of the *Acanthopteri*. It is indeed only when the joints of Malacopterygian rays have much length that they have great flexibility; and there are gradations of abbreviation and consolidation until the joints become nearly or wholly obsolete, and the rays as pungent as the first rays of the pectorals and dorsal of the Siluroids, which are powerful bony weapons, often strongly toothed or serrated. Yet these strong bones (which, in the fossil state, are named Ichthyodorulites) frequently betray their compound nature by their tips being soft, flexible, and jointed.

There are many peculiarities in the skeleton of the Siluroids, arising from the absence of some bones, and the greater development of others. The cavity of the cranium is not open laterally, as in most osseous fishes, but is closed, as in the *Cyprinidæ*, by the orbitosphenoids and the ethmoid that unite with the prefrontals, carrying forward the cranial cavity to the nasal bone without leaving a membranous septum between the orbits. The petrosal is often wanting in fishes of this family, and some do not possess even the parietal. But the supraoccipital is greatly developed, and in many, the suprascapula is united by suture to the sides of the cranium. In numerous members of the family the skull is enlarged, posteriorly, to form a kind of helmet which spreads over the nape; the lateral angles of this production are formed by the suprascapulæ, augmented and fixed by suture, and the median part is the extension of the supraoccipital, which stretches out to touch or even articulate with the osseous expansions of the anterior interneurals. The supraoccipital, which is generally very large, articulates anteriorly with the frontal, and passing backwards between the postfrontals, the parietals, the mastoids, and the suprascapulæ, goes past them all on the nape. The mastoids interpose between the postfrontals and the parietals, so as to come in contact with the supraoccipital, and the parietals, but little developed, are pressed to the back part of the cranium, and in some instances wholly disappear.

Classification—Malacopteri.

The suprascapula most frequently unites to the mastoid by an immoveable suture, which includes the parietal when that bone is present, and extends even to the supraoccipital; it gives out besides two processes, one of them resting on the exoccipital and basioccipital, or wedging itself between them, and the other going to the first vertebra; sometimes a plate from the exoccipital supports that same vertebra. This vertebra, though it presents a pretty continuous centrum beneath, is in reality composed of three or four coalescent vertebræ, as we ascertain by its diapophyses by the circular elevations of the neural canal and by the holes for the exit of the pairs of spinal nerves. There is great variety in the development of the various processes of the bones we have mentioned, and there is no less in the magnitude and connexions of the first three interneurals.

In general, in the species which have a strong dorsal spine, the second and third interneurals unite to form a single plate, named in the *Histoire des Poissons* the "buckler," and which is usually more or less crescentic in shape; the great spine is articulated to the third interneural, and there is only the vestige of a spine on the second interneural in form of a small oval bone, forked below, whose function is to act as a bolt or fulcrum to the great spine when the fish wishes to use it as an offensive weapon. The great spine itself is joined by a ring to a second spine which belongs to the third interneural. This articulation by ring exists in *Lophius* and a few other fishes not of this family.

The first interneural does not carry a ray, and it varies much in the species whose helmet or casque is continuous with the buckler, as in many of the *Bagri* and *Pimelodes*. In these cases the supraoccipital, extending backwards, conceals the first interneural, passing over it to touch with its point the buckler formed by the second and third interneurals. In other instances, as in *Synodontis* and *Auchenipterus*, the supraoccipital and second interneural, forking and expanding, inclose and join themselvest o the first interneural, but leave a larger or smaller space in the middle of the nuchal armour which they contribute to form. When the point of the supraoccipital does not reach quite to the second interneural, the first interneural remains free from connection, and occasionally shows us a narrow plate, interposed between the other two; in such a case the helmet is not continuous with the buckler. The neural spines of the coalescent centra which form the apparently single first vertebra, concur also in sustaining the nuchal plate-armour and the first great dorsal spine; they carry the interneurals, are joined to them by suture, and one of them is often inclined towards the occiput to assist in sustaining the head; in fact, this part of the skeleton is constructed to give firm mutual support.

The scapular chain of the Siluroids is also formed to give the resistance to the strong weapon with which it is armed. The suprascapula, as we have said above, is often united by suture to the cranium, and it obtains support below by one or two processes that are fixed on the basioccipitals and exoccipitals, and upon the diapophysis of the first vertebra: *no scapula* is ever present; it is between the two arms

Classification—Malacopteri.

of the suprascapula that the top of the coracoid is fixed. In most osseous fishes the coracoid completes the lower key of the scapular arch in joining its fellow by suture or synchondrosis without the intervention of the radius; but in the Siluroids the radius descends to take part in this joint, and sometimes even to occupy the half of the suture, which is not unfrequently constructed of very deep interlocking serratures. The solidity of this base of the pectoral spine is further augmented by the intimate union of the radius and ulna, which often extends to junction by suture, or even to coalescence; and these bones, moreover, give off two bony arches,—the first, a slender one arising from the salient edge of the radius near the pectoral fin, and going to the interior face of the ulna that is applied to the interior surface of the ascending branch of the coracoid; this process is analogous to one in the *Cyprinidæ* where it is a separate bone: the second and broader supplementary arch does not exist in the *Cyprinidæ*, and is often perforated by a large hole; it also emanates from the same salient edge of the radius, but proceeds in an opposite direction to the inferior edge of the coracoid, a little before the insertion of the pectoral spine. These two arches give attachments to the muscles that move this spine; in the *Synodontes* and many *Bagri*, the upper arch remains in a cartilaginous or ligamentous condition; while in *Malapterurus* it is the lower arch that does not ossify, but both are fully formed in the *Siluri* and many other Siluroids more closely allied to that typical genus. The *epicoracoid* is also wanting in the Siluroids (Nos. 49, 50, figs. 10 and 15.) The pterygoid and entopterygoid (25, 24, *id.*), are reduced to a single bone, and so are the epitympanic and pretympanic: the mesotympanic (31) is wholly wanting, and the palatine is merely a slender cylindrical bone. The suboperculum is likewise constantly absent in all the Siluroids. This long anatomical detail has been extracted from the *Histoire des Poissons*, because without it descriptions of this peculiar and interesting family could not have been understood.

The Siluroids have no true scales, though some of them (*Doras*) have the lateral line armed with bony plates, and in others (*Callichthys*) these biserial plates are developed so as to incase the entire body. There are also varieties of external structure similar to those which occur in other large families of fishes, such as the different positions of the fins, and even the entire absence of certain of these members in some groups. Many of the Siluroids are fresh-water fishes which attain a great size, and they are what are called ground fishes, and remain habitually at the bottom of the pieces of water that they inhabit. In the genus *Silurus*, as well as in *Pimelodus*, the choroid vasoganglia and pseudobranchiæ are both absent. *Silurus glanis*, L., is the largest of European fresh-water fishes, and the only one of this extensive genus inhabiting the Continent. It is smooth, greenish black, spotted with black above, and yellowish-white beneath. The head is large, with six barbels. It sometimes attains the length of 12 or 15 feet, and the weight of 300 or 400 lbs. As this creature is somewhat unwieldy in its motions, it does not pursue its prey, which consists of small fishes, but lies concealed among the mud, and seizes such unwary stragglers as happen to come within reach. The fishermen of the Spree say that they always take the largest fish of this kind in a thunder-storm. Insects are the best bait for the younger ones. It has occasionally been observed in the sea, but always near the mouths of rivers. Gronovius and Temminck both authenticate its occasional capture in the salt water. The flesh is fat and sweet, and its lard has been employed in some places as a substitute for that of the hog. Sir Robert Sibbald, at the conclusion of his list of river fishes, adds *Silurus sive Glanis;* from which it has been inferred that this gigantic species may, at one period, have inhabited the Scottish rivers; but this fish is a stranger to the waters of France, Spain, and Italy, as well as to England, which furnishes a strong argument against the conclusion that has been drawn from the sentence in Sibbald, unsupported as it is by any reference to accounts of its capture in Scotland. In fact, it is in the western European rivers that it is common, in the Elbe to the north, and the Danube on the south, and in the rivers still further west; and it is one of the fishes brought to the market at Constantinople. It occurs in the Scandinavian peninsula but rarely. In the rivers that fall into the Caspian it is very common, but it is a stranger to all the Siberian rivers which flow towards the Arctic Ocean. It is undoubtedly the *Glanis* of Aristotle.

Classification—Malacopteri.

The Synodonts of all the Siluroids that possess an adipose fin are the most remarkable for the armature of the head and nape, as they are also for their peculiar dentition. They are either destitute of parietals, or these bones at an early period of the life of the fish coalesce with the suprascapulæ. The suprascapulæ extend to the sides of the supraoccipital, but this latter bone goes still further backwards to join the second interneural plate; embracing, in conjunction with it, the plate of the first interneural, as we have mentioned above. The process of the suprascapula which rests on the basioccipital descends lower, and expands into a thin plate, to which the anterior lobe of the air-bladder is attached. The ossicles of Weber are present in their usual form; but the first parapophysis of the compound or coalescent anterior vertebral centra reaches forward between the suprascapula and exoccipital, and then sends a thin plate downwards into the air-bladder, in which it forms a diaphragm. The coracoids and ulnoradial bones, united below by suture, expand upwards in form of a vertical plate, which constitutes a bony diaphragm, dividing the branchial from the abdominal cavity, leaving a single opening for the passage of the œsophagus. Some species of *Synodontis* have been supposed to be the Nile fishes mentioned by Strabo, under the name of χοιρος (*porcus*), which, according to Aristotle, are the only marine fish that are not deterred by dread of the crocodile from ascending the Nile. This Saurian does not dare to attack it on account of its strong spines. The Mugils also ascend the river, but it is under the protection of the Synodonts. The species of which Strabo speaks has not yet been clearly made out, and may possibly be a Siluroid of a different group.

The *Doras* of South America have excited attention by their habit of travelling during the dry season from a piece of water about to dry up, in quest of a pond of greater capacity. These journeys are occasionally of such a length, that the fish spends whole nights on the way; and the bands of scaly travellers are sometimes so large, that the Indians who happen to meet them fill many baskets of the prey thus placed in their hands. The Indians suppose that the fish carry a supply of water with them, but they have no special organs like the *Anabas*, and can only do so by closing the gill-openings, or by retaining a little water between the plates of their body, as Mr Hancock supposes. This gentleman adds, that both the *Doras* and *Callichthys* make regular nests, in which they cover up their eggs with care, and defend them, male and female uniting in this parental duty until the eggs are hatched. The nest is constructed at the beginning of the rainy season of leaves, and is sometimes placed in a hole scooped out in the beach. The *Callichthys* differ in many parts of their skeleton from other Siluroids, and their cranium does not owe its breadth to the expansion of the supratemporals, but to the development of the three frontals, and the coalescence of a piece of the mastoid and suprascapula. These fish, like the *Doras*, travel in search of water, and sometimes bury themselves in the mud of wet meadows, where they are often captured by the natives, who dig them

Classification—Malacopteri.

out. The *Callichthys* are monogamous, both male and female remaining by the side of the nest, and watching it carefully. A specimen of the nest, spawn, and fish, exists in the College of Surgeons of London.

Arges, *Brontes*, and *Astroblepus*, are three forms of Siluroids of exceeding interest. They are some of the small fishes which issue from the bowels of the active volcanoes of South America, and are carried into the plains beneath by the torrents of muddy water, which these mountains vomit forth. They issue from Cotopaxi, Tungurahua, Sangay, Imbaburu, and Cargueirazo, a phenomenon first properly communicated to the scientific world by the illustrious Humboldt. They are expelled from craters or from lateral openings, always 16,000 or 17,000 feet above the sea, and the plains themselves into which these clayey streams descend, lie at least at half that height. Humboldt ascertained, by consulting the records of the neighbouring towns, that in 1691 Imbaburu threw out myriads of these fish in the neighbourhood of the city of Ibarra, and has continued to do so down to a late period. Cotopaxi also covered the estate of the Marchèse di Salvatègre with so large a quantity of these subterranean Siluroids, that the odour of their decaying bodies spread far and wide, so much so indeed, that the pestilential fevers which then prevailed were attributed to these putrid exhalations. In the eruption of 1698, when the peak of Cargueirazo fell in, vast quantities of these fish were brought down by the muddy and smoking streams which the mountain poured forth. M. Humboldt has proposed many questions bearing on these facts, without offering a solution. What streams of water, or what lakes exist in the cavernous recesses of these mountains? How does it happen that water submitted to so high a temperature retains air enough to support the life of such multitudes of fishes? How do animals with flesh so soft escape being cooked as they pass far, and for a long time, through the smoke which envelopes the streams of mud that issue during the eruption? These fish are called in the country *preñadillas*, a name not confined to a single species. The one that Humboldt specially described is the *Arges cyclopum*, originally named by him *Pimelodus cyclopum*.

In *Clarias* the nape is not armed, and the development of the bones of the head is lateral; the suborbitars, which, in the rest of the family, are mere slender tubes, in this genus give extension to the helmet, and the supratemporals which, in most fishes are very small, and in the greater number of Siluroids are imperceptible, here become enormously large, and coalesce on the sides of the cranium, with the prefrontal, frontal, postfrontal, and mastoid. An apparatus for holding water in the vicinity of the branchiæ exists in this genus, and its near allies analogous to that of the *Anabasidæ*. The *Clarias anguillaris* of Hasselquist has been by some writers on Egypt considered to be the *Alabes* of Strabo, cited by Archestratus, as one of the sacred fishes of the Nile. It is now known on the banks of that river by the name of *Harmouth*, or, as Sir Gardner Wilkinson writes the word, *Karmoot*. It was either worshipped, the latter author says, in the Thebaïd, or was connected with one of the genii of the Egyptian Pantheon, who appears under a human form, with the head of this fish in the sculptures of the Diospolite tombs. In Lower Egypt the *Karmoot* was caught for the table; but there is no evidence of its having been eaten in the Thebaid, which may be an argument in favour of its sacred character.

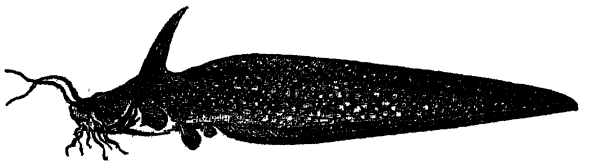


Fig. 85.
Plotosus microceps.

Plotosus is a genus of the Siluroid family which frequents the seas of southern Asia and the eastern coasts of Africa, and from thence southwards to Australia, where there are several species. One of these, *Pl. microceps*, is represented by the annexed woodcut, and the lips by figure 50.

Aspredo differs greatly from the rest of the Siluroids, and from other osseous fishes, in the rudimentary and immoveable condition of its gill-flaps, the three pieces that generally perform the office of a valve to the gill-openings being mere vestiges confluent with the preoperculum in such a way, that the opening and closing of the aperture does not depend on the tympanico-opercular apparatus. The mouth likewise is peculiar, the premaxillaries being articulated longitudinally, so that the orifice is a slit in the axis of the fish, with teeth in its posterior part only. Some curious sucker-like appendages are formed on the females at certain times by the expansion of pores and development of filaments on their edges. These are not found in the males. Bloch named a species *Cotylephorus* which had these organs, and M'Clelland has characterized a genus chiefly by their existence. Their presence, however, appears to be temporal, and to extend to the females of all the species.

Malapterurus electricus, Lacép. The electric powers of this fish were noticed by Adanson in 1756, but in Purchas' *Pilgrims*, there is a much earlier account of it extracted from the narrative of Baretus and Oviedo, dated 1554. It is there said, that there exists in the Nile a fish (called by Purchas a *torpedo*), which, if held in the hands, causes on the slightest movement a severe pain in all the arteries, nerves, and joints of the body. In the same work Richard Jobson is reported to have perceived in the River Gambia a fish like an English Bream, but thicker, which, on one of the sailors taking hold of, he instantly cried out that he had lost the use of his hands and arms. Another sailor, on touching the fish with his foot, felt his legs benumbed. This was in 1620. As the *Malapterurus* abounds in the Nile and in Senegal, and the *torpedo* has no resemblance to a Bream, the former was doubtless the fish to which Purchas alluded, notwithstanding his use of the name Torpedo. Rudolphi[1] has given a detailed description, with figures of the electric organs of this fish. In the great work on Egypt by Geoffroy (Pl. XII., 2), there is the figure of a *Malapterurus* opened to show the viscera, but by a singular inaccuracy the fish is represented as scaly; now there are no scales whatever on this fish, and no fish known to possess electric powers has either scales or spines. The *Torpedo*, the *Gymnotus*, and the *Malapterurus*, have all naked skins. The *Tetrodon electricus* is also destitute of spines on the skin, though all its congeners have skins as bristly as those of a hedgehog.

M. Valenciennes, examining the electric organs of the *Malapterurus* with a full knowledge of what had been previously observed by Geoffroy and Rudolphi, describes it as being composed of a thick layer of spongy cellular tissue, lying immediately under the skin, and framed of thin interlacing leaflets, filled with a gelatinous fluid, and lined on its internal face by a silvery aponeurosis to which it adheres strongly. This aponeurosis extends from the forehead and the gill-openings to the posterior end of the anal, and is divided into lateral halves by a membranous raphè that appears on the dorsal and ventral aspects. Under this aponeurosis run the great vascular and nervous trunks, whose branches pass through it, to be expended on the cellular tissue. Then beneath this aponeurosis there is a peculiar membrane which forms the subject of Rudolphi's *Memoir*. It consists of at

[1] *Ueber den Zitter-wels, Abh. Berl. Acad.* vii.

Classification—Malacopteri.

least six layers, readily separable the one from the other, as well as from the subjacent muscles, to which it is attached merely by a loose and scanty cellular tissue. These aponeurotic layers extend to the caudal. They are thin, dense, and can be stretched under the finger; their external surfaces become flocculent when they imbibe water. These flocculi resemble moist cotton, and when examined with a high microscopic power, present a felt-like interlacement of extremely minute fibrils. The tunics receive from their interior sides filaments of the same nerve (*par vagum*, Rudolphi) which runs under the aponeurosis. There are other filaments also of extreme tenuity, which penetrate the six layers to expend themselves on its interior surface; these spring from the intercostals. In thus deriving the nervous energy of its electric organs from the "vagus" and from the "rami ventrales" of the spinal nerves, as well as in possessing the cellular apparatus of the *Torpedo* and the laminated membranous one of *Gymnotus*, the *Malapterurus* combines the characters of these two genera in its peculiar organ. In the *Edinburgh Philosophical Journal* for 1856, Mr Murray gives a good figure of a species of this genus from the Bight of Benin. The Arabs, fully appreciating the nature of the benumbing powers of the *Malapterurus*, name it *Raad* or *Raasch* (thunder). The fish gives its discharge when touched on the head, but is powerless when held by the tail, and in fact the electric organ does not reach the caudal fin. In giving a shock it moves the tail however, as it must do when the muscles of the body are acting. A fish of only seven inches in length can give a vigorous discharge. The fish is eaten, and it is one of the most esteemed Siluroids as an article of diet.

M. Valenciennes considers *Trichomycterus* and *Eremophilus* as forming a link between the Siluroids and the Cyprinoids, through *Cobitis;* indeed, he was long in doubt as to which family they actually belonged, and he has been led to assign them a place among the Siluroids chiefly by the absence of subopercula. The want of an adipose fin weighed less with him, as this member is wanting also in some Siluroids; neither does he consider the absence of ventrals of sufficient importance to exclude a genus from a family group. *Trichomycteri* were found by Mr Pentland in the rivulets which fall into that vast alpine sheet of water, Lake Titicaca, which is frequented by the Cyprinoid *Orestias*, also an apodal, and in the affluents of the Apurimac, one of the sources of the Amazon. He discovered them also in Rio de Guatanai, Rio de Pontezualo, and in Lake Compucila, on the Andes, to the west of Cuzco, and at an elevation of 14,000 feet. *Eremophilus* inhabits the waters of the Valley of Bogota, 8500 feet above the sea level.

Family XVIII.—SILURIDÆ, Agass.

Skin naked, or covered with bony shields, without scales. Premaxillaries forming the border of the upper jaw, the maxillaries being reduced to mere vestiges, or elongated into barbels; all have barbels; suboperculum wanting. Epicoracoid wanting, or reduced to a mere process of the coracoid. The postfrontal or temporal apparatus has two ossicles less than in most osseous fishes; the pseudobranchiæ are wanting. The swim-bladder is present in the majority, and is connected by a chain of ossicles with the acoustic organ; no pancreatic cæca; stomach cæcal. In most the first pectoral ray is very strong and serrated; most have an adipose fin upon the back. Branchiostegals nine to eighteen.

ANALYTICAL TABLE OF THE *SILURIDÆ* (Dum.)

Dorsal, single (*Siluroïdes*, Dum.)
- *Dorsal, containing bony rays.*
  - Dorsal extending along the whole back, CLARIAS 33.
  - Dorsal short, with
    - *Its spinous ray close to the skull*.....TRACHELOPTERUS 24.
    - *Its spinous ray on the back.*
      - Caudal forked.....SCHILBES 2.
      - Caudal rounded.....BRONTES 31.
- *Dorsal sustained by branching rays.*
  - Eyes lateral.
    - *Eyes conspicuous*.....SILURUS 1.
    - *Eyes scarcely visible*.....CETOPSIS 3.
  - Eyes on the dorsal aspect.
    - *Tail slender, tapering, trenchant*.....ASPREDO 37.
    - *Tail tapering little*.....SACCOBRANCHUS 35.
  - *Dorsal on the tail, without bony rays*.....MALAPTERURUS 40.

Dorsals two (*Dipteronotes*, Dum.)
- *Second dorsal with bony rays united to the caudal.*
  - Head protected by a bony helmet.....CHACA 38.
  - Head clothed with soft skin.....PLOTOSUS 36.
- *Second dorsal with one bony ray, not united to the caudal.*
  - Head helmed; body cuirassed; barbels...CALLICHTHYS 29.
- *Second dorsal destitute of bony rays; body naked.*
  - Snout elongated.
    - *Snout round; lateral line keeled, spinous*.....DORAS 28.
    - *Snout broad, flat, arched.*
      - Eyes lateral, level with the nostrils.....PLATYSTOMA 6.
      - Eyes depressed below the nostrils...HYPOPHTHALMUS 25.
  - Snout short.
    - Head covered by a bony helmet.
      - *Dorsal long; body very long*.....HETEROBRANCHUS 34.
      - *Dorsal long; body abbreviated*.....SYNODONTIS 27.
      - *Dorsal short; barbels*.....BAGRUS 4.
      - *Dorsal short; no barbels*.....SILUNDIA 9.
    - Head naked.
      - *Caudal round at the end*.....PIMELODUS 16.
      - *Caudal forked.*
        - Barbels more than four.....GALEICHTHYS 7.
        - Barbels two only.....DIPLOMYSTAX.
        - Barbels none.....AGENEISOSUS 26.

OBS.—Dumeril includes *Arius*, No. 13; *Phractocephalus*, No. 5; and *Pangasius*, No. 8, under the genus *Bagrus*, No. 4; and he omits from his table *Astroblepas*, No. 32, and *Eremophilus*, No. 43, together with several other genera characterized by Valenciennes. His genus *Diplomystax* is founded on *Arius papillosus* and *A. raninus* of the *Histoire des Poissons;* and he has instituted a genus *Conostomus* for the reception of the *Pimelodi* that have elongated conical muzzles terminated by a small mouth; and which have moreover very small adipose fins. *Macrones*, another of his genera, embraces several *Bagri* with long slender muzzles, and an adipose fin longer than the anal, together with a very long scaleless body.

GENUS I. SILURUS, Linn. Dorsal short on the fore part of the back, without sensible spines; no adipose fin; a long anal. Raduliform or card-like teeth on the jaws, and a band of vomerine ones behind the premaxillaries. Some have four barbels, and some only two. Sixteen species.

GENUS II. SCHILBES. A strong, denticulated dorsal spine, elevated nape, broad depressed head, greatly compressed body, and very distinct teeth. Barbels eight. Branchiostegals eight to ten.

GENUS III. CETOPSIS, Agass. Eyes almost imperceptible, being nearly covered by skin. Six barbels. One dorsal composed of soft rays. Convex, obtuse, truncated head; moderate mouth; single row of teeth on the mandible and front of the vomer; a band sometimes on the premaxillaries. Gill-opening a small hole; branchiostegals ten.

GENUS IV. BAGRUS, Cuv. and Valenc. (*Mystus*, Artedi.) A rayed dorsal with spine, and an adipose one; a pectoral spine. A band of villiform or card-like teeth on the premaxillaries, behind which, on the roof of the mouth, there is a second arched villiform band, or a single row of teeth, not separated in the middle. They are divided into groups according to the number of their barbels, and subdivided by the forms of the head, the lengths of the adipose or anal, and variations in their dentition. Sixty-one species are described in the *Histoire des Poissons*. In *Bagrus filamentosus* the air-bladder is divided by a septum, in which there is no opening; and in other species, the lateral compartments are subdivided by transverse septa.

GENUS V. PHRACTOCEPHALUS, Agass. (*Sirarbci*, Spix.) Incomplete osseous rays, encased in the upper border of the adipose fin. A flat head, with a deeply sculptured bony casque; and an expanded transversely oval shield before the dorsal, free, and altogether detached from the bones of the skull. Nine branchiostegals; six barbels round the mouth.

GENUS VI. PLATYSTOMA, Agass. (*Sorubim*, Spix.) Snout depressed. Branchiostegals numerous. A transverse band of teeth, but more completely divided by the smooth median line of the vomer into two plates on each side, than in the *Bagri*. Thirteen species.

GENUS VII. GALEICHTHYS, Valenc. Head rounded, skinny,

Classification—Malacopteri.

and without a conspicuous casque. First dorsal ray elongated into a flat cutaneous filament. The palatine teeth a narrow band divided by smooth lines into four patches. Branchiostegals six; four or six barbels. Five species.

Genus VIII. Pangasius, Valenc. Four short barbels; no prolongations of the fin rays. Ten branchiostegals. Air-bladder divided into four parts by three contractions. One species.

Genus IX. Silundia, Valenc. A small smooth head, like that of *Schilbes*. Very small adipose fin; long anal. Only two small (maxillary) barbels; teeth of the jaws hooked, and longer than in other *Siluridæ*; a transverse band in front of the roof of the mouth, as in *Bagrus*. Twelve branchiostegals. Two species.

Genus X. Sciades, Müll. and Trosch. A cross band of palatine teeth, and behind them two clusters.

Genus XI. Ariodes, Müll and Trosch. Palatine teeth forming two separate patches, and sometimes farther back a single tuft only.

Genus XII. Eutropius, Müll. and Trosch. One confluent band of teeth on the vomer and palatines. Head small; nape high; the head and adjoining part of the body compressed near the dorsal aspect. Tail long and high, strongly compressed. Anal long; adipose fin very small.

Genus XIII. Arius, Valenc. Teeth on the roof of the mouth disposed in two widely-separated plates, supported for the most part by the palatines only, but in some species encroaching on the angles of the vomer. Branchiostegals five to eight, rarely ten to twelve. The teeth may be villiform or pavement-like, the passage to the pavement-like teeth being gradual; some species have the ordinary nuchal armour of a triangular (interparietal, Cuv.) supraoccipital plate, with the apex truncated, and a small crescentic interspinal plate; others have a very large separate supraoccipital disk, and the barbels vary in number. On combinations of these diversities of structure several groups are established in the *Histoire des Poissons*, in which fifty-one species are described. Air-bladder in some divided lengthwise into two separate sacs.

Genus XIV. Osteogeneiosus, Bleek. A rayed and an adipose dorsal fin. Conical, acute, curved, crowded teeth on the premaxillaries, and mandibles in many rows; palatine teeth in two oblong arched plates in the fore part; the mesial line of the roof of the mouth smooth; eyes far back. Two premaxillary barbels, bony and rigid. Branchiostegals five. Head cuirassed; gill-openings extremely narrow. Indian Archipelago.

Genus XV. Batrachocephalus, Bleek. Dorsal fins two, the hinder one adipose. Thick, cylindrical, premaxillary and mandibular teeth in many rows; vomer and mesial line of the roof of the mouth smooth; a few crowded cylindrical teeth on the anterior angles of the palatine bones; eyes above. Head cuirassed; no barbels. Five branchiostegals. Indian Archipelago.

Genus XVI. Pimelodus, Lacép. *Roof of the mouth smooth, edentate.* Barbels six or eight. Some species want the casque; others possess it; it is sometimes continuous with the buckler of the first osseous ray of the dorsal; sometimes distinct and not continuous. Forty-three species are described in the *Histoire des Poissons*.

The following two genera have been published since the date of that work:—

Genus XVII. Rita, Bleek. Dorsals two, the posterior one adipose. Conical teeth in the upper jaw pluriserial; mandibular teeth conical in the anterior rows, granular in the posterior ones; vomerino-palatine teeth granular, disposed in two oblong patches in the fore part of the palate. Branchiostegals eight or ten; barbels six, fleshy, belonging to the nose, premaxillaries, and mandible. Ventrals eight-rayed. (*Arius rita*, Cuv. and Valenc.)

Genus XVIII. Bagarius, Bleek. Dorsals two, the posterior one adipose. Barbels eight, on the jaws bony, rigid; upper jaw teeth pluriserial, acute, placed in a curved quadripartite band; mandibular teeth biserial, with an interior series of canines at the symphysis only; no teeth on the vomer, palatines, or entopterygoids. Branchiostegals twelve. Rays of the ventrals six. No air-bladder.

Genus XIX. Euanemus, Müll. and Trosch. Narrow gill-openings. Body laterally compressed. Cranium covered with skin. Card-like teeth in one band on the upper and under jaw; none on the vomer or palatines. First ray of the dorsal and pectoral fins spinous; dorsal fin wholly anterior and small; a very small adipose fin; rays of the ventrals much more numerous than in other *Siluridæ*. Eyes covered with skin. Barbels six. One species *E. columbetes*.

Genus XX. Ketengus, Bleek. Dorsal fins two, posterior one adipose. Cuneiform uniserial teeth on the premaxillaries and mandible; vomer and palatines smooth. Head cuirassed; eyes superior. Five branchiostegals; four fleshy barbels. Strait of Madura.

Genus XXI. Calophysus, Müll. and Trosch. No palatine teeth; a row of stronger teeth on the upper jaw and mandible, behind which, on the one or the other, a row of smaller teeth. The end of the first dorsal and pectoral ray simply jointed, not denticulated; a long adipose fin. Six barbels; narrow gill-opening; seven branchiostegals. A very small swim-bladder, which is bordered behind with an elegant fringe of cæcal processes. Two species.

Classification—Malacopteri.

Genus XXII. Erethistes, Müll. and Trosch. Narrow gill-openings. Head big, broad, pointed anteriorly, rough. Besides the occipital process there is always another like it. The scapular girdle has a long bony process above the pectoral, and another beneath it; mouth small. Card-like teeth in the upper and under jaw; none on the palatines. A moveable spine forming the first ray of the dorsal and pectoral fins; an adipose fin; anal small.

Genus XXIII. Auchenipterus, Valenc. Siluroid with an adipose fin. Head small; teeth almost imperceptible. Branchiostegals five; no teeth on the roof of the mouth. Dorsal very far forward, or on the nape. Casque united by suture with the dilated bucklers of the first and second interspinals covering the nape to the dorsal, as in *Doras* and *Synodontis*. Seven species.

Genus XXIV. Trachelyopterus, Valenc. *No adipose fin*, yet allied to *Schilbes* and *Pimelodus*. Barbels six. Villiform teeth on the jaws, none on the roof of the mouth. A solid, osseous casque, united, as in *Auchenipterus*, and coming near the dorsal, owing to the shortness of the supraoccipital plate, and the completely obsolete chevron. Pectorals attached under the throat. One species.

Genus XXV. Hypophthalmus, Valenc. An adipose fin. No teeth; eyes near the ventral aspect. Fourteen branchiostegals. Dorsal fin small, well back, with a bony ray; a strong ray in the pectoral also; ventrals small; anal long. Six barbels. Three species.

Genus XXVI. Ageneiosus, Lacép. Maxillary barbels only, and very short; in one species denticulated and resembling horns. Eyes depressed as in *Hypophthalmus*. Branchiostegals eleven. A bony ray in the dorsal and pectoral; a moderately long anal. Three species.

Genus XXVII. Synodontis, Geoffroy St Hilaire. Remarkable among the Siluroids having an adipose fin, for the arming of the head, which shows much affinity with that of *Auchenipterus* and *Doras*. Supraoccipital plate large, united by a long transverse suture with the greatly dilated interneural buckler, which is further prolonged along the base of the dorsal by its junction with three interneural plates; very wide strong pointed coracoids attached to the suprascapulars which form the lateral angles of the helmet. Enormous strongly-toothed pectoral spines; a high pointed and trenchant dorsal spine. Snout short, terminated by the nasal which supports very small premaxillaries covered with finely villiform teeth. Mandible composed of two short slender limbs, and carrying in front a bundle of teeth that, individually, are very thin lancets, each supported on a stalk as fine as a hair, and terminated by a small recurved and gold-coloured hook. This dentition resembles that of *Salarias*.

Genus XXVIII. Doras, Lacép. *Pimelodi* with the lateral line cuirassed by keeled bony plates, each ending in a spine. Head armed as in *Auchenipterus*, and the coracoid similarly formed. The very thick dorsal and pectoral spines are strongly toothed. In some the snout is depressed, and the mouth at its extremity is furnished with two broad villiform bands of teeth on the jaws; in others, the mouth is a round hole under a conical snout, and having small groups of mandibular teeth only. Ten species.

Genus XXIX. Callichthys, Linn., Gronov. *Pimelodi* cuirassed on the lateral line like the *Doras*, and with an adipose fin; but the lateral shields are narrow, embrace the whole height of the fish, and form two rows, somewhat tiled and crossing in the middle. Head covered with a helmet; mouth small, almost toothless; two barbels at each corner of the mouth. Three branchiostegals. Dorsal and pectoral spines often feeble. No air-bladder; intestine frequently doubled back; stomach globular and small. Ten species.

Genus XXX. Arges, Valenc. Teeth bifid, and slightly curved at the points, ranged in rows on the jaws and producing a sort of harrow which no other Siluroid, nor any other fish, is known to possess. Roof of the mouth smooth and edentate; two maxillary barbels, and papillæ at the nostrils. First dorsal small, with a weak ray in front; adipose fin long; ventrals well forward. Four branchiostegals. Two species.

Genus XXXI. Brontes, Valenc. An *Arges* without the adipose fin. No casque. Eyes, two minute points on the top of the head. Branchiostegals four. One species.

Genus XXXII. Astroblepus, Humb. An *apodal* resembling otherwise, externally, *Brontes;* having a depressed head; eyes above. A single dorsal; no adipose fin. First rays ending in filaments. Four branchiostegals. One species.

Genus XXXIII. Clarias, Gronov. Helmet extending to the temples and cheeks; the supraoccipital point more or less rounded, in some semicircular. Nape exposed; no predorsal buckler. Teeth on the jaws and arc of the vomer. Head depressed, obtuse. Body long; caudal truncated. Anal long and low; dorsal without

Classification—Malacopteri.

a spine running along the whole back; its posterior half sometimes replaced by an adipose fin. Pectoral spine small. Branching appendages for holding water attached above the branchiæ; air-bladder divided. Fourteen species.

Genus XXXIV. Heterobranchus, Geoff. Dorsal shorter than in *Clarias*, the rest of the back being occupied by an adipose fin; caudal rounded. Head broad and flat; supraoccipital process of the helmet rounded. Short, fine, crowded villiform or bristle-like teeth on the jaws and arc of the vomer; a complex suprabranchial apparatus. Six barbels. Three species.

Genus XXXV. Saccobranchus, Valenc. Helmet like *Clarias* and *Heterobranchus*. Villiform teeth on the jaws, and two arched dental plates on the vomer; a complex suprabranchial apparatus. Small dorsal far forward; long anal. Seven branchiostegals; the branchial reservoir different in form from that of *Clarias* or *Heterobranchus*. Eight barbels. One species.

Genus XXXVI. Plotosus, Lacép. An elongated body, ending in a compressed pointed tail. No hard helmet, the smooth rounded depressed skull being covered with soft skin. Lips fleshy; strong conical teeth on the jaws; pavement-like teeth on the vomer; eight barbels. A short, higher, anterior dorsal, and a long, low, posterior one, uniting with the long anal at the point of the tail, without a distinct caudal. Small trenchant, toothed and pointed dorsal and anal spines; a cauliflower-shaped tubercle in a funnel behind the anus, of unknown use, existing in addition to the genital tubercle at the external opening of the seminal deferent canal. Nine species.

Genus XXXVII. Aspredo, Linn. Differ from other fish in the gill-covers being fixed and without motion, there being merely vestiges of the three opercular pieces, soldered to the preoperculum. Mouth peculiar, the premaxillaries being articulated longitudinally under the snout, and carrying teeth on their posterior edge only; and the maxillaries ending in barbels, articulated to the nasal anterior to the premaxillaries. Head flat, anteriorly. Body naked, wide at the pectoral region, tapering into a long slender tail, trenchant beneath, and terminated by a distinct small caudal. Dorsal small, high; strong, flat, serrated pectoral spines; anal long; no adipose fin; cup-shaped suckers on the ventral surface at certain times. Branchiostegals five. Six species, all American. M'Clelland describes five Indian fish belonging to a genus named *Glyptosternon*, which does not seem to differ from *Aspredo* in the characters that he assigns to it.

Genus XXXVIII. Chaca, Valenc. Head broad and much depressed, as wide before as behind, thus being quadrangular; tail tapering and much compressed at the end. Two dorsals and two anals; posterior ones uniting to form a caudal at the extremity of the tail, or it may be said, caudal running forward on the dorsal aspect to above the front of the anal, and about half as far on the ventral aspect, in which point of view there would be one anal and one dorsal near the head, supported by a strong osseous first ray. Serrated pectoral spines. The chin cirrhated by eight filaments. Air-bladder very large, composed of two lobes separated by the spinal column.

Genus XXXIX. Sisor, Hamilt. Buch. A *Hypostomus* without lateral pieces of mail, its skin being soft; remarkable for the size of its premaxillary barbels, and the prolongation of the upper caudal ray into a filament as long as the rest of the fish. Body slender, long; the chevron in front of the dorsal three-lobed. Mouth edentate, with fourteen barbels in all. Large gill-openings; four branchiostegals. One species, which attains the length of seven feet.

Genus XL. Malapterurus, Lacép. No anterior dorsal; an adipose fin near the caudal; ventrals beyond the middle of the fish; and an anal occupying about half the distance between them and the rounded caudal; no pectoral spine. Body shaped somewhat like that of a *Cobitis* or *Galaxias*, the tail being thickish, but the head is conical and ends bluntly. Lips fleshy, with six barbels; fine villiform teeth on each jaw; none on the vomer. A short oblique gill-opening; branchiostegals seven. Stomach small, siphonal; air-bladder fusiform, pointed posteriorly with two globular lobes in front, in advance of the ossicles of Weber. Its outer coat is thick and spongy. A double electrical organ.

Genus XLI. Ailia, Gray. A long, greatly compressed, moderately high fish, with a small head and rounded snout like a *Schilbes*. Back naked, except near the tail, where there is a small adipose fin; a very long, even anal, and forked caudal. Eight barbels. Teeth on the jaws and roof of the mouth minute.

Genus XLII. Trichomycterus, Valenc. Allied to *Malapterurus* by general form, the depression of the head, thinning of the snout, and construction of the cranium, but distinguished by a dorsal placed in the middle of the back, the absence of an adipose fin, and the want of an air-bladder. Branchiostegals eight. Aspect considerably like that of *Cobitis*. Six barbels, one at each anterior nostril, and a pair at the corner of the mouth on each side. Tail thickish. Fine curved teeth in a band on the jaws; palate smoothed. Three species.

Genus XLIII. Eremophilus, Humb. Closely resembling *Trichomycterus* in general aspect, but apodal; connected like that genus to the Siluroids by the absence of subopercula; and to *Cobitis* by the want of ventrals. Jaws armed by a band of long villiform or bristle-like teeth. Branchiostegals eight; no scales. Siphonal stomach and long intestine; no air-bladder.

Classification—Malacopteri.

GONIODONTS.

This family has grown out of the genus *Loricaria* of Linnæus, which, as characterized by him, consisted of fishes whose bodies were mailed in hard angular plates or scales, distinguished from *Doras* and *Callichthys* by the mouth opening under the snout. Müller considers them to be a separate group of the Siluroid family, and as such they are described by Valenciennes, in the *Histoire des Poissons*. Lacépède divided the Linnæan *Loricariæ* into two groups, reserving that appellation for the species that have no adipose fin, and giving the name of *Hypostoma* to those that have a kind of adipose fin but one that is preceded by a hard bony ray. Agassiz, when characterizing and naming the family, adopted Lacépède's generic divisions, and added two others, *Rhinelepis* and *Acanthicus*. The premaxillary and mandibular teeth of the Goniodonts are composed of albuminous tissue, like the teeth of the Chætodons, and have the same elasticity.

In the *Loricariæ* the top of the skull is prolonged backwards by the extension of the supraoccipital, which forms a kind of first scale, that reaches to the two plates developed from the points of the interneurals of the first compound vertebra,—the second of the plates being the chevron, on which the spine of the dorsal stands and moves. The mastoids and suprascapulæ enlarge the sides of the skull, and form the wide osseous vault, which affords the necessary space and breadth for containing the anterior portion of the abdominal viscera. The diapophyses of the great compound vertebra are plates curved like a sabre, and are supported below by the centra, and above by a styloid process resting on the vertical occipital crest. The scapular arch is very strong and shuts up the fore-part of the abdomen by a bony septum, while the coracoids, in form of the letter V, give the firmness necessary to sustain the dermal shields and spines. The coalescent radius and ulna bent horizontally support the pectoral plates. There are only eight abdominal vertebræ, with ribs as fine as bristles, and sixteen caudal ones.

Family XIX.—GONIODONTIDÆ.

Goniodontes, Agass.; *Loricarini*, aliorum. Related to the *Siluridæ*, but differing from them in possessing pseudobranchiæ, and in their intestines. Head and body mailed in hard, angular plates; orifice of the mouth on the ventral aspect under the snout, and bounded by the premaxillaries and maxillaries; long, slender, flexible teeth ending in hooks on the premaxillaries and mandible, which are separated at the symphysis; a broad, circular, cuticular fold surrounds the mouth. Gill-cover mostly immoveable; the styloid epicoracoid absent as in the *Siluridæ*, and represented by a process of the coracoid. The heart lodges in a bony capsule formed by the coracoid. No cæcal enlargement of the stomach; intestine long, frequently bent; no pancreatic cæca. Swim-bladder wanting, in which they differ from the *Siluridæ*. There is much phosphate of lime in the scales.

Genus I. Loricaria, auct. Body depressed, broader than high. Tail very much compressed. Teeth in both jaws. A single dorsal and no adipose fin.

Genus II. Hemiodon, Knor. Body very much depressed. Teeth on the mandible only. Premaxillaries rudimentary; toothless.

Genus III. Acestra, Knor. Body elongated, nearly cylindrical. Teeth in both jaws, furnished with a tranverse radical process. Dorsal and anal fins opposite.

Genus IV. Rhinelepis, Agass. Osseous plates resembling scales, imbricated, rough like a file. A short thick body. Lower lip often dilated into a membranous velum, and fringed with filaments. Three branchiostegals. Hooked teeth surrounding the orifice of the mouth in rows; the front ones notched at the point. A single dorsal. Three species.

Classification—Pharyngognaths.

Genus V. Acanthicus, Agass. Articulated spines on the snout, cheeks, and gill-covers, like those of a hedgehog. Osseous plates on the body, crested and spinous; distinct squamiform bucklers on the belly. Teeth with a double curvature, arranged like those of *Rhinelepis*; mouth encircled by a complete velum. A single dorsal.

Genus VI. Hypostomus, Lacép. *Second dorsal* analogous to an adipose fin, having an *osseous ray in front*. Body thick and short. Head especially large. Bony armour, like that of *Loricaria*, on the body. A large first dorsal opposed to the ventrals and anal. Pectoral spine rough, long, and strong. Branchiostegals three. Seven species.

Order III.—PHARYNGOGNATHS.

This order is founded on the character, common to all its members, of the lower pharyngeals being united to form one bone. In external aspect there is no similarity between the families of *Scomberesocidæ* and *Labridæ*, which belong to it.

Order III.—PHARYNGOGNATHI, Müll.

Endo-skeleton ossified; exo-skeleton in some as Cycloid, in others as Ctenoid scales; inferior pharyngeal bones coalescent. Swim-bladder without an air-duct. Ventral fins in some on the thorax, in others on the abdomen.

Sub-Order I.—MALACOPTERYGII.

Fins without spines.

SCOMBERESOCIDÆ.

Of this group of Pharyngognaths we may obtain a correct notion from the Garfish or Greenbones of our coasts, named also by the fishermen Mackerel Guides, because they annually come into shallow waters at the time of the Mackerel fisheries. This fish belongs to the genus *Belone* which contains many species, and among others *B. caudimacula* and *B. cancila*, which inhabit the fresh waters of the peninsula of Hindostan, and afford an instance, in addition to many others, that generic assemblages are independent of habitat, as to the species being marine, lacustrine, or fluviatile. The British seas furnish an example of the genus *Scomberesox*, also, in the Saury Pike or Skipper. The latter name is given in consequence of the habit these fishes have of leaping out of the water, which is also practised by the Belones. Some species of this genus have an air-bladder, while others want it; a remarkable peculiarity in fishes so similar in aspect, but which also occurs among the Mackerel.

The *Exocœti* or Flying Fishes have ever been an object of great interest to navigators. The monotonous and quiet voyage of a ship running before the trade-winds is enlivened by the flights of large bands of these creatures rising before the bows of the vessel, and like a flight of larks or sand-pipers glittering in the sun, and often by a simultaneous impulse, changing the direct line for one nearly at right angles, before settling in their native element again. The muscular force by which this progress through the air is effected has engaged the attention of Humboldt. This illustrious and accurate observer states that the Flying Fish move by myriads constantly in a right line, and in a direction opposite to that of the waves. He doubts whether this flight be generally assumed as a means of escape from voracious fishes, and with reason. As we have noticed above, their near allies the Belones and Scomberesoces have the habit at certain times of leaping frequently from the water, and we have observed the same thing to occur in the spawning season among the shoals of *Malloti*, which often land themselves in numbers on the dry beach. There seems to be something in the constitution of these fishes which impels them to this movement, and the *Exocœti* are organized to carry it to the fullest extent by the size of their pectoral fins and the power of the muscles which move them. There are some who assert that the flight of the *Exocœti* is a mere leap, resembling the ricochet of a stone skimming along the surface of the water, but the pectorals are certainly impelled against the air in the course of the flight. The bands frequently undulate in their height above the water before subsiding into it again; and, as mentioned above, it is not rare to see them change their direction, though this is not done till just before the termination of their aërial course. Their flight is rapid, greatly exceeding that of a ship going 10 miles an hour, and we are not inclined to limit it to a distance of 500 feet. It is not easy to form a correct judgment of distance under such circumstances; but having often watched their flights when in a frigate 120 feet long, it appeared to us to exceed the length of the ship many times, and its altitude was such that in the night they frequently fell on board. Many shoals, consisting entirely of small ones, from 2 to 3 inches long, showed a smaller power of sustaining themselves in the air, and more frequently glanced against the summit of the coming wave, but the larger kinds rose vigorously into the air.

Classification—Pharyngognaths.

Family I.—SCOMBERESOCIDÆ, Müll.

Maxillaries coalescent with or adherent to the elongated premaxillaries at the corner of the mouth, under the nasal, and covered in part or wholly by the preorbitar scale bone.

Genus I. Belone, Cuv. Upper border of the jaw formed by the premaxillaries, which, together with the mandible, are elongated into a long bill; teeth on these bones forming a narrow stripe, the interior row consisting of taller conical ones; roof of the mouth smooth (except in the species which frequents the Channel); two small patches of teeth in the upper pharyngeals, more pointed than those on the lower pharyngeals, which are short, conical, inclining to the pavement form. Gill-openings large; branchiostegals, twelve. A hard helmet, formed of the cranial bones, is variously sculptured and furrowed. Body elongated. Scales very thin, like those of *Scomber*, and not easily perceptible, except one row of keeled ones on each side. Dorsal and anal opposite each other, and far back. No pyloric cæca; large air-bladder. Twenty-six species.

Genus II. Scomberesox, Lacép.; *Sairis*, Rafin. Jaws constructed nearly as in *Belone*, but the mandible is always the longest, and the maxillary, instead of being confluent with the premaxillary, is merely in apposition; the teeth are extremely small, and uniserial on the jaws; none on the roof of the mouth or tongue. Shape of the body much as in *Belone*. Dorsal and anal far back, opposite to one another, and followed by detached finlets of variable number, according to the species. A scaly keel, as in *Belone*, but which becomes obsolete near the anal, and does not reach the caudal. No pancreatic cæca; the air-bladder present in some species is wanting in others, as in the species of *Scomber*. Five species.

Genus III. Hemiramphus, Cuv. The distinctive character of this genus is expressed by the name, and consists in the edentate, pointed projection of the mandibular symphysis, producing a kind of half bill. The upper jaw is formed by the premaxillaries soldered together, and the maxillaries joined to them at the angle of the mouth widen and form a spur which is concealed by the preorbitar. A narrow band of small granular teeth exists in both jaws. In other respects these fishes resemble *Belone*, and as in that genus, the intestinal canal is straight, without pancreatic cæca. The air-bladder runs the whole length of the abdomen, between the spine and a tense arch of the peritoneum; and in the species (three) which M. Valenciennes examined, he found its structure cellular, similar to that of *Amia*. Thirty species.

Genus IV. Exocœtus, Linn. (Sub-Family, *Exocœtini*, Bonap.) Recognizable at once by the large pectoral fins that are capable of being used as wings or parachutes. Head and body scaly, with a scaly keel on each flank. Head flattened above and on the sides. Dorsal opposite the anal. Eyes large. Premaxillaries without nasal pedicels, forming the border of the upper jaw; maxillary not soldered to the premaxillary, but having nearly the same position as in *Belone*, and gliding under the preorbitar; jaws armed with small pointed teeth, composed of osteo-dentine, and the pharyngeals with crowded teeth, having compressed crowns and several cusps, like those of *Cyprinodon*, *Acanthurus*, and other genera. Branchiostegals ten to twelve. Intestine straight, without pyloric

cæca; upper lobe of the caudal shorter than the other; air-bladder large, closed. Thirty-three species. Some have barbels, and have been made the types of separate genera.

CHROMIDIDÆ.

This family is included by Müller among the Pharyngognaths with spinous rays in the fins. It is not treated of in the *Histoire des Poissons*, and the generic characters in the table are from Cuvier's *Regne Animal*, or from Rüppell's works. The members of this group agree with the Ctenoid Labroids in having only one nostril to each nasal sac.

Sub-Order II.—ACANTHOPTERYGII.

Family I.—CHROMIDIDÆ, Bonap.

Chromides, Müll. Lateral line interrupted. Teeth villiform. One dorsal. A single nostril to each pituitary sac.

Genus I. Chromis, Cuv. General aspect of *Labrus*, with their lips, protractile premaxillaries, pharyngeal bones, and the filaments of their dorsal rays; but the entire caudal and the soft dorsal and anal to a considerable height are scaly. Their teeth are disposed in two card-like bands on the jaws and pharynx, with, in front, a row of conical teeth. Branchiostegals six. Lateral line ceasing under the dorsal, and not recommencing on a lower level. Stomach cæcal; two pancreatic cæca. The *Bolti* of the Nile has no pancreatic cæcum, but its stomach is cæcal. Its dentition is that of the Mediterranean species.

Genus II. Cychla, Bloch, Schneid. Have the body more elongated than *Chromis*, and their teeth in a broad band, and wholly villiform.

Genus III. Sarotherodon, Rüpp. General habit of *Chromis*. Both jaws armed with an outer row of slender chisel-shaped teeth, smaller at their insertion, wider at their edges, behind which a band of brush-like teeth. Palatines and tongue unarmed; at the pharynx fine brush-like teeth, on a single three-cornered plate below, and two roundish transverse plates above. Four gills. Opercula without scales; pretty large scales on the body. Lateral line interrupted. A dorsal fin extending along the whole back, two-thirds of it supported by spines; three spines in the anal; ventrals behind the pectorals. Guinea coast.

CTENO-LABRIDÆ.

A small but very natural family separated from the *Sciænidæ* by their united pharyngeals, and the want of muciferous cellular structure of the bones of the skull. They are denominated in the *Histoire des Poissons* "Sciænoides a moins de sept rayons branchiaux et a ligne latérale interrompue;" and are there said to be beyond the bounds of the Linnæan genus *Sciæna*, and to have analogies with the Labroids. They are small fishes, of a peculiar rounded oval form, and clothed with large scales, a well-marked family likeness pervading the several genera. Their strongly ciliated scales separate them from the true Labroids, whose scales are cycloid. They are edible, but they do not form the objects of special fisheries, not only from their want of size, but because they do not assemble together in numbers. The Glyphisodons and others of the family are prettily banded, and show a pleasing combination and variety of colours.

Family II.—CTENO-LABRIDÆ, Müll.

Compressed oval or oblong fishes, with the head forming part of the general elliptic profile. One dorsal spinous in front; anal also spinous in front, placed with the dorsal on the posterior curve of the oval. Tail between the vertical fins short, moderately high. Scales ctenoid. Air-bladder closed, without appendages. Ovarium closed, with an excretory duct behind the anus. Cranium not cavernous in its outer walls. A single nostril to each pituitary sac.

Genus I. Caprodon, Schleg. Teeth card-like on both jaws, before which a row of bigger ones; the three fore teeth of the premaxillary on each side being large cutting teeth; front mandibular tooth very large, and pointing backwards; behind it one somewhat smaller; in the middle of the limb of the mandible there stands a large tooth arched backwards, and then follow some more card-like teeth. Branchiostegals, five.

Classification—Pharyngognaths.

Genus II. Amphiprion, Schneid. Body oval, compressed. A single dorsal. Lateral line terminating under the end of the dorsal. Head obtuse; uniserial, small, conical, obtuse teeth on the jaws; palate edentate. Five branchiostegals. Preoperculum, operculum, suboperculum, and interoperculum *denticulated strongly*, and *striated* on their surfaces. Air-bladder simple. Sixteen species.

Genus III. Premnas, Cuv. Form that of an *Amphiprion*, with interrupted lateral line, and obtuse uniserial teeth, but the opercular pieces are less strongly toothed, and the suborbitar scale-bones much more armed, producing under the eye one or two large spines pointing backwards. A few denticulations exist on the ascending edge of the preoperculum, and on the border of the suboperculum; but the opercular pieces are not strongly streaked on the surface, as in *Amphiprion*. Stomach globular, small; three pancreatic cæca; large globular air-bladder. Three species.

Genus IV. Pomacentrus, Lacép. Form oblong. Head obtuse; incisorial uniserial teeth. Preoperculum denticulated; operculum entire on the border, and without spines; suborbitars often toothed. Lateral line ending under the soft portion of the single dorsal; four or five branchiostegals. Twenty species.

Genus V. Dascyllus, Cuv. Resembling *Pomacentrus*, but the teeth, instead of being trenchant, are in a villiform band, with stronger conical ones in the outer row. Three species.

Genus VI. Glyphisodon, Lacép. Having a strong resemblance to *Pomacentrus*, but the preoperculum is not denticulated. Body compressed, oval, covered as well as the head with large scales. Profile rounded. Mouth small; teeth on the jaws only, uniserial, close together, narrow and straight, trenchant at the crown, and often notched. Lateral line ending under the end of the dorsal. For the most part thirteen dorsal spines (rarely twelve), each with a membranous filament at its tip; two anal spines (rarely three). Stomach very large, cæcal; three thick pancreatic cæca; ovaries discharging by a tube behind the anus. Thirty species.

Genus VII. Etroplus, Valenc. Oval compressed form of *Glyphisodon*. Eye more elevated than in that genus, and the suborbitar scale-bone large and not scaly. Snout also destitute of scales. Dorsal (seventeen or eighteen) and anal spines numerous (eleven to thirteen). Three species.

Genus VIII. Heliases, Cuv. Resembling *Glyphisodon* in the oval compressed body. Small mouth. Entire or smooth-edged preoperculum. Large scales and short lateral line, and in the number of spines in the dorsal and anal, but having the teeth of *Dascyllus*. Branchiostegals five, rarely six.

CYCLO-LABROIDS.

The name *Labrus* applied to a fish is cited by Pliny as occurring in a passage of Ovid which has not been pre-

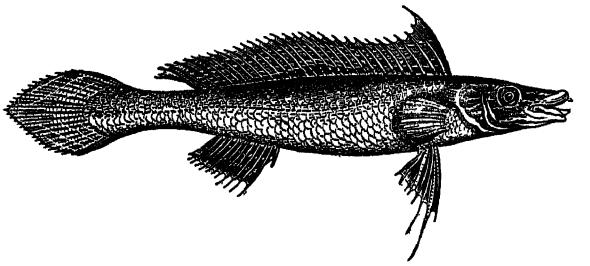


Fig. 86.
Odax lineatus.

served, and the kind of fish it was used to designate cannot now be ascertained. The name was widely and vaguely applied by modern ichthyologists until Cuvier gave the precise characters of the genus which it now distinguishes. Several species occur in the British seas; none of them prized as an article of diet. The Tautog (*Tautoga nigra*) of New York, however, is a fish in great request for the table, and sells at the rate of 8 lb. for a dollar. It is tenacious of life, and is kept in stews to fatten. In great colds it becomes torpid, and will not eat. When the dog-wood (*Cornus florida*) comes into flower the Black Tautog is in season.

The *Epibulus* seizes insects by suddenly thrusting out its mouth, and engulphing those that come within the scope of the elongated tube; at least so says Renard; and the

Classification—Pharyngognaths.

accounts of this fish shooting drops of water at its insect prey, like the Chelmons, does not appear to be based on correct observation. *Scarus* was the name given by Forskål to a group of fishes resembling the *Labri* in all their characters except in dentition, their teeth being incorporated with the substance of their jaws to form convex bones like those of the Tetraodons. The researches of Cuvier prove fully that the fish so named by the ancients was truly of this genus. It was held in high repute either for the address attributed to it of skilfully withdrawing other fishes from the nets in which they were inclosed, or because the epicures greatly esteemed its intestines, or on account of the vast expense incurred in endeavouring to multiply it on the Italian coasts, that it might administer to the extravagant luxury of the world's capital. Aristotle has several passages respecting its rumination. His assertions have been repeated by Pliny, Ælian, and others, without examination; and Ovid and Oppian have spoken of it as a matter beyond doubt, yet no one has verified the observation of Aristotle. It passed also among the ancients as a fish that had a voice; and Suidas says that it produced sounds by ejecting water in blowing, and that it could not make itself heard when it was deep in the water. Athenæus, quoting Seleucus as his authority, states that the *Scarus* is the only fish that sleeps and is never taken in the night. Ælian says that it is the most ardent in love of all fishes, and that many males may be enticed into the nets by the pursuit of a female attached to a line. But still it was the most prudent of fishes, and the most active in showing friendship for its companions. If one was caught by a hook, the others endeavoured to cut the line; or if entrapped in the meshes of a net, they tried to drag it out by the tail!

> "Sic et Scarus arte sub undis,
> Contextam si forte levi de vimine nassam,
> Incidit, assumtamque dolo tandem pavet escam.
> Non audet radiis obnixa occurere fronte,
> Aversus crebro veniens sed verbere caudæ,
> Laxans subsequetur, tutumque evadit in æquor."
>
> OVID.

It was most plentiful and of the best quality in the Carpathian Sea, between Crete and Asia Minor, but was not unknown even in early times on the Italian coast, though Columella says that it seldom passed beyond Sicily in his day. But in the reign of Claudius, according to Pliny, Optatus Elipertius brought it from the Troad, and introduced it into the sea between Ostium and Campagna. For five years all that were caught in the nets were thrown into the sea again, and from that time it was an abundant fish in that locality. In the time of Pliny it was considered to be the first of fishes (*Nunc Scaro datur principatus*); and the expense incurred by Elipertius was justified, in the opinion of the Roman gourmands, by the extreme de icacy of the fish. It was a fish, said the poets, whose very excrements the gods themselves were unwilling to reject. Its flesh was tender, agreeable, sweet, easy of digestion, and quickly assimilated; yet, if it happened to have eaten an Aplysia, it produced *cholera morbus*. In short, there is no fish of which so much has been said by ancient writers. In the present day the *Scarus* of the Archipelago is considered to be a fish of exquisite flavour; and the Greeks still name it *Scaro*, and eat it with a sauce made of its liver and intestines. It feeds on fucus; and M. Valenciennes thinks that the necessity for masticating its vegetable diet thoroughly, and the working of it with that intent backwards and forwards in the mouth, may have given rise to the notion of its being a ruminant; and it is certain that its aliment is very finely divided when it reaches the stomach. The adjoining woodcut represents *Callyodon chlorolepis*, a fish of the Australian seas, and number 56, gives views of the teeth of the same species. Woodcut 86 is a representation of *Odax lineatus*; and figures 25, 38, and 39, are views of

Classification—Pharyngognaths.

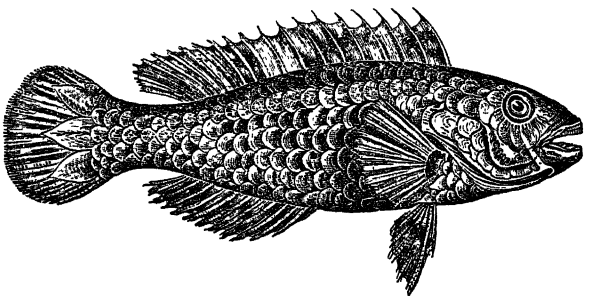


Fig. 87.
Callyodon chlorolepis.

Labroid scales. The family of *Ambiotocidæ* was constituted by Agassiz for the reception of a single genus of fishes that frequent the western coasts of North America.

FAMILY III.—CYCLO-LABRIDÆ, Müll.

Oval, elliptical, or oblong scaly fishes, more or less compressed, generally with a proportionally high parallel-sided tail between the vertical fins. Scales cycloid. A single dorsal supported in front by spinous rays, which have frequently membranous processes behind their points. Jaws covered by fleshy lips; palate smooth, toothless. Three pharyngeal bones, viz., two above and one below, armed with teeth, which are in some species pavement-like, in others lamellated, and in others pointed. No pancreatic cæca; a closed, simple air-bladder; shut ovisacs, with an efferent tube behind the anus.

ANALYTICAL TABLE OF THE *CYCLO-LABRIDÆ* (Dum.)

Cheeks scaly; preoperculum crenulated.		
Dorsal scaly at the base.		
Mouth protractile; teeth even	CLEPTICUS	7.
Mouth not protractile; teeth unequal	COSSYPHUS	2.
Dorsal not scaly.		
Mouth protractile.		
Dorsal with short soft rays.		
Scales very large	EPIBULUS	21.
Scales of ordinary size	CORICUS	6.
Dorsal with long filaments	LACHNOLAIMUS	8.
Mouth not protractile.		
Teeth equal to one another	CRENILABRUS	3.
Teeth unequal.		
Dorsal scaly	ACANTHOLABRUS	5.
Dorsal not scaly	CTENOLABRUS	4.
Cheeks scaly; preoperculum not crenulated.		
Dorsal very long.		
Scales very large; teeth uniserial	CHEILINUS	18.
Scales of ordinary size.		
Suboperculum denticulated	MALAPTERUS	12.
Suboperculum very entire	MALACANTHUS	10.
Dorsal of ordinary length; rays tasselled	LABRUS	1.
Cheeks scaleless.		
Snout abnormal, like a beak	GOMPHOSUS	15.
Teeth unequal, reclining, diverging	ANAMPSES	14.
Teeth equally curved	CHEILIO	11.
Snout ordinary, pointed.		
Preorbitar denticulated	TAUTOGA	9.
Preorbitar smooth-edged	JULIS	13.
Snout ordinary, smooth and blunt.		
Profile curved, convex	XYRICHTHYS	16.
Profile descending, trenchant	NOVACULA	17.

GENUS I. LABRUS, Linn., Artedi. Lips large, thick, and as if double. Six branchiostegals. Upper jaw generally considerably protractile; teeth on the jaws simple, conical in one or more rows. Pharyngeals cylindrical, smooth, and rounded on the crowns. No spines on the opercular bones. Lateral line almost straight, continuous. Cheek and operculum scaly. Thirty species.

GENUS II. COSSYPHUS, Cuv. and Valenc. Maxillaries wide and thick. *Behind the exterior row of pointed teeth, small, round, granular teeth crowded together.* Opercular pieces scaly. Vertical fins sheathed in scales which rise and fall with the rays, but do not form so deep a sheath as those of the Percoids or Sparoids. Almost all have distinct crenatures on the ascending border of the preoperculum, but in some these appear at the angle of the bone only, and are very feeble. Fifteen species.

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Genus III. Crenilabrus, Cuv. Upper jaw not protractile; *preoperculum deeply toothed;* lips thickly fleshy; teeth conical, uniserial, without the granular band of *Cossyphus*, and also without the scaly sheathing of the fins. The continuous lateral line and cycloid scales distinguish them from *Chromis* and *Cichla*. Thirty-six species.

Genus IV. Ctenolabrus, Cuv. and Valenc. A band of villiform teeth behind the outer row of conical teeth on the jaws. Other characters those of *Crenilabrus*, such as the finely denticulated preoperculum, three anal spines, &c. Ten species.

Genus V. Acantholabrus, Cuv. and Valenc. Dentition of *Ctenolabrus*, but with numerous anal spines, representing the *Percoid Centrarchus*. Six species.

Genus VI. Coricus, Cuv. Conical jaw teeth in one row, as in *Crenilabrus;* jaws greatly protractile, like those of the *Menidæ*. Premaxillaries with long pedicels, and limbs which are thrust out when the mandible is depressed. Preoperculum rounded at the corner, denticulated on the ascending border, but having a smooth lower one. Pharyngeal teeth small, round grains crowded together. Short intestine; stomach siphonal, without dilatation; no pancreatic cæca. Distinguished from *Epibulus* by its continuous lateral line; representing the Menoid *Smaris* and *Gerres*. Four species.

Genus VII. Clepticus, Cuv. Protractile mouth, withdrawing beneath the vault of the preorbitars; denticulated preoperculum; continuous lateral line. Teeth in one row, few, and very small; pharyngeal teeth lamellated, the plates serrated. Vertical fins covered in great part by scales like those of the body. One species.

Genus VIII. Lachnolaimus, Cuv. Resembles *Labrus* in the lips; in general form; in the membrane which descends from the preorbitars; in the scaly cheeks, and in the filamentous tips of the dorsal spines; but the tips of the anterior dorsal spines are flexible. Lateral line continuous. Anterior teeth strong, curved, and standing forwards, followed by a series of small teeth of even height. The pharyngeals, instead of being wholly covered with pavement-like teeth, as in *Labrus*, are only partially so, the rest of the bone being clothed with velvety membrane. No pancreatic cæca. Six species.

Genus IX. Tautoga, Mit. Labroids distinguished by a double row of strong conical teeth on both jaws, and the extent of thick, scaleless integument on the face, which reaches to the operculum, suboperculum, and interoperculum, and even on the preoperculum the scales are few. Branchiostegals five. Lateral line continuous. Nine species.

Genus X. Malacanthus, Cuv. Resembling *Coryphæna* in the length of the dorsal and anal, and in the rays of these fins being nearly as flexible, but allied to *Lachnolaimus* by scaly cheeks, and a continued lateral line. The proper generic character is the long dorsal, with only three or four simple rays in front, the others being branched. Body slightly compressed, long. Scales small. Anal nearly as long as the dorsal. Mouth tolerably large; lips fleshy; a row of teeth on the jaws; large, and curved in front, much smaller towards the angles of the mouth. Palate and tongue smooth; upper pharyngeal teeth card-like; under pharyngeal teeth in some species wholly card-like, in others partly so, partly pavement-like. A pretty *strong spine at the angle of the operculum*. Stomach siphonal; no pancreatic cæca. Two species.

Genus XI. Cheilio, Comm. Premaxillaries widening interiorly into a granular osseous plate peculiar to this genus among the Labroids. Exterior row of *teeth triangular, compressed, and trenchant*, like those of some *Sphyrænæ* or *Cybiums;* the symphysial pair hooked, and longer than the others, which are of equal height among themselves, and in the interspaces between all these teeth there are small conical ones. The *lateral line is continuous;* and there are a few scattered scales on the cheeks. Fin rays flexible. Eight species.

Genus XII. Malapterus, Valenc. Combines many of the characters of *Malacanthus* and *Cheilio*, having the flexible rays of *Cheilio*, teeth of *Labrus*, scaly operculum of *Malacanthus*, but *not* the opercular spine. One species.

Genus XIII. Julis, Cuv. Lateral line continuous; stiff and pointed spines in the dorsal. Head entirely naked, that is to say the suborbitar chain, preoperculum, and other bones of the gill-cover, the under surface of the head, and the jaws, are destitute of scales. Teeth conical in the outer row, longer and stronger the nearer the symphyses; within there are some granular teeth, largest in the old fish, being indications of teeth incorporated with the bone, as in *Cheilio*, and more fully shown in *Scarus*. Some species have a canine at the corner of the mouth pointing forwards, forming the genus *Halichorus* of Rüppell. Pharyngeal teeth as in *Labrus*. One hundred species.

Genus XIV. Anampses, Cuv. Two teeth on the upper jaw, one on each side of the symphysis, turning from each other, flattened longitudinally; chisel-shaped at the crown and trenchant; the mandibular pair more conical, yet a little flattened at the point; pharyngeals of *Labrus* for bruising. Branchiostegals six. General form that of one of the higher bodied *Jules*. Head naked. Lateral line continuous. Six species.

Classification—Pharyngognaths.

Genus XV. Gomphosus, Lacép. (*Helops*, Comm.) Body oblong, compressed. Scales large. Head quite naked; eye small; nostrils near the orbit; muzzle slender, elongated, cylindrical; orifice of the mouth formed by the premaxillaries and mandible. Uniserial teeth on the jaws, the anterior ones longer; pharyngeal teeth pavement-like, as in *Labrus*. Gill-covers approaching one another under the throat; gill-openings narrow. Branchiostegal membrane adherent to the isthmus; branchiostegals six. Dorsal and anal but slightly elevated, and of uniform height. Lateral line branching and deflexed near the caudal. Stomach and œsophagus straight; no pancreatic cæca; a long, narrow air-bladder. Three species.

Genus XVI. Xyrichthys, Valenc. Form that of a Labrus, except that the profile of the face is almost vertical, with the eye high up; this is owing to the growth of the snout directly downwards, while the mandible of ordinary length is horizontal. The resulting aspect is peculiar. Many characters common to it and *Labrus* or *Julis*. Head naked, and, from compression, trenchant in the face, which is sustained by the nasal bone. Dorsal long and of uniform height. Teeth in one row, longest near the symphysis; pharyngeal teeth small, pavement-like; palate and tongue smooth. Lateral line interrupted generally as in *Scarus*, but the tubes on each scale simple. A species of double lip is formed by the edge of the preorbitar, which descends to the corner of the mouth. Intestinal tube simple, without any stomachal dilatation, and without pancreatic cæca; air-bladder large, pointed anteriorly, rounded behind. Fourteen species. Two species have the three front rays detached as a separate fin, and form the only instance, except *Novacula*, of a Labroid with two dorsals.

Genus XVII. Novacula, Valenc. Preoperculum scaly under the eye, with the mandible more ascending in other respects, like *Xyrichthys*. Generally the first two dorsal rays are somewhat detached from the others, and connected to them by basal membrane only. Six species.

Genus XVIII. Cheilinus, Cuv. Lateral line interrupted under the end of the dorsal. Lips thick; large, uniserial, conical teeth on the jaws. Large scales on the cheek; scales of the body broad and thin, advancing on the base of the caudal, but leaving the dorsal and anal naked as in *Labrus*. Splanchnology also as in that genus, but the bones are green in some, if not in all the species, like those of *Belone*. Twenty-four species.

Genus XIX. Chærops, Rüpp. Both jaws armed with similar tapering stripes of teeth, succeeded posteriorly by small tufts of teeth; four stout conical canines in front of each jaw. Thick lips. Scales of the operculum and preoperculum of moderate size; on the body the scales are larger. Lateral line interrupted. Spines of the dorsal and anal strong and pointed. Java.

Genus XX. Cirrhilabrus, Schleg. A toothed preoperculum; an interrupted lateral line. Scaly gill-cover. Ventrals prolonged into filaments. Branchiostegals five.

Genus XXI. Epibulus, Cuv. Protractile mouth, the mechanism of which differs from that of *Coricus*. The nasal pedicels of the premaxillaries play in grooves of the skull, and reach back to the occiput, while the descending branch is attached by a long ligament to the lower end of the maxillary bone, and, consequently, when the mouth opens, draws forward that end of the maxillary together with mandible, which is also connected to the same end of the maxillary. The hypotympanic and mesotympanic unite to form a lever, and assist in this movement. The scales are very large, and cover the cheeks, but are there embedded in the skin, and the face is naked. The large jaws, with the projection of the hypotympanic and angular portion of the mandible, give a peculiar aspect to the fish which otherwise resembles a *Glyphisodon*. Branchiostegals five. Lateral line interrupted. One species.

Genus XXII. Scarus, Forsk. Labroids of oblong and rather massive forms, lateral line interrupted under the end of the dorsal, and recommencing lower down. Large scales extending to the gill-covers and cheeks. Jaws resembling those of *Tetraodon*, each divided into halves by a median suture. The teeth are incorporated with the bone, and shine through the glazed surface in crowded quincuncial order; the oldest form the trenchant border of the jaw, and as they are worn away they are succeeded by the lower ranks, new pulps developing at the base of the jaw to keep up the succession. In some species the quincuncial surface is even and polished, in others it is granular from the prominence of the crowns of the teeth, and in some a few pointed canines protrude from the angle of the upper jaw, or from other parts of it. Pharyngeal teeth trenchant and standing up like verticle tiles, producing in the using, narrow, projecting ellipses of dentine surrounded by enamel; the base of each tooth is osteodentine, and it is bound to the others by cement. Each of the superior pharyngeals carries two or three longitudinal ranges, the number varying with the species; the single under pharyngeal is fixed by a thin vertical plate in the angle formed by

Classification—Anacanths.

the last pair of branchial arches, and rests upon the lateral processes of the coracoid. Its concave surface, studded with compressed teeth in quincunces, receives and acts against the upper pharyngeal dental plates; the length of these plates increases with age. On each side of the inferior pharyngeal there are two mucous sacs, papillose within. Stomach without a cæcum, and no pancreatic cæca. General aspect, except in respect of the teeth, that of *Cheilinus*, generally with a higher body than *Labrus* or *Julis*. Ninety species.

Genus XXIII. Callyodon, Gronov. *Scari*, whose anterior teeth are tiled in many rows, the lateral ones of the upper jaw being pointed and scattered, while within the jaw there is a row of much smaller ones. Figure 56 represents the teeth of *Callyodon chlorolepis*. Twelve species.

Genus XXIV. Odax, Comm. Head and body elongated; snout pointed; lips swollen, and a fold from the cheek and preoperculum makes a posterior lip as in *Labrus*. Lateral line continuous, and composed of simple not branching tubes, as in *Labrus*. Teeth incorporated with the jaw, but the compound dental pieces thus formed are thinner than in *Scarus*, the jaws bulging less; pharyngeals as in *Labrus*, with which they have more affinity than with *Scarus*. Eight species.

Family IV.—AMBIOTOCIDÆ, Agass.

The general aspect of the fishes on which this family is founded is that of *Pomotis*, or of the higher bodied *Sparidæ*; they are compressed and oval, with middle-sized cycloid scales; opercular pieces without spines or serratures. Branchiostegals six. Lips moderately thick; orifice of the mouth formed above by the premaxillaries, to the exclusion of the maxillaries; both these bones somewhat protractile; teeth on the premaxillaries, mandible, and pharyngeals only, none on the vomer or palatines. By their entire gill-covers, they are farther removed from the Perch family than from the Sparoids, but the cycloid scales separate them from the latter, which have all ctenoid scales. By their thick lips they approach the Labroids, but differ in the construction of the mouth. M. Agassiz gives an interesting paper on this family in Troschel's *Arch. für Naturg.*, 1854. The name of *Ambiotoca* is deduced from the mode in which the young are produced, analogous to that of the Kangaroos. The designation of *Holconoti* has also been proposed on account of a naked stripe parallel to the hinder basis of the dorsal fin. Troschel remarks that this family is a peculiar one, nearly allied to the *Labridæ cycloidei*, but that it cannot enter that group on account of the unusual structure of the gills.

Genus I. Ambiotoca.

Order IV.—ANACANTHS.

This order was indicated by Müller, and according to the characters which he assigns to it, as given in the table, the only difference that exists between it and the *Acanthopteri* is the absence of spinous or pungent rays in the fins; but many of the *Gobiidæ* have also rays wholly flexible, and that family may be considered as furnishing links between the orders. Indeed, there are some forms which may, with almost equal propriety, be placed in either. The ventral fins, when present, are attached to the thorax or throat.

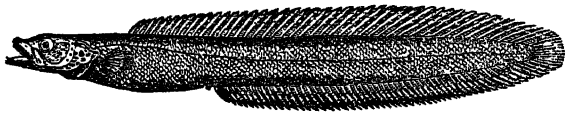


Fig. 88.
Machærium subducens.

On the *Ophididæ* we need not dwell, the members of that family being fishes of small size of little utility to man. The groups composing it have been investigated by Dr Kaup of Darmstadt, and our table gives the results of his labours. Fig. 88 represents the *Machærium subducens*, an

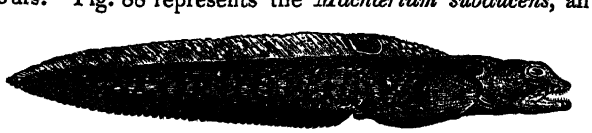


Fig. 89.
Gymnelis viridis.

Australian species, and fig. 89 *Gymnelis viridis*, an inhabiant of the Arctic seas.

Classification—Anacanths.

Order IV.—ANACANTHINI, Müll.

Endo-skeleton ossified; exo-skeleton in some as cycloid, in others as ctenoid scales. Fins supported by flexible or jointed rays; ventrals beneath the pectorals, or none. Swim-bladder without air-duct in the *Gadidæ*, absent in *Ophididæ*, *Echeneidæ*, *Macrouridæ*, and *Pleuronectidæ*.

Sub-Order I.—APODES.

Family I.—OPHIDIDÆ.

Gadus-like fish without ventrals. Body elongated, more or less dagger-like posteriorly; the tail surrounded without a break by the vertical fins.

Genus I. Machærium, Rich. Anus at the termination of the first third part of the length of the fish. Body scaly. Mandible destitute of a barbel; uniserial, incisorial teeth on the jaws. Dorsal beginning somewhat behind the pectoral; anal occupying two-thirds of the length of the body. Six branchiostegals. Lateral line ceasing under the tenth ray of the dorsal. No swim-bladder. Two species.

Genus II. Ophidium, Lin. Anus at the termination of the first third part, or of the half of the length of the fish. Body scaly. Two pair of barbels attached beneath the point of the glosso-hyal (or lingual) bone. A swim-bladder. Small sword-shaped fish, with lowly developed dorsal and anal fins, supported by simple rays only. Air-bladder large and oviform, with three proper ossicles, the middle one of which is moved by a peculiar muscle. Six species.

Genus III. Gymnelis, Reinh. (*Cepolophis*, Kaup.) Ophidia without barbels, and destitute of scales; resembling the proper *Ophidia* in the blunt head. The vomerine teeth do not project forwards, but lie deep in the palate. Anus situated in the fore part of the fish. Pectorals and vertical fins moderately developed. They are distinguished from *Fierasfer* in that the anus is not in the pectoral region, but farther back. The body also is less slim, and the tail not so much dagger-like. Two species.

Genus IV. Fierasfer, Cuv. (*Echiodon*, Thomp.; *Oxybeles*, Rich., Bleek.) Anus in the pectoral region. Vomer projecting forwards, with blunt or laterally compressed teeth. Seven branchiostegals. No scales. Three species.

Genus V. Encheliophis, Müll. Abrachial as well as apodal; anus behind the gills. Six branchiostegals.

GADOIDS.

This is a most important family, and the fisheries established for the capture of its various members have, more than any other tribe of fishes, been the means of forming great numbers of hardy and able seamen. Its members live in cold or temperate climates, and constitute a very important article of fishery. The greater number are considered wholesome, and form a light and agreeable food,—the flesh separating easily by boiling into white flaky layers. The great sand-bank of Newfoundland is the most famous station of the Cod fisheries, and is resorted to by English fishermen, who chiefly use the hook and line. The fish abound in this place probably on account of the great quantity of the smaller animals which serve as food, viz., mussels, clams, &c.

Morrhua vulgaris, the common Cod (*la Morue*, Fr.; *Kabliau*, Germ.), measures from two to three feet in length. The back is spotted with yellowish brown. It inhabits the whole Northern Ocean, and occurs in vast profusion. This fish dwells in salt water only. It is not found nearer the equator than the 40th degree of latitude. The weight of the common Cod varies from 12 to 80 or even 100 pounds. It is extremely voracious, and its digestive powers are seemingly very great. It feeds upon smaller fishes, such as Herrings, on Mollusca, Worms, and Crustacea, and even on the young of its own species. It has a strong, muscular stomach, and is said to possess the power of rejecting by the mouth substances, such as wood, &c., which it finds indigestible. In spring it comes nearer the shore in order to deposit its spawn. This happens in January in England, in February in Norway, Denmark, and Scotland, and in March in Newfoundland. One female is said to contain from *our* to *nine millions* of eggs! The most extensive Cod fisheries

Classification—Anacanths.

on our coasts are off the Western and Shetland Isles, but they are still greater in more northern countries. The Cod has been fished on the coast of Sweden since the year 1368 by the inhabitants of Amsterdam. The English resorted to the fisheries of Iceland before the year 1415; and it is stated that in the year 1792, 200 French vessels, of a burden of 191,153 tons, were employed in the Cod fishery. Every year more than 6000 European vessels are engaged in this fishery.

The flesh of the Cod has a good flavour, and may be easily preserved. The tongue, salted and dried, has been considered a great delicacy. The gills are preserved and used as bait. The liver is eaten, and of late years the oil it yields has brought a high price owing to its importance as a medicine. The swimming-bladder affords a very good isinglass. This important species constitutes a principal article of food to the inhabitants in some parts of Iceland, Norway, and other northern countries. In a dried state it is also much used in some papal kingdoms of the south. In the neighbourhood of the Isle of Man, and elsewhere, there is a variety of the Cod named the Red or Rock Cod, the skin of which is of a brightish vermilion colour. Its flesh is much esteemed.

Morrhua æglefinus, the Haddock (*l'Egrefin*, Fr.; *Schollfisch*, Germ.), is as well known, and almost as important, as the Cod in this country; it is of a smaller size, usually eighteen inches long. The back is brown, the belly silvery, and the lateral line black. There is a blackish spot behind the pectoral fin, which tradition assigns to the impression of St Peter's finger and thumb, when he took the tribute money out of the mouth of a fish, the inventors of the legend never adverting to the improbability of a marine fish living in the fresh-water lake of Gennesaret. The Haddock is found, like the Cod, in the Northern Ocean, but does not enter the Baltic. It annually approaches the British shores in February and March, in order to deposit its spawn. The regularity with which it reappears in some districts, on a stated day, is quite remarkable. On the coast of Yorkshire, since the year 1766, it has made its annual appearance on the 10th of December. To this place it comes in such numbers as to form an immense shoal 3 miles broad, and extending 80 miles in length—from Flamborough Head to the mouth of the Tyne. It is in autumn that they visit the shores of Holland and East Friesland, and the neighbourhood of Heligoland. The Haddock frequents our coasts during the greater part of the year, although the largest are taken in the winter. Its flesh is generally best in the months of May and June, and is greatly superior on the east coast of Scotland than when taken in the southern parts of the English Channel. On the coast of Hampshire it is a very inferior fish.

Morrhua callarias, the Dorse, is smaller than the Haddock, resembles the Whiting in taste, and is by many considered to be the best fish for the table of all this family. It is in great request on the coasts of the Baltic. It frequents the mouths of large rivers, and ascends them with the salt tide in June. The *Morrhua lusca* and *barbata*, Bib and Whiting Pout, are considered by one so well acquainted with the British fishes as Mr Yarrell, to be but one species, and are well known on the English coast, being brought in considerable quantities to the market. They are in best condition for the table in November and December.

Merlangus vulgaris, Whiting (*Merlan*, Fr.), is valued on account of its abundance, and the wholesomeness and fine flavour of its flesh. Its fishery lasts the whole year, but is most plentiful in January and February, and is generally carried on within a mile or two of the shore. *Merlangus carbonarius*, Cole-fish (*Kohlfisch*, Germ.) The flesh of the young is rather delicate; that of the adult is somewhat leathery, but it is used when salted and dried, like the Cod. This is the *Podley, Silloch, Cuddy*, &c., of our coasts. The young swarm along the British shores, and form a frequent sustenance of the lower orders of the Western Highlands On one occasion we killed 33 dozen with the rod in a few hours, using a line with 6 small flies. By giving the line one or two additional turns through the water, we frequently pulled 6 ashore at once. It even constitutes an important article of exportation from our northern coasts. In Norway the poor feed upon it; and oil is made from its liver. The adult fish is taken principally in summer; it deposits its spawn in this country in February and March. The Coal-fish is found in the North Atlantic and Pacific Oceans; and sometimes, though very rarely, in the Mediterranean Sea,—for example, near Nice. *Merlangus pollachius*, the Pollock or Pollack, about 18 inches long; resembles *M. carbonarius* in its general form. Its flesh is considered better than that of the Coal-fish, and inferior only to that of the Dorse and Whiting; it inhabits the Atlantic, and is gregarious. It is commonest on the coasts of Norway and the north of England, and sometimes occurs in the Mediterranean in winter. It is easily caught with a white fly.

Classification—Anacanths.

Of the *Merluccius vulgaris*, or Common Hake, great numbers are taken in the ocean, and in the Mediterranean. On the coasts of the Mediterranean it is called Merlan or Whiting; and. when dried, it receives in the north the name of Stock-fish, in the same way as the Cod. It is said to be very abundant in the Bay of Galway, on the west of Ireland, and at Penzance in Cornwall. The flesh is white and flaky, and its liver is considered a delicacy.

The *Brosmius vulgaris*, Tusk, or Torsk, is common in the Shetland seas, but seldom comes so far south as the Firth of Forth. It is a most excellent fish for the table when newly caught, being far superior to the Cod, but rarely appears in the southern markets. It cures well. *Molva*, or *Lota molua*, is the only fresh-water fish of this family which exists in England, and is very local, being confined to a few rivers mostly of the midland counties. It is named the Burbot and Coney-fish, and its flesh is said to be good. One, or perhaps two species frequent the northern waters of the American continent, but their flesh, though wholesome, is lightly esteemed in a country which abounds in Coregoni and Trout of the richest flavour. The roe, which is remarkable for the smallness of its eggs, makes a substantial bread when pounded and mixed with a proportion of flour. The American fish is named Methy, and furnishes names for many rivers and lakes of that country. It is voracious, and feeds much on fresh-water Cray-fish.

The Gadoid family is scarcely known near the equator, but reappears again in the higher southern latitudes in the same generic forms though differing in species, and doubtless fisheries of these useful fishes will hereafter be established on the Australian coasts, when the submarine sand-banks come to be known, and the increase of population raises a greater demand for fish. The subjoined woodcut represents the *Lota breviuscula* from the Bay of Islands, New Zealand.

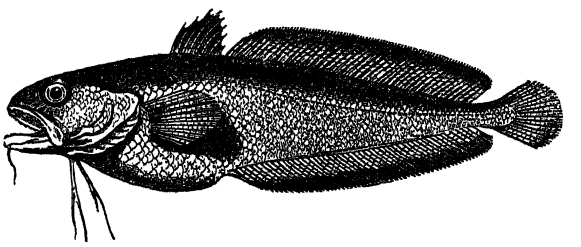


Fig. 90.
Lota breviuscula.

SUB-ORDER II.—THORACICI.

FAMILY I.—GADIDÆ.

Body moderately elongated. Scales small, soft. Head naked.

Classification—Anacanths.

No spines in the fins. Jaws and front of the vomer with pointed teeth, of unequal height, producing card-like or raduliform patches. Branchiostegals seven. One or more dorsal fins. Stomach capacious, cæcal; pancreatic cæca numerous. A large air-bladder with strong walls, often denticulated at the sides; a large branch of the cæliac artery perforates the fibrous coat of the air-bladder, and divides into a dense network inclosing long corpuscles with fine villiform processes, producing together one of the organs named vaso-ganglion, which exists in the air-bladders of many other fishes.

ANALYTICAL TABLE OF THE *GADIDÆ* (Dum.)

Dorsal single.		
Vertical fins separate	BROSMIUS	7.
Vertical fins united	BROTULA	8.
Dorsals several.		
Dorsals two.		
Barbels three; one rostral	MOTELLA	6.
Barbels one.		
Jugulars of many rays	LOTA	5.
Jugulars of one forked ray	PHYCIS	10.
Barbels none; one anal	MERLUCCIUS	4.
Dorsals three.		
Anals two.		
Barbels conspicuous	GADUS L. / MORRHUA C.	1.
Barbels none	MERLANGUS	3.

GENUS I. GADUS, Linn. *partim.* (*Morrhua*, Cuv.) Three dorsal fins; two anals; a symphysial mandibular barbel.

GENUS II. GADICULUS, Guich. Resembles *Morrhua* in the fins, but the barbels are wanting, as in *Merlangus*. Body elongated, compressed. Head small, scaleless; jaw teeth pointed, ranged in many rows. Chiefly distinguished by the bigness of the eyes, and the want of vomerine teeth; the mandible projects a little. Algiers.

GENUS III. MERLANGUS, Cuv. *Gadi*, without barbels.

GENUS IV. MERLUCCIUS, Cuv. Two dorsal fins; one anal fin. No barbels.

GENUS V. LOTA, Cuv. Two dorsal fins; one anal fin. Barbels.

GENUS VI. MOTELLA, Cuv. Number of fins as in *Lota*, but the first dorsal scarcely perceptible.

GENUS VII. BROSMIUS, Cuv. A single long dorsal reaching very near to the caudal.

GENUS VIII. BROTULA, Cuv. Vertical fins uniting at the end of the tail to form one pointed fin.

GENUS IX. ATELEOPUS, Schleg. Snout very thick over the mouth, which is protrusive beneath. A band of card-like teeth above and below; vomer and palatines toothless. Ventrals on the throat one-rayed; a small dorsal over the pectorals; anal very long; caudal small. Japan.

GENUS X. PHYCIS, Artedi, Schneid. Ventrals of a single ray, which is often forked. Head large. A symphysial mandibular barbel. Two dorsals. the second one long.

GENUS XI. RANICEPS, Cuv. Head more depressed than in other genera of this family. Anterior dorsal almost concealed in the thickness of the skin.

GENUS XII. BYTHITES, Rein. Body compressed, thicker anteriorly. Profile of head bluntly rounded. Tail ensiform, tapering to a point. Scales minute, round, imbricated. Lateral line interrupted over the anus. Teeth acute on the premaxillaries, mandible, vomer, and palatines. Branchiostegals eight, the membranes uniting under the isthmus with a free edge; gill-openings very large. Ventrals jugular, of one filiform ray, each very long; vertical fins united, without any distinction of the caudal; rays jointed, divided. A very thick, conical, three-pointed papilla projected backwards behind the anus. No pneumatic tube to the air-bladder. One species.

MACROURIDS.

This family consists of a single genus, which stands next to the Gadoids in the *Regne Animal*, and certainly has many portions of structure of a similar character, particularly the turning down of the edge of the suborbitars, but these bones are much more developed than in *Gadus*, and their reverted plates appear on the surface of the cheek covered with rough scales. The Macrourids are inhabitants of deep water like most of the Gadoids, and have not been discovered near the equator, though they exist in both the northern and southern hemispheres, and in the Pacific as well as Atlantic divisions of the ocean. Figures 30, 32, 33, and 34 represent the scales of several *Macrouri*, remarkable for their discal spines, but differing from the ciliated scales named Ctenoid. The subjoined woodcut represents *Macrourus australis*.

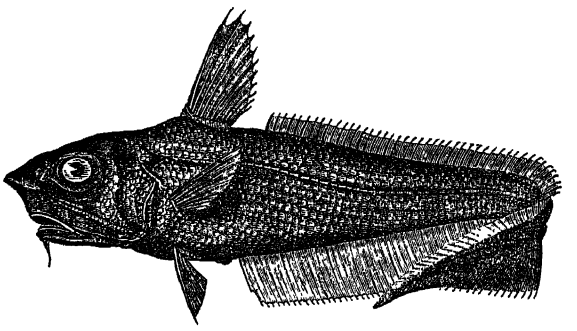


Fig. 91.
Macrourus australis.

FAMILY II.—MACROURIDÆ.

Turbinals largely developed, forming, by apposition of their plates, a thin, high, mesial crest, and a lateral wing-like process on each side; these, in conjunction with the reverted plate of the preorbitar, support a more or less elongated snout, which is generally, perhaps always, acute. Body highest and fullest at the pectoral region, compressed and dagger-shaped posteriorly, or tapering to an acute point. Ventrals, pectorals, and first dorsal, in a vertical line; first dorsal short and high; anal and second dorsal long and even, uniting at the point of the tail without any distinction of caudal. Anus in the anterior quarter of the fish. Teeth fine, villiform on the jaws; palatines, vomer, and tongue edentate; mouth horizontal, inferior behind the projecting snout; premaxillaries forming the border of the upper jaw, and protractile directly downwards, their long pedicels moving under a vault formed by the turbinals; maxillaries behind the premaxillaries, gliding partially under the reverted edge of the preorbitar. Scales studded with acute spines, varying in form and number with the species. Eye large; head encased by the scaly surfaces of muciferous bones. Branchiostegals six. Stomach globular; numerous pancreatic cæca.

GENUS I. MACROURUS, Bloch. (LEPIDOLEPRUS, Risso.) Nine or ten species in the temperate and colder seas of the northern and southern hemispheres.

REMORA FAMILY.

The *Echeneididæ* stand in Cuvier's *Regne Animal* next to the *Discoboles*, but Müller has transferred the latter to *Gobiidæ*, making them a subordinate tribe under the appellation of Cyclopodi, and associating with them generally the fishes that have disks which can be used as suckers. Bonaparte places the *Echeneides* as a group subordinate to his *Gadi*. The absence of spinous rays seems to point out the Anacanthini as their most appropriate order, but the same reason might bring several Gobioid genera with them. One species, however, of *Echeneis* has bony compressed rays in the pectoral, terminated by a little crenulated disk, and some have considered the disk on the head in this genus to be a modified first dorsal fin.

The extraordinary power possessed by this fish (*Echeneis remora*), of adhering tenaciously to any flattish surface, was known to ancient writers, as well as to the curious inquirers of modern times. Pliny luxuriates upon it with his usual discursive verbosity, and the reader may possibly be amused by Philemon Holland's translation of the passages in question:—"Having so far proceeded in the discourse of nature's historie, that I am now arrived at the very height of her forces, and come into a world of examples, I cannot chuse but in the first place consider the power of her operations, and the infinitnesse of her secrets, which offer themselves before our eyes in the sea: for in no part else of this

Classification—Anacanths.

universall frame is it possible to observe the like majestie of nature: insomuch, as we need not seeke any farther, nay, we ought not to make more search into her divinitie, considering there cannot be found any thing equall or like unto this one element, wherein she hath surmounted and gone beyond her own selfe in a wonderfull number of respects. For, first and foremost, is there any thing more violent than the sea; and namely when it is troubled with blustring winds, whirlepuffs, storms, and tempests; or wherein hath the wit of man been more employed (seeke out all parts of the known world) than in seconding the waves and billows of the sea, by saile and ore? Finally, is there ought more admirable than the inerrable force of the reciprocall tides of the sea, ebbing and flowing as it doth, whereby it keepeth a current also, as it were the stream of some great river?

"The current of the sea is great, the tide much, the winds vehement and forcible; and more than that, ores and sailes withall to help forward the rest, are mightie and powerfull: and yet there is one little sillie fish, named Echeneis, that checketh, scorneth, and arresteth them all. Let the winds blow as much as they will, rage the storms and tempests what they can, yet this little fish commaundeth their furie, restraineth their puissance, and, maugre all their force, as great as it is, compelleth ships to stand still: a thing which no cables, be they never so big and able as they will, can perform. She bridleth the violence and tameth the greatest rage of this universall world, and that without any paine that she putteth herselfe unto, without any holding or putting backe, or any other meanes save only by cleaving and sticking fast to a vessell: in such a sort as this one small and poore fish is sufficient to resist and withstand so great a power both of sea and navie, yea and to stop the passage of a ship, doe they all what they can possible to the contrarie. What should our fleets and armadoes at sea make such turrets in their decks and forecastles? what should they fortifie their ships in warlike manner, to fight from them upon the sea, as it were from mure and rampier on firme land? See the vanitie of man! alas, how foolish are we to make all this adoe? When one little fish, not above half a foot long is able to arrest and stay per force, yea, and hold as prisoners, our goodly tall and proud ships, so well armed in the beakehead with yron pikes and brazen tines; so offensive and dangerous to bouge and pierce any enemie ship which they doe encountre. Certes, reported it is, that in the naval battaile before Actium, wherein *Antonius*, and *Cleopatra* the queene, were defeited by *Augustus*, one of these fishes staied the admirall ship wherein *M. Antonius* was, at what time as he made all the hast and meanes he could devise with help of ores to encourage his people from ship to ship, and could not prevaile, untill he was forced to abandon the said admirall, and go into another galley. Meanwhile the armada of *Augustus Cæsar*, seeing this disorder, charged with greater violence, and soone invested the fleete of *Antonie*. Of late daies also, and within our remembrance, the like happened to the roiall ship of the Emperor *Caius Caligula*, at what time as he rowed backe, and made saile from Astura to Antium; when and where this little fish detained his ship, and (as it fell out afterward) presaged an unfortunate event thereby: for this was the last time that ever this emperour made his returne to Rome: and no sooner was he arrived, but his own souldiours in a mutinie fell upon him and stabbed him to death. And yet it was not long ere the cause of this wonderfull staie of his ship was knowne: for so soon as ever the vessel (and a galliace it was, furnished with five bankes of ores to a side) was perceived alone in the fleete to stand still, presentlie a number of tall fellows leapt out of their ships into the sea, to search what the reason might be that it stirred not; and found one of these fishes sticking fast to the very helme: which being reported unto *Caius Caligula*, he fumed and fared as an emperour, taking great indignation that so small a thing as it should hold him back perforce, and check the strength of all his mariners, notwithstanding there were no fewer than foure hundred lustie men in his galley that laboured at the ore all that ever they could to the contrarie. But this prince (as it is for certain knowne) was most astonied at this, namely, that the fish sticking only to the ship, should hold it fast; and the same being brought into the ship and there laid, not worke the like effect. They who at that time and afterward saw the fish, report that it resembled for all the world a snaile of the greatest making: but as touching the form and sundrie kinds thereof, many have written diversly, whose opinions I have set downe in my treatise of living creatures belonging to the waters, and namely in the particular discourse of this fish: neither doe I doubt but all the sorte of fishes are able to doe as much: for this we are to believe, that Pourcellans also be of the same vertue, since it was well knowne by a notorious example, that one of them did the like by a ship sent from *Periander* to the Cape of Gnidos: in regard whereof, the inhabitants of Gnidos doe honour and consecrat the said Porcellane within their temples of *Venus*. Some of our Latin writers do call the said fish that thus staieth a ship, by the name of Remora."

Another species, *Echeneis naucrates*, Linn., commonly called the Indian Remora, has usually twenty-two plates upon the head. In its habits it resembles the preceding; but it seems to be more frequent in the seas of India and America than in those of Europe. The manuscripts of Commerson, as quoted by Count Lacépède, inform us that it is common along the coasts of Mosambique, where it is made use of in a singular way for the purpose of catching turtles. A ring is first fastened round its tail, and then a long cord is attached to the ring. When thus accoutred, the fish, placed in a vessel of sea-water, is carried out in a boat; and as soon as the fishermen perceive a sleeping turtle, they row gently towards it, and throw the Remora into the water, with a sufficient length of cord. It seldom fails speedily to attach itself to the unconscious turtle, which by the tenacity of its adherence is immediately drawn towards the boat and captured.

FAMILY III.—ECHENEIDIDÆ, Bonap.

Remarkable and peculiar in having a flat head occupied on the dorsal aspect by a laminated disk that forms an adhesive sucker by which the *Echeneis* can attach itself to ships or other fishes, most commonly to the large Sharks. Body elongated, tapering much towards the tail; scaly. Dorsal single, malacopterous opposite to the anal. Eyes lateral. Mouth small, horizontal; mandible projecting; teeth on the premaxillaries and mandible villiform or fine card-like; a row of hair-like teeth on the edge of the maxillaries, which form the sides of the upper jaw; villiform teeth on the front of the vomer and the surface of that bone, and of the tongue rough. Branchiostegals eight. Stomach cæcal, large; a wide, short intestine; no air-bladder. The laminæ of the disk are spinous on the edges, the spines being in most species very short and slender; the number of laminæ varies in different species.

GENUS I. ECHENEIS, Linn.

FLOUNDER FAMILY.

Though the *Pleuronectidæ* do not require the same armaments for deep-sea fishing that the Gadoids do, yet they are of great importance to our maritime population, and give employment to large bodies of fishermen at most parts of the coast. These fish abound in comparatively shallow water, where the bottom is sandy, though some of the largest, as the Turbot and Holibut, are taken further out to sea. As they feed habitually at the bottom, the Flounders are chiefly captured by trawlers. Mr Yarrell states that London alone pays L.15,000 a-year to the Danes for lobsters to make sauce for the Turbots brought to the London

Classification—Acanthopterous Fishes.

market, which amount, according to the same authority, to 88,000 in a season. Pennant has particularly described the extensive Turbot fishery at Scarborough. There are three men in each of the fishing-boats, each man having three lines, and each line 280 hooks. All the nine lines are fastened together, and then extended to about three miles in length; they are laid across the current, and are allowed to remain for six hours before they are hauled in. This fish is called the Water or Sea Pheasant, by the French common people, on account of its fine flavour.

Family IV.—PLEURONECTIDÆ.

Peculiar among fishes in showing a want of symmetry in the head, the eyes being turned to that side, which is uppermost when the animal swims, and is always darker-coloured than the other side. Body extremely compressed, so that the ventral and dorsal aspects are mere edges, the sides forming disks, round, oval, ovate, or elliptical, differently coloured, the paler one simulating the belly, and being beneath in the usual position of the fish. Dorsal extending along the whole back, and in some running forwards to the nostrils; anal fringing in the sam eway the ventral edge; jaws and ventrals generally unsymmetrical, being smaller on the pale side. Branchiostegals six. The presphenoid is twisted to one side, and the mid-frontal is one of the most distorted bones in the cranium of these fishes. There is no want of symmetry in the spinal column and its processes posterior to the scapular arch; the interneural and interhæmal spines are in pairs, supporting one dermoneural or dermohæmal spine. No air-bladder.

ANALYTICAL TABLE OF THE *PLEURONECTIDÆ* (Dum.)

Body rhomboidal.		
Dorsal over the eyes which are dextral.		
Teeth broad, trenchant	PLATESSA	1.
Teeth villiform	HIPPOGLOSSUS	2.
Dorsal over the upper lip; eyes sinistral	RHOMBUS	3.
Body oval, or much elongated.		
Pectorals very distinct, on both sides	SOLEA	4.
Pectorals distinct on one side only	MONOCHIR	5.
Pectorals wanting.		
Vertical fins separated	ACHIRUS	6.
Vertical fins united	PLAGIUSA	7.

GENUS I. PLATESSA, Cuv. Obtuse, trenchant, uniserial teeth on the jaws; most frequently pavement-like teeth on the pharyngeals. Dorsal not coming further forward than the centre of the upper eye; caudal separated by intervals from the dorsal and anal. Form rhomboidal. Eyes generally on the right side. Pancreatic cæca three, small.

GENUS II. HIPPOGLOSSUS, Cuv. Fins of *Platessa*, with generally a more oblong form. Teeth card-like, often strong and pointed on the jaws and pharyngeals.

GENUS III. RHOMBUS, Cuv. Teeth on the jaws and pharyngeals villiform, or card-like, as in *Hippoglossus*, but the dorsal comes forward to the border of the upper jaw, and extends like the anal to near the caudal. Eyes for the most part on the left side.

GENUS IV. SOLEA, Cuv. Mouth curved and turned almost wholly to the blind side of the head; teeth situated on that side only, finely villiform; form oblong; snout round, and almost always advancing before the mouth. Dorsal commencing at the mouth and extending like the anal to the caudal. Lateral line straight. Blind side of the head often garnished with cutaneous shreds like villi. Intestine long, often doubled; no pancreatic cæca. In some the caudal is not distinct from the other two vertical fins. These form the genus *Brachirus* of Swainson, or *Synaptura* of Cantor.

GENUS V. MONOCHIR, Cuv. *Soles* destitute of a pectoral on the blind side, or having merely an almost imperceptible vestige of one, the pectoral on the side of the eyes being very small.

GENUS VI. ACHIRUS, Lacép. Abrachial Soles, with the vertical fins distinct.

GENUS VII. PLAGUSIA, Brown. Abrachial Soles, with the vertical fins united.

Order V.—ACANTHOPTEROUS FISHES.

This order, the most extensive of all for the variety of forms and number of species, includes fishes under every condition that a fish can exist, whether it be with regard to the freshness or saltness of the water it inhabits, its temperature, depth, altitude above the sea, or other circumstances. There is certainly some connection between the ciliated scales with which the great majority of fishes of this order are clothed, and the spinous terminations or serrated edges of many of the bones of the head and shoulder which appear on the surface, and assume more or less the conditions and functions of dermal productions. The ctenoid scale, however common it may be in the order, is not universal, and the first family, the Uranoscopes have chiefly cycloid scales. The absence of a pneumatic tube to the air-bladder is perhaps a more constant character, but the viscus itself is not always present. The ventral fins are, when they exist, placed, in the majority, near the pectorals.

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Order V.—ACANTHOPTERI, Müll.

Endo-skeleton ossified; exo-skeleton as *ctenoid* scales. Fins with one or more of the first rays unjointed or inflexible spines; ventrals in most beneath or in advance of the pectorals. Swim-bladder without air-duct.

URANOSCOPIDÆ.

The Uranoscopes are remarkable for their power of raising their eyeballs out of their sockets, and of retracting them again within the level of the orbits. They frequent the bottom of the sea, and, like many ground fish, some of them have organs of touch developed in form of barbels, and they have also a peculiar membranous filament under the tongue, which they can protrude at pleasure. The Mediterranean Uranoscope was named *Agnus* and *Callionymus* by the ancient Romans, and Pliny says that the same fish was called *Callionymus* and *Uranoscopus*. Aristotle remarks correctly that the gall-bladder of this fish is attached to the right lobe of the liver, and is of greater size than in other fishes; and the dramatic poets referred to it proverbially when alluding to an angry man. Its gall was supposed to have some power of rendering the sight more clear, of removing deafness, and of depressing the fungus growths of old sores. The species are more numerous in the Australian seas than in any other quarter of the ocean. *Trachinus* has some resemblance in external characters to the *Sclerogenidæ*, especially in the simplicity and thickness of the lower pectoral rays, and in the projection of the tips of the anal rays beyond the membrane, but they are distinguished by the second suborbitar not crossing the cheek to the preoperculum. The Uranoscopes, indeed, make an approach to this peculiar structure, but in them the suborbitar articulates with the upper limb of the preoperculum, and does not buttress its angle, as in the true Sclerogenids. The projecting tips of the anal rays occurring in many ground fishes are seemingly organs of touch. The family generally, as here assembled, corresponds with Cuvier's group of Jugular Percoids, but we have brought into it *Hemerocœtes*, which is placed at the end of the Gobioids, next *Callionymus*, in the *Histoire des Poissons*, and also an Australian fresh-water genus *Gadopsis* not described in that work. The internal structure of several of the genera must be investigated before the correctness of this grouping can be ascertained. None of the family are of importance as articles of food. The woodcut No. 46 represents *Uranoscopus macropygus*, an Australian species, which has no first dorsal; the head of *Bovichthys* is represented by No. 45, drawn to show the branching mucoducts; a scale of *Gadopsis* is shown by No. 26; and one from the lateral line of *Hemerocœtes* by No. 43.

Family I.—URANOSCOPIDÆ.

Trachinidæ, Bonap. Ventrals composed of a spine and five jointed rays, situated before the pectorals (in *Trichodon* and *Stillago* a little behind the pectorals). *Scales cycloid*, or *wanting*, acanthoptery-

Classification—Acanthopterous Fishes.

gii. Anus generally before the middle of the fish, and the tail often considerably longer than the body. One or two dorsals; edges of the preorbitar and preopercular pieces entire; not serrated; sometimes a strong spine from the surface of the operculum, or from the shoulder. Mouth formed above entirely by the premaxillaries, with the maxillaries in the membrane behind them; teeth on the jaws and vomer; palatine teeth in some present, in others none. Branchiostegals six or seven, rarely five. Abdominal cavity sometimes prolonged past the anus; no air-bladder; cæcal stomach; pancreatic cæca three to twelve, or more, sometimes none (*Hemerocœtus*).

Genus I. Trachinus, Linn. Head compressed; a strong opercular spine. Villiform teeth on the jaws, on the anterior point of the vomer, on the fore end of the palatines, on the entopterygoid, on the pharyngeals, and on the short tubercles of the branchial arches. Cranium more or less rough, and the suprascapular finely denticulated. A small spinous dorsal far forward, and not connected to the soft dorsal. Abdominal cavity of small extent. Four species.

Genus II. Percis, Bloch. *Trachini*, with the head more depressed and the spinous and soft dorsal joined; vomerine, but no palatine teeth; somewhat of a Labroid aspect. Some were described as *Labri* by Schneider, and Bloch named another *Enchelyopus*, conceiving it to be a Gadoid fish. Cavity of the abdomen not extensive. Fifteen species.

Genus III. Pinguipes, Cuv. The Labroid aspect of this genus is striking. Lips thick, covering the strong, conical, and somewhat curved teeth. A single dorsal spinous in front, without a notch between. Vomerine and palatine teeth. Three species.

Genus IV. Uranoscopus, Linn. Head large, cubical, bony, rough, and sculptured, depressed with the protractile eyes on the dorsal aspect. Mouth cleft vertically, so that the mandible forms the extremity when it is closed against the abbreviated snout. Suborbitars large, cuirassing the cheeks, but attached to the temples, and not forming a fulcrum to the spinous preoperculum as in the *Sclerogenidæ*. Scales small, cycloid. Nominally two dorsals, but some species want the spinous one. A humeral spine, which in some is large and crenated. Some have a barbel at the symphysis of the mandible externally, and some have a filament under the tongue within the mouth. Branchiostegals six. Stomach cæcal; pancreatic cæca numerous (twelve). Seventeen species.

Genus V. Bovichthys. External aspect of *Cottus*. Head large, depressed, rounded, with large eyes near the dorsal plane. Mouth terminal; villiform teeth on the jaws, vomer, and palatines, the outer row on the jaws being thicker and taller. *No scales*. Skin very porous, mucoducts disposed in branching lines on the head, and strongly prominent along the lateral line. Branchiostegals seven. Fins large, the two dorsals contiguous; five lower pectoral rays, and all the anal rays, except the two posterior ones, simple and projecting beyond the notched membrane; the pectoral resembling that fin in *Cottus*, and the anal that of *Trachinus*. Operculum ending in a large flat spinous point, clothed with skin; no other particular armature of the head; a curved spine from the front of the operculum being quite hidden by the soft parts.

Genus VI. Percophis, Cuv. A long slender fish resembling *Sphyræna*. Head pointed; mandible prominent; teeth strong, curved ones in front of villiform bands in the jaws; teeth also on the vomer and palatines. Anus at the end of the anterior third of the whole length. First dorsal posterior to the base of the pectorals at a little distance from the long soft dorsal; anal longer than the latter. A small opercular spine. Branchiostegals seven. *Scales ciliated*. Abdominal cavity prolonged to a considerable distance beyond the anus; stomach cæcal. One species.

Genus VII. Hemerocœtes, Cuv. Form elongated, slender, roundish, tapering but slightly towards the tail, with a long even dorsal and anal separated from the caudal. Dorsal rays all simple and jointed; anal rays branched at the tips, like those of *Trachinus*; ventrals before the pectorals of one spine and five jointed rays. Head depressed; eyes large, prominent, partly on the dorsal aspect, near together; mouth protractile, and when thrust out the upper ends of the maxillaries project upwards like spines. Branchiostegals seven. Teeth setaceous, in villiform bands on the premaxillaries, mandible, anterior corners of the vomer, pharyngeals above and below, and palatines. Tongue and isthmus of the gills smooth. Head unarmed, together with the body, scaly. A row of pores on the preoperculum. *Stomach cæcal*; intestine short, making but one flexure; no pancreatic cæca. One species.

Genus VIII. Gadopsis, Rich. Aspect of *Gadus*. Scales cycloid, extending to the cheeks and gill-covers. A single dorsal with spinous rays in front; anal with three spinous rays; one bifid, jointed ventral ray without a spine, situated far forward on the throat. Head unarmed. Branchiostegals six. Teeth card-like on the premaxillaries, vomer, palatines, and mandible. A fresh-water Australian fish.

Genus IX. Aphritis, Cuv. and Valenc. Body elongated. Dorsals two, separated. Mouth rather small; close, short, villiform teeth on the jaws, palatines, and chevron of the vomer. The absence of strong-pointed teeth distinguishes this genus from *Percophis*; the presence of palatine teeth separates it from *Percis*, and the two dorsals from *Gadopsis*; the scales appearing to be ciliated when viewed through a lens rather throws a doubt of the propriety of placing the genus in this group. Branchiostegals six. Stomach cæcal; four pancreatic cæca. A fresh-water Tasmanian fish.

Genus X. Trichodon, Stel. General aspect of *Uranoscopus*. Five preopercular spines; operculum ending in a flat point. Head flat above; mouth descending almost vertically, and, when shut, having the mandible in front; eyes lateral, not on the dorsal aspect as in *Uranoscopus*. No scales. *Ventrals thoracic*. Cheek not cuirassed by the suborbitars; teeth in card-like bands (individually slender, pointed, and recurved) on the jaws and front of the vomer, but the palatines are toothless, as is also the tongue. Two dorsals separated by a short interval; several of the lower pectoral rays simple. *Five branchiostegals*. One species.

Genus XI. Sillago, Cuv. *Acanthopteri*, with a long conical head and rather depressed snout, terminated by the fleshy lips of a small mouth. Two continuous dorsals, the second long and low. Upper jaw somewhat protractile, and the mandible articulated considerably before the eye; teeth on the jaws villiform, with an outer row of conical ones. A villiform band on the front of the vomer; preoperculum denticulated on the ascending edge, curving over the throat, so as nearly to touch its fellow. Six branchiostegals. Scales *ciliated*, covering the opercula, cheeks, and upper part of the head behind the eyes. Cæcal stomach; pancreatic cæca from two to four; a large forked air-bladder. Ten species. Cuvier is uncertain about the proper position of this genus, but thinks that it is most allied to the *Sciænidæ* with which it might be placed were it not for its vomerine teeth. It is put here at the end of the *Uranoscopidæ* chiefly because no more eligible situation offers.

PERCOIDS.

Few families of fish have been more fully investigated by ichthyologists than this one, yet the vast number of species that belong to it is embarrassing to students, and the strong external characters which many possess have withdrawn the attention from the more important varieties of structure, to slight serratures of the opercular bones, or the greater or smaller size of the scales on some parts of the head, and other slight modifications of the surface, which are obvious to the eye indeed, and therefore useful for subdividing a genus containing many species, but are not of themselves sufficient to establish generic groups or other divisions of higher importance. These comparatively unimportant external characters have however been too generally employed for this purpose, and the importance of the want of teeth on the roof of the mouth having been too rigidly insisted upon, as a variety of structure of family rank, has caused the wide separation of species nearly connected by aspect, habits, and general conformation. Many Percoids have been placed with the Sciænoids merely because the minute teeth of the palate are early deciduous. On the other hand, forms have been brought together by a few technical characters which have comparatively little natural affinity, and an ichthyologist who is intimately acquainted with ichthyic anatomy has a wide field before him where he may render great service by reducing the at present heterogeneous assemblages to more fitting order. In the mean time we shall, with a few exceptions, follow our principal authorities—Müller for the general arrangement, and the *Histoire des Poissons* for the generic groups. We have found it convenient to introduce into our table, as distinct families, the Percoids of Cuvier which have more or fewer branchiostegals than seven; or whose ventrals vary in composition from the normal number of five articulated rays, or depart from their usual position in this family under the pectorals. The useful analytical table given in the *Histoire des Poissons*, abbreviated by the removal of these groups, will remain as follows:—

TABLE OF GENERA.

Two dorsals, or one dorsal notched to its base.

All the teeth villiform.

PERCA, LATES, ENOPLOSUS, DIPLOPRION, NIPHON. LABRAX, CENTROPOMUS, HURON, GRAMMISTES, ASPRO, AMBASSIS, APOGON, CNIDON, PSAMMOPERCA, PRIOPIS, MICROÏCHTHYS, BOGODA, POMATOMUS.

Canine teeth among the others.

CHEILODIPTERUS, LUCIOPERCA, ETELIS.

A single dorsal.

Canine teeth among the others.

SERRANUS, PLECTROPOMA, DIACOPE, MESOPRION, APRION.

Teeth all villiform.

CENTROPRISTES, GRYSTES, POLYPRION, PENTACEROS, ACERINA, RHYPTICUS, AULACOCEPHALUS, APSILUS, GLAUCOSOMA.

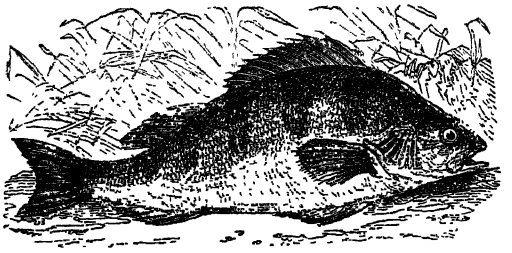


Fig. 92.

Perca fluviatilis.

The common Perch (*Perca fluviatilis*, Linn.), one of the most beautiful of the fresh-water fishes of Europe, is too familiarly known to require description. It inhabits both lakes and rivers, but shuns salt water. As an article of food it is still in some estimation, although the character given of it in that respect by Ausonius is higher than accords with modern views. The female deposits her ova, united together by a viscid matter, in lengthened strings, a peculiarity noted by Aristotle. The number of these eggs sometimes amounts to nearly a million. The Perch occurs over all Europe, and most of the northern districts of Asia. Pennant alludes to one said to have been taken in the Serpentine River, in Hyde Park, which weighed nine pounds. But even one half of that weight would be regarded as extraordinary, and Pennant reports the fact on the authority of another.

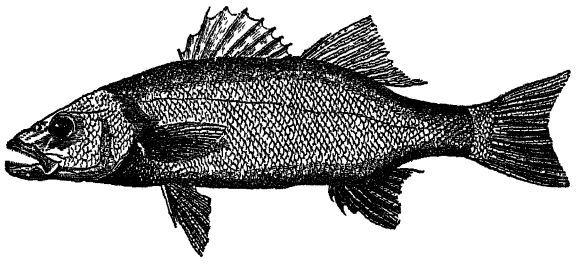


Fig. 93.

Labrax lupus.

The fish here represented is the *Labrax lupus*, Basse or Sea Perch, a fish of a chaste and pleasing aspect, though destitute of the more strongly contrasted colours of the fresh-water species. Its upper parts are gray, with bluish reflections, which gradually shade away into a silvery whiteness on the under surface. The pectoral fins are slightly tinged with red. It occurs along the Dutch and British shores, but is much more abundant in the Mediterranean. It is a voracious fish with a remarkably large stomach, and received from the ancient Romans the appropriate cognomen of *lupus*. By the Greeks it was highly esteemed: Archestratus, even termed a large kind taken near Milet, "offspring of the gods." They attributed to the *lupus* a tender regard for its own safety; and Aristotle says that it is the most cunning of fishes, and that when surrounded by a net it digs for itself a channel of escape through the sand.

Classification—Acanthopterous Fishes.

> "Clausus rete *lupus* quamvis immanis et acer
> Dimotis cauda submissus sidit arenis,
> Atque ubi jam transire plagas persentit in auras
> Emicat atque dolos saltu diludit inultus."—OVID.

The Basse sometimes attains the length of 3 feet, though it is seldom met with much above half that size.

There is little that calls for attention from the other Percoids with two dorsals. Though interesting from the variety of forms they display, we must leave these to be studied in their leading features as given in the annexed table, and give the space we can allot to species of more importance, either objects of commerce or of large fisheries, or from the associations connected with them.

In the *Histoire des Poissons*, the Percoids with a single dorsal form a second great division of the family; and, were it not for the break in the close affinities between the two groups that would be caused by making this division a separate family, the number of species that it contains might render such a proceeding expedient as a mere matter of convenience. Cuvier remarks that the Percoids, in which the spinous portion of the dorsal is connected with the soft one by a sufficiently even border, is much more numerous in species than the typical division with two dorsals; and he found it necessary, therefore, in arranging them, to have recourse to characters of a sufficiently minute kind. Bloch drew his from the denticulations of the preoperculum and the spines of the operculum; but he has frequently used them without judgment, and we frequently meet in his arrangement with Labroid and Sciænoid fishes stuck in among the Percoids. The same errors exist, in greater or smaller numbers, in the works of his successors, because they attended more than they ought to have done to external characters, passing over the more essential conformities of internal structure. "Our (Cuvier's) precautions in separating fish whose teeth are supported by different parts of the mouth have saved us from much of this confusion, but yet there remained a considerable number of species which we could divide into groups only by employing subordinate characters. We characterized the primary divisions by the teeth, which in some are villiform and of even height, as in *Perca* and *Labrax*; sometimes interspersed with canines, or teeth a little higher and more pointed than the rest of the villiform band. Next we looked to the operculum, the edge of whose bony piece is sometimes smooth or rounded, sometimes terminated by two or three points more or less acute. Next we attended to the preoperculum, whose edges may be either smooth or denticulated, or armed in various ways with spines. Lastly, the bones of the jaws, smooth or scaly, furnish the final subdivisions; and to distinguish certain genera, we take characters from striking configurations of other parts of the fish." These are the rules which the greatest of ichthyologists, whether ancient or modern, framed for his guidance in the distribution of this portion of the finny tribes. Since his labours were brought to a close many new species have been discovered, and not a few new forms described; and we have therefore, as intimated above, relieved the overloaded Percoid group by removing some of the minor assemblages made by Cuvier himself, and placing them under distinct family appellations. It must be kept in mind, however, that the great mass of *Acanthopteri*, though exceedingly numerous in species, and presenting a great variety of generic forms, vary very little in the more essential parts of structure; and that the subdivisions which their numbers have made necessary are not of the same value in the animal scale as others containing perhaps only one or two species in other parts of the table.

The *Serrani*, called also Sea Perches, are numerous,

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and many of them very beautiful. They abound in all the warmer seas. *Anthias* and *Merou* are mere subdivisions of the genus framed on the existence of scales on the jaws, and their greater or smaller size. In *Esox*, and many other genera, subdivisions, founded on the greater or smaller extent of the head covered by scales, would be as numerous as the species; but in *Serranus* some such plan of grouping is necessary to enable the ichythologist to describe the multitude of species he has to deal with. Some of the *Serrani* were known to the ancients by the name of *Perca*, and

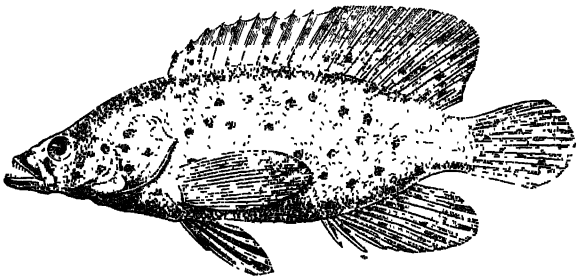


Fig. 94.
Serranus altivelis.

still are called by the Roman fishermen by that of *Percia*, and by the Venetians by that of *Sperga*. The *Anthias* was more renowned in classical times. Aristotle says that the fishers of Sponges called it "sacred," because no voracious fishes came to the places which it frequented, and the diver might descend with safety. Pliny reports a singular story regarding it: The fishermen of the Chelidonian Isles, he says, practise the feeding of this fish, always presenting themselves in the same dress until its apprehensions are lulled, and then they introduce a hook into the paste they had daily given it. As soon, however, as an Anthias was deceived so as to allow itself to be hooked, its companions came to its aid, and endeavoured to relieve it by cutting the line with their dorsal spines, shaped like a saw.

> "Anthias his tergo quæ non vidit utitur armis.
> Vim spinæ novitque suo verso supinus
> Corpore lina secat fixumque intercipit hamum."
> OPP., *Halieut.*, 46.

The modern Greeks give the name of *Anthias* to the *Gymnetrus;* and it is probable that the *Anthias* of Ælian was the *Scomberoid alalonga* of the modern Italians.

FAMILY II.—PERCIDÆ.

Genus Perca, Artedi and Linn. Body oblong, scaly; scales ctenoid; opercular bones variously armed. *Seven branchiostegals.* Teeth on the vomer, and most frequently on the palatines. No barbels; cheek not cuirassed. *Ventrals of five jointed rays, thoracic* or subbrachian. Fins always amounting to seven in number, often to eight. Stomach cæcal, that is, the pyloric opening lateral; pancreatic cæca few in number and not bulky; intestinal canal little folded.

(a.) *Two dorsals, or one dorsal with a notch extending to its base; all the teeth villiform; no canine teeth.*

GENUS I. PERCA, Cuv. Preoperculum denticulated; operculum spiniferous; suboperculum feebly denticulated. Tongue smooth. Fourteen species.

GENUS II. LATES, Cuv. Suborbitar and coracoid strongly denticulated; coarse denticulations at the angle and lower border of the preoperculum. Three species.

GENUS III. CNIDON. Mull. and Trosch. Agrees with *Lates* in the almost total want of *pseudobranchiæ*, but is distinguished therefrom by the entirely smooth under border of the preoperculum, whose hinder border is toothed and sends out a spine beneath. Nostrils remote from each other. Scapula with only one spine and the suborbitar scale bone nearly smooth.

GENUS IV. PSAMMOPERCA, Rich. Body a handsome and regular ellipse, the rather small head forming the acute anterior end of the curve. Ctenoid scales rather large. Dorsal notched nearly to the base, moving in a scaly sheath. Teeth on the jaws; vomer and palatine bones crowded, *rounded, granular;* tongue smooth; cheeks and gill-covers scaly; preorbitar entire on its edge, smooth; angle of the operculum running out horizontally into a short strong spine, above which the edge of the bone is set with teeth like a comb; under limb of the bone smooth; a small spine on the operculum. Differs from *Perca* in the form of the teeth and by the absence of a well-marked preopercular disk; from *Percolabrax* by its smooth tongue and solitary opercular spine; and from *Lates* by the absence of angular teeth on the lower limb of the preoperculum, and by the perfectly entire preorbitar. This genus might enter the group having a single dorsal. One species, Australia.

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GENUS V. LABRAX, Cuv. (*Percolabrax*, Schlegel.) Suborbitars and coracoid not denticulated; two opercular spinous points. A disk of villiform teeth on the tongue. Eight species.

GENUS VI. CENTROPOMUS, Lacép. Operculum without spinous points. Dorsals separated by a small scaly interval. Preoperculum denticulated on its posterior border, with some teeth in the raised anterior edge of its disk. One species.

GENUS VII. ENOPLOSUS, Cuv. Suborbitar denticulated. Preoperculum denticulated and armed by a strong spine; operculum and coracoid without spines. Body and vertical fins greatly elevated.

GENUS VIII. DIPLOPRION, Kuhl and Van Hass. Trispinous operculum; operculum obtuse at the angle, with a denticulated line on the surface of its limb and coarse denticulations on its edge; preorbitar entire. One species.

GENUS IX. GRAMMISTES, Bloch. Scales minute, enveloped in mucoid epidermis. Dorsals near each other. Spinous preoperculum and operculum; no apparent anal spines. Two species.

GENUS X. ASPRO, Cuv. Body elongated. Dorsals at a little distance from each other. Snout thick, smooth, and projecting beyond the mouth. Two species.

GENUS XI. AMBASSIS, Commer. (*Chanda*, Hamilt. Buch.) Both the anterior and the posterior edges of the preopercular limb denticulated; a recumbent spine pointing forward in front of the dorsal; operculum ending in a point; distinguished from *Apogon* by the contiguous dorsals, and the recumbent spine before the dorsal fin. No pancreatic cæca, in which the genus departs from the ordinary Percoid structure. Fourteen species.

GENUS XII. PRIOPIS, Kuhl and Van Hass. Frontal border of the orbit serrated; in other respects like *Ambassis*. One species.

GENUS XIII. MICROÏCHTYS, Rüpp. General aspect and the form and position of the fins as in *Ambassis*. Free border of the preoperculum not denticulated; an acute ridge extending from the eye dorsal above the scaly operculum. Lateral line commencing under the first rays of the second dorsal; only two stiff rays in the anal. Mandible projecting a little beyond the upper jaw; orifice of the mouth moderately large, armed by a row of wholly fine teeth; no teeth visible on the palate. Gill-openings large; branchiostegals seven. Large scales on the body, easily detached. One species. Sicily.

GENUS XIV. BOGODA, Bleek. Separated from *Ambassis* by their *entire preorbital scale-bones* and *conical jaw-teeth*, which are bigger on the fore part of the mandible. Dorsals two, united at the base; ventrals thoracic. Teeth on the jaws, vomer, and palatines. A recumbent spine before the dorsal. Branchiostegals six. Anal spines three. Pseudobranchiæ. Six species. Bengal.

GENUS XV. NIPHON, Cuv. Strong pointed spine at the angle of the preoperculum; fine denticulations on the vertical limb, and coarse teeth on the horizontal edge of that bone. Three strong, sharp opercular spines; serrated preorbitar. Long subelliptical body. Dorsals connected at the base; three anal spines.

GENUS XVI. POMATOMUS, Risso. Somewhat of the aspect of *Mugil*. *Eye very large.* Two short dorsals near the middle of the back, separated from each other; anal posterior to the last one, also short; back a little keeled in front of the dorsal. Scales ciliated as in the rest of the family, covering the cheeks and gill-covers. Caudal deeply forked. Stomach cæcal; twenty-two pancreatic cæca, long, and forming two groups; air-bladder very large, simple, with red elliptical granular bodies interiorly. One species.

GENUS XVII. APOGON, Lacép. Scales large, readily deciduous. General aspect of *Mullus*. Dorsals two short, widely separated. Villiform teeth. A double preopercular border finely denticulated. Pancreatic cæca few.

(b.) *Two dorsals, or one dorsal deeply notched. Long canine teeth accompanying the villiform bands on the jaws.*

GENUS XVIII. CHEILODIPTERUS, Lacép. Have the characters of *Apogon*, with the addition of long pointed more or less curved teeth on the jaws, along with the fine villiform bands, which exist also on the vomer and palatines. Preoperculum with a finely den-

ticulated line round the fore part of its limb, as well as serratures on its hinder edge; operculum entire, without spines. Large, readily deciduous scales, and the dorsals well separated. Stomach large, cæcal; about three pancreatic cæca. Three species.

Genus XIX. Lucioperca, Cuv. Some of the teeth on the jaws long and pointed. Border of the preoperculum with a single line of denticulations only, which are on the posterior edge of the limb. Scales rough. Large cæcal stomach; four pancreatic cæca. Five species.

Genus XX. Etelis, Cuv. A single short pungent point on the operculum; very minute serratures on the preoperculum. Curved canine teeth on the jaws, but not on the palatines. Dorsals contiguous. Scales large. Stomach a large cæcal bag; five pancreatic cæca; a large air-bladder, with its vasoganglions in little red stripes.

(c.) *A single dorsal; canine teeth among the others.*

Genus XXI. Serranus, Cuv. Preoperculum rounded at the angle, denticulated on the horizonal portion of the curve, as well as on the ascending one; two or more spinous points on the operculum. *Jaws not scaly.* Twenty-six species.

Genus XXII. Anthias, Bloch. *Serrani* of small size, and generally brilliant colours. Head and jaws *scaly*, the maxillary being densely covered with conspicuous scales. Six species.

Genus XXIII. Merou, Cuv. *Serrani* of larger size generally than *Serranus* proper, or *Anthias*. Operculum with two, or mostly three, spines. Very small scales on the mandible. One hundred and forty species.

Genus XXIV. Plectropoma, Cuv. Serratures on the lower border of the preoperculum turned obliquely forwards, and somewhat resembling the denticulations of a cock's comb. Upper border mostly entire. In other characters *Serrani*. Operculum spinous. Sixteen species.

Genus XXV. Diacope, Cuv. Characterized by a rounded notch above the angle of the preoperculum which receives a small knob of the interoperculum. In other characters *Serrani*. Forty species.

Genus XXVI. Mesoprion, Cuv. *Serrani* in fins, teeth, and preopercular denticulations, but with an unarmed operculum, ending in a smooth point, not spinous, nor pungent. Nearly allied to *Diacope*, and many species have even the knob of the interoperculum and corresponding notch in the preoperculum, but never so distinctly formed. From *Ventex*, which they resemble in external form, they are distinguished by their vomerine teeth and denticulated preoperculum. Fifty-four species.

Genus XXVII. Aprion, Cuv. Canines on both jaws; short villiform teeth on the vomer and palatines. Operculum with two very small spinous points; but the preoperculum smooth-edged. It would be almost an *Etelis* if its dorsal were not single; or a *Grystes*, if it wanted the canines. Air-bladder ample. One species.

(d.) *A single dorsal, with villiform teeth only, and no canines.*

Genus XXVIII. Acerina, Cuv. Whole head destitute of scales. Muciferous excavations in the bones of the cranium; five or six in the suborbitar chain, and more on the limbs of the mandible; small spinous points with sinuses between, but no serratures on the border of the preoperculum. Two anal spines. Two species.

Genus XXIX. Pentaceros, Cuv. Body oval, high. Preorbitars, opercular pieces, cranium, and coracoid, coarsely striated. Cheek scaly. Blunt conical tuberosities over the eye and on the occiput. Scales of the body striated and granulated, and strongly adherent. Villiform teeth on the jaws and front of the vomer. Ventrals wide apart, their spine very large; five anal spines. Cæcal stomach; nine pancreatic cæca; a large air-bladder. One species.

Genus XXX. Centropristis, Cuv. Analogous to the *Serrani* in the union of characters derived from a spinous operculum, and a serrated preoperculum. Differs from *Polyprion* in the absence of a denticulated crest on the operculum, and the want of denticulations on the preorbitar. The snout, jaws, and gill-membranes are destitute of scales, but the cranium, cheeks, and opercular pieces are scaly, the scales on the operculum being larger than those of the cheek. Fourteen species.

Bonneville divides this genus into three groups: *Centropristis* proper, having bigger conical teeth mixed with the granular ones on the jaws, and an interior band of vomerine teeth in a chevron. It comprehends *C. atrarius, tabaccarius, atrobranchus, hirundinaceus*, and *brasiliensis*. *Homodon* (*Arripis*, Jenyns) has card-like teeth on the jaws; an oblong, three-cornered group of vomerine teeth, and a more elongated body. *C. truttaceus, georgianus* (Australian fish). *Myriodon*, all the jaw-teeth equally minute; vomerine teeth in a chevron. *C. scorpenoides*.

Genus XXXI. Aulacocephalus, Schleg. Three spines on the operculum; preoperculum strongly serrated on its horizontal border. Caudal fin rounded. One species.

Genus XXXII. Glaucosoma, Schleg., Rich. Aspect Sciænoid. Low spinous part of dorsal, peaked soft part. Head, except the lips and gill-membrane, densely scaly. Scales on the basal half of the soft-rayed vertical fins. Technically *Centropristis*, but having a very different general appearance. Card-like teeth on the jaws, vomer, and palate. Scales moderately large, ctenoid. Preoperculum crenulated; two flat, bony points to the rounded operculum. Branchiostegals seven, occasionally eight. Two species.

Genus XXXIII. Grystes, Cuv. *Centropristis*, with a smooth-edged preoperculum. Scales small, thin, embedded in the skin, extending over great part of the fins, and covering the gill-rays, throat, and all parts of the head, except the lips and the folds that shut up when closed. Notch between the dorsals equal to half their height.

Genus XXXIV. Apsilus, Cuv. Belonging to the Percoids, with a single dorsal, but distinguished by the total absence of true spines or denticulations on the opercular bones, or those of the shoulder. Teeth very fine villiform, in a narrow band on the jaws and palatines. Seven branchiostegals. Differs from *Centropristis* in the want of denticulations on the preoperculum, and from *Grystes* in having no opercular spine. Scales thin.

Genus XXXV. Rhypticus, Cuv. No denticulations on the operculum or preoperculum, but short spines on both. Head smooth, without scales. Scales deeply imbedded in a muciferous skin. In other characters much like *Serranus*. Few spines in the dorsal. A long cæcal stomach, pointed at the end; six or seven pancreatic cæca; air-bladder oval, not large. Two species.

Genus XXXVI. Polyprion, Cuv. Preoperculum strongly and irregularly denticulated, and the anterior border of its limb rough. A strong spiny crest traverses the middle of the operculum longitudinally, and there is a less prominent point below it; the edges of the suboperculum and interoperculum are finely denticulated. The preorbitar is also slightly crenated, and there are denticulated crests and tubercular eminences on the upper border of the orbit and top of the cranium, with serratures on the suprascapulars and coracoid bones, giving the head some resemblance to that of a *Scorpæna*. Stomach cæcal, obtuse; two pancreatic cæca. One species.

THERAPONIDÆ.

The preceding family of Percoids contains the genus *Perca*, as sketched out by Artedi and Linnæus. The numerous species discovered subsequent to the days of these naturalists, and accumulated in the rich Parisian museum, brought to the knowledge of Cuvier many new Percoid forms which departed more or less from the typical *Percæ* of the older ichthyologists. In the *Histoire des Poissons* these are mostly introduced as appendages to the normal Percoids, and contain fishes with fewer branchiostegals than seven, or with more soft ventral rays than five, or with some other striking external peculiarity by which they can be distinguished as minor groups, but which differ little from the true Percoids in essential internal structure. We have separated one large group of these Percoid allies as they may be called, to form the family of *Theraponidæ*, distinguished from the more typical Percoids by the characters indicated in the table. But in the family thus brought together, there are several minor groups very natural in themselves, but which do not retain a general family likeness, extending to all the groups. The first three genera are distinguished from the others by the lower rays of their pectorals being simple, and formed evidently as organs of touch, and the next three genera are American fresh-water fish, of much beauty and neatness of aspect. These are followed by five or six genera, with generally well-armed opercular bones; then there are several newly proposed genera, in which a family aspect is less recognisable; and, lastly, we have placed at the end of the family *Macquaria* and *Latilus*, two genera associated by Cuvier with the Sciænoids, but which, notwithstanding the absence of teeth on the palate in the one, and the wholly toothless mouth of the

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other, seem to be more nearly allied to certain members of this group than to any other family in this system.

Family III.—Theraponidæ.

Thoracic scaly fishes. Branchiostegals six. Two dorsals, or the spinous and soft dorsals united to form one fin. Scales ctenoid or cycloid. Teeth on the jaws, and most generally on the palatines and vomer. Opercular pieces variously denticulated or spinous, or some of them unarmed. Five soft rays in the ventrals, with one spine; lower pectoral rays in some genera unbranched, jointed, and prolonged beyond the membrane, but in most of the ordinary form. A rather heterogeneous assemblage of Percoids, brought together by the single character of six branchiostegals, but differing in some having cycloid, others ctenoid scales, and even in the same genus in the presence or absence of teeth on the palate, the teeth of that part falling out when the fish is still young.

Genus I. Cirrhites, Comm. Resemble *Mesoprion* in their scales, fins, and in having a denticulated preoperculum, and the operculum ending in a flat, smooth corner, but are distinguished by the lower pectoral rays being thickened, simple, though jointed, and elongated beyond the membrane, seemingly to serve as organs of touch, such as exist in many of the *Sclerogenidæ*. The vomer is armed with villiform teeth, but there are none on the palatines. Stomach rather short; pancreatic cæca four; no air-bladder. Eight species.

Genus II. Aplodactylus, Cuv. Lower pectoral rays thick, fleshy, jointed, but not branched, and protruding beyond the narrow membrane at the tips. Teeth thin narrow plates lobed at the crown, in many rows on the jaws, the outer row taller than the interior ones, the newest of which are very short, and to the naked eye raduliform. General aspect of *Grystes*. Scales small, striated on the edges, covering most of the head and fins. Interoperculum scaleless; preoperculum smooth-edged. A small, flat, smooth opercular point. Branchiostegals six. Ventrals posterior to the pectorals, in consequence of the elongation of the pubic bones, which are attached to the coracoids. Stomach small, cæcal, with an ascending pyloric branch exceeding it greatly in size; two short pancreatic cæca; a large, simple air-bladder. Three species. Distinguished from *Cirrhites* by its teeth, like those of *Crenidens*.

Genus III. Chironemus, Cuv. Differs from the Sciænoid *Cheilodactylus* in having vomerine teeth on the fore-part of the bone; teeth generally setiform, few and feeble. Scales cycloid; opercular pieces and cheeks covered with scales, not greatly smaller than those of the body. Preorbitar high, like that of a Sparoid. Preoperculum smooth-edged, rounded at the angle; operculum with two flat points, scarcely pungent. Cæcal stomach, pretty large; four pancreatic cæca. One species.

Genus IV. Centrarchus, Cuv. (*Ichthelis*, Rafin.) Oval, compressed body. A single dorsal. Villiform teeth on the jaws and front of the vomer; on the palatines in two patches, and on the base of the tongue; no canines. Preoperculum generally entire; angle of the operculum divided into two flat points. Anal spines from three to nine. Scales ctenoid. Nine species.

Genus V. Pomotis, Cuv. A rounded, skinny, coloured lobe prolonging the operculum, whose bone ends in an obtuse angle. Pharyngeal teeth cylindrical, with flat tops, disposed in a pavement-like manner; villiform teeth on the jaws, and a row across the front of the vomer, but none on the tongue. Three anal spines. Stomach cæcal, obtuse; pancreatic cæca six. Ten species.

Genus VI. Bryttus, Cuv. *Pomotes* with a narrow band of villiform teeth on the tongue. Three anal spines. One species.

Genus VII. Pomanotis, Guich. Body compressed, oval, high, covered with ciliated scales. Snout short and conical, but obtuse; a moderate-sized mouth; teeth on the jaws crowded, conical, acute, the exterior ones somewhat curved. Preoperculum, interoperculum, suboperculum, serrulated at the corners. Tongue smooth. Operculum spinous, without a membranous border. Dorsal single; ventrals thoracic. Branchiostegals six. Fresh water, Aleppo. Near *Centrarchus*, *Pomotis*, and *Bryttus*.

Genus VIII. Priacanthus, Cuv. Angle of the preoperculum projecting in form of a flat spine, which is denticulated or crenulated on the edges like the rest of the bone; resembling *Anthias* in the whole snout and jaws being covered with strongly ctenoid scales, which extend along the median line of the throat. No canines, but narrow bands of villiform teeth on the jaws, the chevron of the vomer, and along the palatines. Mandible projecting at the chin. Eyes large. Six branchiostegals. Posterior orifice of the nostril a vertical slit; anterior one a small round hole. Form oval; the dorsal and anal rounded. Stomach large, cæcal, rounded posteriorly; five thick pancreatic cæca; air-bladder of moderate size, rounded anteriorly, pointed behind. Eighteen species.

Genus IX. Dules, Cuv. *Centropristis* by external form and interior structure, but their six branchiostegals have caused us to place them in a separate group. Some have a single dorsal, and three opercular spines; others a notched dorsal, and only two spines on the operculum. Vestiges of serratures on the suborbitar, and some very fine and little apparent ones on the preoperculum. Teeth coarsely villiform on the jaws, chevron of the vomer, palatines, and tongue. Twelve species.

Genus X. Therapon, Cuv. Villiform teeth on the jaws; denticulated preorbitars; preoperculum, and often the suprascapular or coracoid, also denticulated. Six branchiostegals. No scales on the cranium, snout, or jaws. Spinous part of the dorsal folding back into a scaly furrow. Air-bladder always divided into two distinct sacs by a contraction as in the *Cyprinidæ*, the *Characini*, and *Myripristis*. The palatine teeth are in some deciduous at a young age. Some have the outer row of jaw-teeth stronger than the others. Stomach cæcal, pointed; about twelve pancreatic cæca; anterior division of the air-bladder globular. Twelve species.

Genus XI. Datnia, Cuv., are a group merely subordinate to *Therapon*, and differ in having a more elevated body, a straight or concave profile, a pointed snout, and by the dorsal spines being stouter, and occupying a greater length of the back, though not more numerous. The dorsal is slightly notched, and they have *no teeth on the palate*. Stomach cæcal, rounded behind. Three species.

Genus XII. Pelates, Cuv., is a third division of *Therapon*, and is distinguished by a more even dorsal, less notched, and by the operculum ending in two feeble points, scarcely to be felt through the integument. Snout somewhat obtuse; mouth small; jaws equal; teeth villiform in three or four rows, *but none on the vomer or palate*. Three species.

Genus XIII. Helotes, Cuv. A fourth division of *Therapon*, having like the first one a deeply-notched dorsal, and an opercular spine. Body oblong. Head small; mouth narrow, as in the third division; exterior row of teeth minutely tricuspid; *no palatine teeth*. Two species.

Genus XIV. Datnioides, Bleek. Distinguished from *Therapon*, *Datnia*, *Pelates*, and *Helotes*, by the *suborbitar scale bones not being notched*, and by a *simple swim-bladder*. Dorsal fin simple. Premaxillary and mandibular teeth simple, pluriserial; no canines. Vomer and palate smooth. Preoperculum denticulated, without larger spines; suborbitars edentate. Branchiostegals six; lips membranous, entire, not fimbriated. Head scaly above; snout scaleless.

Genus XV. Badis, Bleek. Separated from *Nandus* by the *entire preoperculum* and *toothless tongue*. Dorsal fin single. Teeth on the jaws, palatines, and entopterygoids; tongue smooth; suborbitar scale bones and preoperculum not toothed. A single opercular spine. Branchiostegals six. Lateral line interrupted. Upper jaw protractile; inferior pharyngeals oblong, contiguous, but not united.

Genus XVI. Nandus, Cuv. Mouth protractile; teeth villiform, very close and short on the jaws, palatines, and chevron of the vomer. Preoperculum and interoperculum finely denticulated on the edge; opercular spine so small as to be easily overlooked. Scales smooth, cycloid. Intestines resembling those of a Labroid; stomach siphonal, with a very short ascending branch; no pancreatic cæca; air-bladder simple. One species.

Genus XVII. Catopra, Bleek. Dorsal solitary. Setaceous teeth on the jaws, palatines, and vomer; pterygoid and lingual teeth granular, in an oblong patch. Preorbitar scale bone and preoperculum denticulated; two flat spines on the operculum. Branchiostegals six. Lateral line interrupted; upper jaw protractile. Bleeker makes a family group of this genus and *Nandus*, and indeed the position of *Nandus*, with its siphonal stomach, and want of pancreatic cæca, does not seem to be with *Therapon*.

Genus XVIII. Anoplus, Schleg. Distinguished from *Datnia* by having vomerine teeth; from *Nandus* by the want of palatine teeth. Branchiostegals six. One species, *A. banjos*.

Genus XIX. Boleosoma, Dekay. Two dorsals. Smooth-edged preoperculum; operculum scaly, with a spine. Branchiostegals six. Nape narrow, compressed. Rivers, New York.

Genus XX. Pileoma, Dekay. Two separated dorsals. Smooth preoperculum. A flat, weak, opercular spine. Ventrals with five soft rays. Teeth of equal size. Lake Champlain.

Genus XXI. Lepisoma, Dekay. Body and fins scaly. Fleshy appendages along the lower edge of the head and round the eyes. One dorsal. Branchiostegals six. Teeth on the jaws, vomer, and palatines. Ventrals before the pectorals. One species. Florida.

Not having access at present to the works in which Dr Dekay has described these three fresh-water genera, we merely give the generic characters, as quoted in the *Archiven für Naturgeschichte* for 1844; and cannot therefore, without more data, fix their proper place in the system. Along with these genera, ranged in the family of *Theraponidæ*, we place part of the Sciænoids, "with fewer than six branchiostegals," described in the *Histoire des Poissons*. Their abstraction from the Sciænoids renders the characters of that group more precise, and they are separated from the *Theraponidæ*

Classification—Acanthopterous Fishes.

more by the toothless palate than any difference of form or general structure.

Genus XXII. Lobotes, Cuv. Branchiostegals six. A single dorsal; thoracic ventrals with five soft rays. Body, opercular pieces, and cheeks scaly. Snout short; prominent mandible; profile of face somewhat concave. Very coarse denticulations on the preoperculum. Soft portions of the anal and dorsal prolonged in such a manner that posteriorly the fish appears to be trilobate, the rounded caudal forming the middle and longest lobe; entire form oval and thickish. Spines of the fins strong, and those of the back reclining in a scaly furrow when at rest. Four pores, or four groups of minute pores towards the end of the mandible. Scales ciliated. Lateral line continuous. Stomach cæcal, very large, and fleshy; three pancreatic cæca; large oblong air-bladder. Four species.

Genus XXIII. Scolopsides, Cuv. Connected with the Sciænoids, and especially with *Pristopoma* and *Diagramma* by the denticulations of the preoperculum; but there are either no pores on the end of the mandible or only very minute ones, easily overlooked. The peculiar generic character consists in the second suborbitar scale bone ending in a spinous point, close under the orbit, pointing backwards; and the third bone of the chain frequently sends out one in the opposite direction which meets it. Body oval or oblong. Dorsal continuous in outline. Eye large. Mouth moderate. Scales pretty large, extending to the occiput, opercular pieces, cheeks, and throat. Dorsal spines reclining on a scaly furrow, and having their broader sides turned alternately to the right and left, as in many Sciænoids and Sparoids. Caudal notched or forked. Stomach cæcal, rounded, very small: pancreatic cæca six thick, as long as the stomach; air-bladder simple. Twenty-two species.

Genus XXIV. Heterognathodon, Bleek. Scaly fishes. Dorsal solitary. Branchiostegals five. Rays of the pectoral entire. Suborbitar scale bones smooth, without spines. Preoperculum denticulated; a solitary opercular spine. Premaxillary teeth bristle-shaped, pluriserial, with four canines anteriorly; mandibular teeth also pluriserial and bristle-shaped, with two canines, and a row of conical teeth behind. Batavia.

Genus XXV. Macquaria, Cuv. General form Percoid, with the muciferous excavations of the bones of *Acerina*. *No teeth*. Branchiostegals five. A pit and two small pores beneath the end of the mandible as in many Sciænoids. Preoperculum, suboperculum and interoperculum, suprascapular and coracoid, finely denticulated or serrated; operculum terminated in two thin, flat, bony points. Scales rough, ciliated. Stomach cæcal; eight pancreatic cæca; air-bladder either absent or very small. One species.

Genus XXVI. Latilus, Cuv. Forms in the division of Sciænoids, with an undivided dorsal, as given in the *Histoire des Poissons*, a genus remarkable for its arched profile descending almost vertically, the very short snout and large eye, near the profile. Horizontal mouth reaching the front of the eye, and a general form of the tapering body, resembling *Coryphæna*. Teeth, a cross band in front of the vomer, none on the palatines; four or five larger curved teeth in front of the villiform band on the jaws. Branchiostegals six. Peroperculum very finely denticulated; operculum ending in a single point. Suprascapular smooth. Dorsal rays slender, flexible. Scales minutely ciliated. Lateral line straight, continuous. Stomach cæcal; one pancreatic cæcum only observed; air-bladder simple, large. One species.

POLYNEMIDS.

This small family has relations with the first group of the *Theraponidæ*, in the existence of long feeler-like rays in the pectorals. In one species of Polynemus, the long free pectoral rays have obtained for it the appellation of Paradise-fish, from the resemblance these filamentous rays bear to the tail-feathers of a bird of Paradise. Polynemus is also remarkable as being a genus, otherwise natural, of which the species exhibit great varieties in the form of the air-bladder. In some, that viscus is lobed posteriorly, and fringed on the sides with many pointed processes; in other species, the air-bladder, though large, is quite simple, and in others there is no air-bladder at all, just as it is wanting in some species of *Scomber*. The *Polynemus indicus*, which has a large air-bladder with from twenty-eight to thirty-five of these lateral appendages springing from it, and also a very great number of pancreatic cæca divided into two bundles, furnishes most of the isinglass that is procured at Penang. The weight of this fish is commonly from 4 to 6 lb., and seldom exceeds 20 lb. The air-vessel of a good-sized fish when dried and ready for the market weighs upwards of two ounces, and the isinglass is considered to be very good, and fetches from 25 to 30 Spanish dollars the pikul. The prepared air-vessels are known in eastern commerce by the name of "Fish-maws," and in 1842 between 12,000 and 13,000 dollars worth were exported from Prince of Wales Island (Singapore). They are not obtained exclusively from the *Polynemus*, though its isinglass is among the best. Dr Cantor, from whom these particulars are quoted, says that the fishery is carried on in a very rude manner, chiefly by the Chinese, and might be almost indefinitely extended by European capital and skill.

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Family IV.—POLYNEMIDÆ.

Acanthopterygians with abdominal ventrals, a position resulting from the elongation of the pubic bones which are suspended to the coracoids. Teeth on the jaws, front of the vomer, and palatines. Two dorsals; scaly appendages in the axillæ of the pectorals and ventrals. Scales ctenoid, feebly ciliated. Pancreatic cæca.

Genus I. Polynemus, Linn. Body oblong. Head covered, even to the branchiostegal membrane, with deciduous scales. Preoperculum denticulated. Villiform teeth on the two jaws, front of the vomer, and on the palatines; tongue short and broad, smooth. Wide gill-openings; seven branchiostegals. The two openings of each nostril near to one another and near the end of the snout. Dorsals widely separated, the second one being distant also from the caudal, and corresponding in position with the anal; caudal forked, generally unequal. Small scales on the three vertical fins, and on the base of the pectoral; a number (varying with the species) of the under pectoral rays free, long, and filiform, separated from the rest of the fin by a scaly space. Anal spines, one, two, or three. Stomach obtusely cæcal; several pancreatic cæca (six or more); air-bladder large, pointed, and entering among the muscles of the tail; in some species the air-bladder is wanting, in others that viscus has many (from twenty to thirty) processes on the ventral surface. Sixteen species.

With this we associate a Sciænoid genus, which has had no other more appropriate place assigned to it as yet, and which has many characters in common with Polynemus.

Genus II. Cheilodactylus, Lacép. Sciænoids with an oval compressed body; small mouth; villiform teeth, or conical, scarcely acute, on the jaws only, and not on the palate. Preorbitars and preopercula without denticulations. Numerous dorsal spines, and ventrals attached under the middle of the pectorals, but with the pubic bones suspended from the coracoid. Branchiostegals six, more rarely five only. Stomach cæcal; pancreatic cæca two, short; rectum dilated, muscular. The lower pectoral rays, to the number of six or seven, are simple, and one of them commonly thicker than the rest, is elongated into a filiform tip, which often reaches the end of the anal. Caudal forked. Many have a slight prominence before the orbit, and in one or two species it rises in a conical form. Eight species.

Genus III. Latris, Rich. A division of *Cheilodactylus*, with generally more-elongated elliptical bodies, and none of the simple rays of the pectoral passing the membrane. The ascending limb of the preoperculum is minutely serrated in some, and smooth in others. Three Australian species.

SURMULLET FAMILY.

The fishes of this family were denominated τρίγλη by the Greeks, and *mullus* by the Romans. The Greek name is said to have originated in the three spawning seasons attributed to the Surmullets, and they were dedicated to the tergeminous or tricipitous goddess Hecate. The Latin name had another origin according to Pliny—*a colore mulleorum calceamentorum*, from the red-coloured shoes or buskins worn by the kings of Alba, and afterwards by the consuls, prætors, and curule ediles. By the luxurious Romans, the Surmullets were held in such repute that they sought for them far and wide, and without regard to expense. They seldom exceeded 2 lb. in weight, and the purchase of a large one, the price augmenting in a greater ratio than the size, was considered to be an act of magnificence. A Surmullet of 3 lb. weight was an object of admiration, and one of 4 lb. entailed ruin on the purchaser.

"Mullus tibi quatuor emptus
Librarum, cœnæ pompa caputque fuit,
Exclamare libet, non est hic improbe, non est
Piscis: homo est; hominem, Calliodore voras."
MARTIAL, l. x. 31.

Seneca relates the history of a Surmullet that was presented to Tiberius, and which that emperor, in a fit of economy, sent to the market. Apicius and Octavius were competitors for it, and the latter became the purchaser at the cost of 5000 sesterces, or upwards of L.40 sterling. Asinius Celer paid 8000 sesterces for one in the reign of Caligula. The high-priced fish were brought from a distance, as they did not thrive in ponds, and increased little there in weight, though extraordinary pains and expenditure were employed in the endeavour to rear them. It was one of the luxuries of a giver of feasts to cause these fishes to swim down streams led through the banqueting room, that his guests might enjoy the sight of their brilliant colours during their repast, or to let them die in glass vessels, that all the varying hues of the expiring fish might glut their eyes. Seneca says the fish swim under the very couches of the guests, and they are caught under the table that they may be the sooner placed upon it, for no Surmullet was considered to be fresh unless it expired in the hands of the guests. They were exposed in vessels of glass, that the different colours they assume during a slow and painful agony may be noticed. Nothing was considered to be more beautiful than a dying Mullet. The struggles of the fish to escape death bring out the most brilliant scarlet tints, which are followed by a general paleness; and in the passage from life to death these two extreme tints mingle, says the author from whom we borrow, in the most agreeable manner. The liver of the Surmullet was considered to be the most delicious part, and was bruised in wine to make a *garum* for the flesh. Even in the present day the Surmullet is considered to be one of the best of sea-fishes—its flesh being white, firm, tender, of an agreeable flavour, and easily digested because it contains little fat. The scales of the Surmullets are strongly ciliated.

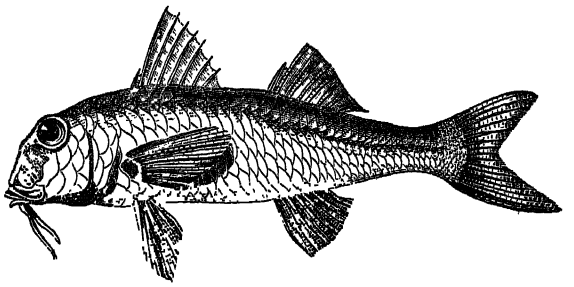


Fig. 95.

Mullus barbatus.

FAMILY V.—MULLIDÆ.

Les Mulles, Cuv. A perfectly natural family, distantly allied to the Percoids, but readily distinguishable from other *Acanthopterygii* by the two dorsals, widely separated from one another, by the large and easily-detached scales of the head and body, and by the pair of symphysial barbels of the mandible which retire between the limbs of that bone when not in use. Body oblong, little compressed. Fins of moderate spread. Profile more or less convex above and below. A high narrow preorbitar; small mouth, with feeble teeth. Gill-opening wide; four branchiostegals. Mucoducts forming the lateral line divided into a cluster of branches on each scale. Siphonal stomach; numerous pancreatic cæca.

GENUS I. MULLUS, Linn. No teeth on the upper jaw; a disk of pavement-like teeth on the front of the vomer. No spine on the operculum. No air-bladder. Two species.

GENUS II. UPENEUS, Cuv. Short teeth on both jaws, sometimes closely villiform (*Upeneoides*, Bleek.) sometimes distinct and uniserial (*Upeneus*, Bleek.) Some have villiform teeth on the palate or vomer; in most these bones are destitute of teeth. Thirty-eight species.

GENUS III. ACROPOMA, Schleg. General aspect of *Mullus*, but distinguished by the want of barbels. Anus nigh the ventrals, at a wide distance from the anal fin. Jaw-teeth pointed, the foremost being canines. Branchiostegals seven.

HOLOCENTRIDES.

This small family consists of that division of Cuvier's Percoids whose members have more than seven branchiostegals, and whose soft ventral rays exceed five. The group is a natural one, all the species having a common likeness which is very recognisable. They are the only *Acanthopteri* which have this unusual number of rays in the ventrals, and are fishes remarkable for the brilliancy of their colours, the neatness of their forms, and their very ctenoid scales. They are not the objects of any special fishery.

FAMILY VI.—HOLOCENTRIDÆ.

Holocentrini, Bonap. Acanthopterygians, with more than five branching rays in the ventrals, and seven branchiostegals. A natural group, recognisable by the large, very strongly-toothed or serrated scales, the furrows and streaks on many of the bones of the cranium, face, and gill-cover, the serratures on the edges of the opercular pieces, and the general stoutness of the spines of the fins. Cheeks scaly. Dorsals single, or deeply notched, or two contiguous dorsals. Small spines above and below the caudal; dorsal spines falling back into a furrow. Otolites large. Air-bladder connected with the otocrane by an ossicle and a tympanum closing the orifice; stomach cæcal; numerous pancreatic cæca (eight to twenty or more).

GENUS I. MYRIPRISTIS, Cuv. Somewhat of the aspect of *Apogon*. Cranium sculptured. Dorsals two, contiguous, or one deeply notched. Preoperculum with its border serrated, and also a serrated line in front of the limb, but *no spine at its angle*, by which it is distinguished from *Holocentrum*. Villiform teeth on the jaws and front of the vomer, with a few bigger ones in front of the jaws of a short obtuse conical form. Tongue smooth. An acute opercular spine. Stomach cæcal, reaching the middle of the cavity of the abdomen; nine pancreatic cæca; a fibrous exterior coat of the air-bladder, which is large, and divided into two by a contraction. Fourteen species.

GENUS II. HOLOCENTRUM, Cuv. *Myripristis* with a *strong spine at the angle of the preoperculum*. Dorsal slightly notched. Third anal spines generally very large. Otocrane not always connected with the air-bladder, which is simple and extends the whole length of the belly, and is not forked anteriorly. Stomach cæcal; eight pancreatic cæca. Twenty species.

GENUS III. BERYX, Cuv. *Holocentra* with a very large eye, but differing in having a single dorsal, with only slender spinous rays in front, and without any notch of separation. Anal spines not remarkable for size. Stomach cæcal, cylindrical, obtuse; ascending branch fleshy. Long, slender, numerous pancreatic cæca; air-bladder wide, and running the whole length of the abdomen. Four species.

GENUS IV. RHYNCHICHTHYS, Cuv. General habit of *Holocentrum*, but with the cranial crests prolonged anteriorly into an acute snout, somewhat resembling that of *Macrourus*. A projecting spine at the angle of the preoperculum; strong denticulations on its borders, and also round the posterior edge of the operculum, but no strong spine in the latter. Two species.

MAILED CHEEKS.

The three Linnæan genera, *Trigla*, *Cottus*, and *Scorpæna*, are the foundations of this numerous family, so remarkable for the variety of forms it offers; for the beauty of some, from the splendour of their colours, the elegant arrangement of their tints, or the gracefulness of their fins; and for the ugliness of others of disagreeable shapes, and having loose disgusting skins. Few fishes are so handsome, or more delicate in appearance than *Pterois*, whose fins resemble the long feathers of the gayest birds, while *Pelor* and *Synanceia* are about as ugly as a fish can be. The following table of the genera is taken from the *Histoire des Poissons*.

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TABLE OF GENERA.

No free rays in advance of the dorsal.
Two dorsals.
A parallelopiped head.
Free rays beneath the pectoral.
TRIGLA, PRIONOTUS, PERISTEDION.
Long rays beneath the pectorals, united to form great fins used as wings.
DACTYLOPTERUS.
No detached rays under the pectorals.
CEPHALACANTHUS.
A round or depressed head.
Ventrals under the pectorals.
COTTUS, HEMITRIPTERUS, BEMBRAS, ASPIDOPHORUS.
Ventrals behind the pectorals.
PLATYCEPHALUS.
A single dorsal.
A compressed head.
Villiform teeth on the jaws, vomer, and palatines.
HEMILEPIDOTUS, BLEPSIAS, APISTES, SCORPÆNA, SEBASTES.
Teeth on the jaws and front of the vomer, but not on the palatines.
PTEROIS.
Some small teeth on the jaws only.
AGRIOPUS.
A large head; monstrous in appearance; eye on the dorsal aspect.
Villiform teeth on the jaws and front of the vomer.
PELOR.
Free spines replacing the first dorsal.
Body scales large and imbricated; eight branchiostegals.
MONOCENTRIS.
Body mailed by plates on the lateral line; three branchiostegals.
GASTEROSTEUS, SPINACHIA.

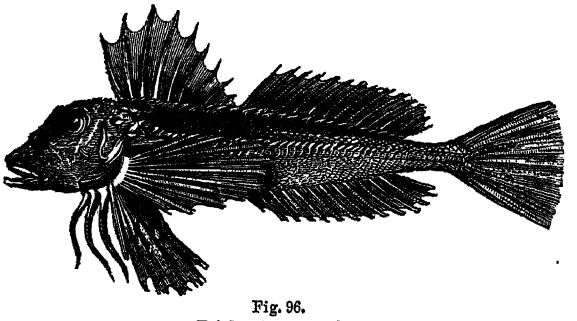


Fig. 96.
Trigla pleuracanthica.

The *Triglæ* or Gurnards are too well known to need a description; at the same time they convey a good idea of the general form of one of the leading tribes of the family, and one in which the characteristic development of the second suborbitar scale bone is well seen. This bone in all the *Sclerogenoids* either covers the whole cheek, or sends a process across it to the curve of the preoperculum opposite to the spine at the angle, to which it serves as a point of resistance when the spine is used as a weapon. This elongation of the suborbitar is often crested by an acute ridge, and is most commonly armed with spinous points. The air-bladders of the Gurnards are variously lobed, and some of the species have been noticed to emit a grunting noise when caught, which some observers have supposed was produced by that organ; but it is the character of the order to have no air-duct to the swim-bladder. The flesh of the Gurnard is very white, firm, and wholesome.

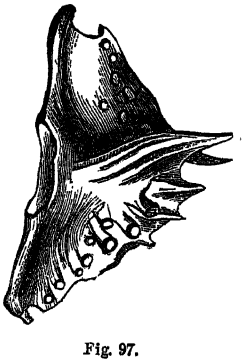


Fig. 97.
Trigla pleuracanthica scale from the lateral line.

The common Dactylopterus or Flying-fish of the Mediterranean (*Trigla volitans*, Linn.), is a species too remarkable for its functions, so opposite to those of its class in general, not to have attracted from an early period the attention of mankind. It is extremely common, and has been mentioned by all the authors who have treated of the fishes of that inland sea. The ardour with which it is pursued by the Dolphins and Bonitos, the sudden effort which it makes to escape these predaceous creatures by vaulting into the air, the new and probably unthought of dangers which there await it from gulls and other aquatic birds, render it an object of the highest interest to the unaccustomed landsman, somewhat wearied with the monotony of a sailor's life. "It is by the extension of the pectoral rays and membrane that the fish is enabled to raise itself from its proper element to the regions of the air, though this is by no means a continual flight, for the utmost it can do is to describe an arc over the surface of the water extending to a distance of about 120 feet, and sufficiently elevated for the fish sometimes to fall on the deck of a large vessel. This power of flight or momentary suspension would be much greater if the pectoral membrane could preserve its humidity longer, but it is soon evaporated in the heat of the tropics; and the membrane, as it becomes dry, loses its buoyant power, and the fish falls. They are sometimes so numerous as to afford much pleasure to the spectator by their repeated flights; and at particular times, especially on the approach of rough weather, in the night, numbers of them may be seen, by the phosphoric light they emit, marking their arched passages in apparent streams of fire." Such is the current account of the flights of this interesting fish, and of the causes of it; but it is probable, as has already been observed of the *Exocœti*, that the Flying-fishes do not soar into the air merely when pursued by their enemies, for this would only be *incidere in Scyllam cupiens vitare Charybdim*, but also to subserve some purpose in their economy.

The *Cotti* are characteristic members of another group of the Mailed Cheeks. The fresh-water species of this genus have the head almost smooth, and only a single spine to the preopercle. Their first dorsal is very low. The most common is the river Bull-head (*Cottus gobio*, Linn.), sometimes called the Miller's Thumb. It is a small dark-coloured fish, 4 or 5 inches in length, and frequent in most of the streams of Europe and the north of Asia. It usually lies concealed beneath stones, from whence it darts with great rapidity upon its prey. It is said to be extremely prolific; and the female, when with spawn, becomes so greatly enlarged, that her ovaries protrude like mammæ. The Bull-head, like the Salmon, has a reddish hue when boiled. It affords a good and wholesome food, much sought after by the mountain tribes of several countries.

The *Scorpænæ* are found in all seas in considerable numbers, and present a great variety of aspects, some being nearly as ugly as a *Pelor*, while others passing, as it were, into the nearly allied genus *Sebastes*, have a Percoid neatness of appearance. The species here figured is an Australian one, *Scorpæna Stokesii*.

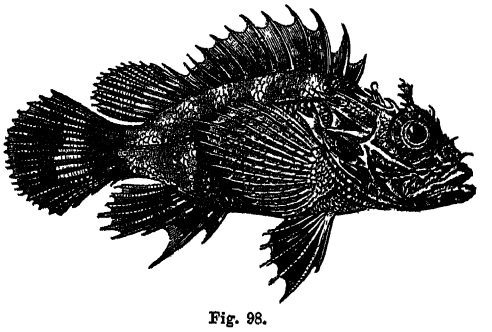


Fig. 98.
Scorpæna Stokesii.

The *Platycephali* may be considered as elongated and

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greatly depressed *Scorpænæ*. The subjoined representation of *Platycephalus cirrhonasus* will give a good idea of the

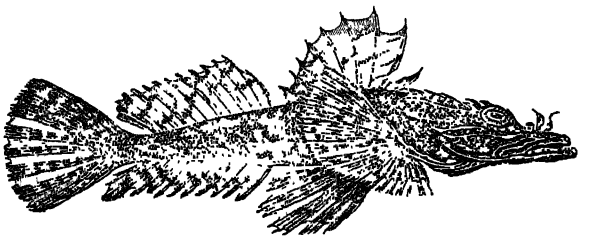


Fig. 99.
Platycephalus cirrhonasus.

form of one, which, however, is not so flatly depressed as many others of the genus. They are common ground-fish in the southern hemisphere. Fig. 42 gives a view of a scale from the lateral line of the same species. *Synanceia horrida*, as the title implies, exhibits by no means an inviting aspect. It is named *Ikan-swangi*, or Sorcerer-fish, by the Malays. *S. brachio* of Cuv. is the species called *Fi-fi*, or *Hideous*, by the Negroes of the Isle of France, who hold it in great abhorrence. In fact, nothing can be conceived more frightful. At first sight no one would consider it a fish, but rather as a mass or unformed lump of corrupted jelly. "Totum corpus," says Commerson, "muco squalidum et quasi ulcerosum." Its head and members seem enveloped in a sack of thick, soft, spongy skin, warty and wrinkled like that of a leper, and irregularly blotted over with various tints of brown and gray. Sometimes it appears entirely black; but it is always gluey and disgusting to the touch. The little eyes are scarcely discernible in the large cavernous head. This species is said to possess great tenacity of life, and survives for a long time out of the water. The skin, in fact, forms a little ring like that of *Pelor* above the point of the operculum, through which the fish can respire at pleasure, leaving the remainder of the gill-opening closed, and the gills consequently little exposed to exsiccation. The inhabitants of the Isle of France regard this fish as a reptile, and dread its sting, meaning the wounds inflicted by its spines, more than that of snakes or scorpions.

The genus *Apistes* was so named by Cuvier from the treacherous way in which these fishes conceal the moveable preorbitar spine, by laying it along the cheek, and on any one attempting to seize them, raising it suddenly so as to inflict a disagreeable wound. The Greek word from whence the name was derived signifies "perfidious." Since Cuvier's time several species have been discovered possessing this suborbitar weapon, but varying considerably in the rest of their form from *Apistes*, as described by him. One of these new forms is *Choridactylus multibarbus*, of which a figure (fig. 9) has been given. Some of these *Apistes*, having large pectorals, are able to sustain themselves in the air for a time, as Flying-fishes. One of the remarkable forms of the family is represented by fig. 14. It is the *Monocentris Japonica*.

The *Gasterostei* differ from the rest of the family in having the spines of the dorsal free and detached. The species are small fishes familiarly known under the name of Sticklebacks (Scotice, *Benticles*), and extremely common in all the fresh waters of Europe. Gesner indeed asserted that they did not occur in Switzerland; but the contrary has been long since ascertained. Our most common species is *G. aculeatus* (Linn.), under which name, however, it is supposed that more than a single kind has been confounded. It is an active and greedy little fish, extremely destructive of the fry of other species, and consequently injurious in ponds where these are sought to be preserved. Mr Henry Baker informs us that it will spring not less than a foot perpendicularly out of the water and to a much greater distance in an oblique direction, when it desires to overcome any opposing obstacle. "It is scarcely to be conceived," he adds, "what damage these little fish do, and how greatly detrimental they are to the increase of all the fish in general among which they live; for it is with the utmost industry, sagacity, and greediness that they seek out and destroy all the young fry that come in their way, which are pursued with the utmost eagerness, and swallowed down without distinction, provided they are not too large; and in proof of this, I must assert that a banstickle which I kept for some time, did, on the 4th of May, devour, in five hours' time, seventy-four young dace, which were about a quarter of an inch long, and of the thickness of a horse hair. Two days after it swallowed sixty-two; and would, I am persuaded, have eat as many every day, could I have procured them for it." The Stickleback sometimes swarms in prodigious numbers. Pennant states that at Spalding, in Lincolnshire, there are once in seven years amazing shoals, which appear in the Welland, coming up the river in the form of a vast column. This concourse is supposed to arise from the multitudes which have been washed out of the fens by the floods of several years, and which collect in deep holes, till, overcharged with numbers, they are obliged to attempt a change of place. The quantity may perhaps be conceived from the fact, that a man employed in collecting them, gained for a considerable time four shillings a-day by selling them at the rate of a halfpenny a bushel. Some of the *Gasterostei* live indifferently in salt or fresh water, and the one represented by figure 13 was taken by Sir Edward Belcher, in the sea at the north end of Wellington Sound, in Lat. 77° N. M. Coste, who studied the manners of these small fishes in the Mediterranean, relates that on the approach of spawning time, the male builds a nest of stalks of grass and other matters in a hollow of the bottom, a little above three feet wide and about six inches and a half deep, creeping over the materials on his belly and cementing them with the mucus that exudes from his skin. The bottom of the nest is first laid, then the sides are raised, and lastly, the top is covered over. A small hole is left on one side for an entrance. When the erection is complete, he seeks out a female, and conducting her, M. Costa says, with many caresses, to the nest, introduces her by the door into the chamber. In a few minutes she has laid two or three eggs, after which she bores a hole on the opposite side of the nest to that by which she entered, and makes her escape. The nest has now two doors, and the eggs are exposed to the cool stream of water which entering by one door flows out at the other. Next day the male goes again in quest of a female, and sometimes brings back the same, sometimes finds a new mate. This is repeated until the nest contains a considerable number of eggs, and each time the male rubs his side against the female and passes over the eggs. Next the male watches a whole month over his treasure, defending it stoutly against all invaders, and especially against his wives, who have a great desire to look at the eggs. When the young are hatched and able to do for themselves, his cares cease. Mr Lecoq made similar observations at another place, but the Italian society to whom the papers of the two observers were transmitted, after inquiring fully into the case, decreed that the right of priority belonged to M. Coste. (*Archiven für Naturg.*)

Family VII.—SCLEROGENIDÆ.

Joues cuirassées, Cuv.; *Cataphractoridæ*, Cant.; *Triglidæ*, Bonap.; *Cataphracti*, Heck.; *Scleroparei*, *Buccœloricatæ*, &c.

The distinctive character of this group is the prolongation of the second suborbitar scale-bone across the cheek to be articulated with the preoperculum in its curve, so as to serve for a fulcrum to the spine, which issues from the angle of that bone. Forms exceedingly variable, but having a family resemblance in their prevailing monstrous character. Several genera have fewer than five rays in the ventrals, an uncommon occurrence among *Acanthopteri*.

Classification—Acanthopterous Fishes.

Genus I. Trigla, Linn. Cheek wholly covered by the enormous second suborbitar, which is articulated by an immoveable suture to the preoperculum, the two moving together; sides of the head almost vertical. Body scaly. Two dorsals. Three free unbranched articulated rays under the pectoral. Snout formed by the union of the prefrontals, turbinals, and point of the nasal, by suture; the preorbitar making a more or less salient projection before them. Branchiostegals seven. Branchial rakers in form of tubercles; villiform teeth on the jaws and pharyngeals, but the palate and tongue are edentate. Lateral line straight to the caudal, on which it forks; it is variously armed. Stomach cæcal; pancreatic cæca numerous (eight to twelve), dividing into two or three lobes anteriorly. Eighteen species.

Genus II. Prionotus. Cuv. *Triglæ* with very large pectorals and villiform palatine teeth. Body scaly. Eight species.

Genus III. Peristedion. Lacép. Body clothed in scaly armour. A long projection of the preorbitar on each side of the snout. Mouth beneath; destitute of teeth, as are also the vomer, palatines, and pharyngeals. Under lip bearded. Body octagonal, with tapering spines on its eight angles. Two free rays under the pectoral. Pancreatic cæca seven; air-bladder pretty large, simple. Two species.

Genus IV. Dactylopterus, Cuv. Head flat above, rounded off into a nearly vertical face; helmet granulated. Eye very large. A very long spine continued from the lower border of the preoperculum. Suprascapula emitting a long spine; articulation of the suborbitar and preoperculum moveable. Teeth pavement-like on the jaws; no teeth on the vomer or palatines. Branchiostegals six; four articulated rays only in the ventrals in addition to the spine. No free rays in the pectoral, but the fin is divided into a smaller anterior part, and a posterior very broad and long part with the tips of the rays going beyond the membrane; some of the anterior dorsal rays are free. Scales of the body hard and firm, those on the flanks keeled, forming, by their close succession, trenchant crests. Stomach cæcal; about thirty pancreatic cæca in two bundles; air-bladder small, deeply bilobate. Two species.

Genus V. Cephalacanthus, Lacép., is a *Dactylopterus* without the wing-like supplementary pectoral, or a *Trigla* without the free rays. Head and body like *Dactylopterus*, of which it is said by Dumeril to be merely the young. An acute and very long spine from the angle of the preoperculum, and another from the suprascapula, both serrated. Pectoral divided into two nearly equal lobes by a fissure. A pointed cæcal stomach; innumerable pancreatic cæca; *no air-bladder*. One species.

Genus VI. Cottus, Linn. A large rounded or depressed head, variously armed with spines and tubercles. No scales. Two dorsals. Teeth on the fore-part of the vomer; no teeth on the palatines. Six branchiostegals. Five, four, or fewer rays in the ventrals; inferior rays of the pectoral unbranched as in *Trachinus*. Pancreatic cæca few in number; no air-bladder. Thirty-six species. Various dismemberments of this genus have been made, and the fresh-water and marine species have been separated—*Uranidea* being the name given to an American fresh-water species, and *Acanthocothus* to the marine ones.

In the fully armed head of a *Cottus* there are ten spinous points more or less produced on each side of the head; one on the turbinal; five on the preoperculum, the one at the angle being a long spine, and the others angular points of the inferior limb; one on the inferior anterior angle of the suboperculum; a spine at the point of the operculum, and acute points or spines on the suprascapula and coracoid. There are also four eminences placed in a quadrangle on the top of the head, one behind each orbit, and another on the occiput on each side. In some these are blunt and smooth; in others spinous; in others rough tubercles, much elevated or even branched. In other species many of the spinous points are obsolete.

Genus VII. Trachydermis, Heck. (*Centridermichthys*, Rich.) General form that of *Cottus*; head less depressed. Turbinals, preoperculum, and inferior angles of the suboperculum spinous; the principal preopercular spine-hooked. Beneath it two acute spines and a blunt point; operculum and preorbitar unarmed. Villiform teeth on the jaws, palatines, and chevron of the vomer; pharyngeal teeth rather coarser, the upper ones forming a tuft on each side. Dorsals contiguous; pectorals like those of *Cottus*, with simple rays below (seven); ventrals having four jointed rays and one spine. Branchiostegals six. Body covered with slender setaceous spines, each springing from a minute cuticular tubercle. Head, belly, axillæ of the pectorals, and a narrow line along the base of the anal, smooth. A genital papilla; pancreatic cæca. Species *Tr. ansata*, China.

Cottus asper (*Fauna Bor. Amer.*) seems to be a second species of *Trachydermis*, with the spines on the same bones of the head, but less prominent, so as to be concealed in the recent fish by the integuments, and the point of the principal preopercular spine not hooked. It is the type of the genus *Cotopsis*, Girard.

Genus VIII. Triglopsis, Gir. Head smooth. Many muciferous canals developed in the bones of the skull and face, as in *Acerina*. First dorsal shorter and much lower than the second one, and distant from it. No palatine teeth; teeth on the chevron of the vomer, and also down the median line. Four preopercular spines, shorter and more slender than is usual in *Cottus*. Gill-openings connected on the throat without an isthmus. Branchiostegals six. All the pectoral rays undivided. One species, Lake Ontario.

Genus IX. Phobetor, Kroy. *Cotti* destitute of vomerine teeth; resembling *Cottus Scorpius* in general aspect. Acute small turbinal spines. Principal preopercular spine snagged; three acute points on the bone beneath it; operculum destitute of both the usual median rib and spine. A small spine pointing downwards from the lower angle of the suboperculum, and crossed by a smaller interopercular spine. Suprascapulæ unarmed. Two small cranial tubercles on each side. No orbital ridges. Lateral line composed of cutaneous mucoducts. Fins large.

Genus X. Icelus, Kroy. Body somewhat compressed, higher than thick. Head large; destitute of scales; armed with spines on the snout, preoperculum, and nape. Teeth minute, setaceous on the jaws, vomer, and palatines. Branchiostegals six. Two dorsals, separated; ventrals of four rays under the pectorals; rays of all the fins undivided. On each side from the nape to the caudal fin a continuous series of bony shields, running near the dorsals. Lateral line composed of bony tubercles. Ciliated scales on the sides and belly, few and scattered; the rest of the skin naked. Three species, *I. hamatus, I. bicornis, I. uncinatus*.

Genus XI. Caracanthus, Kroy. Body higher than in other genera of the family, greatly compressed, oval. Snout very short, truncated; small slender teeth on the premaxillaries and mandible. Branchiostegals six. Preorbitar scale bone armed with a spinous point anteriorly. Two low dorsal fins; short pectoral fins, with simple rays; ventrals entirely rudimentary; two spinous anal rays, set apart from the soft portion of the fin. No scales, but many cutaneous papillæ. One species, Otaheite.

Genus XII. Podabrus, Rich., 1848. Scaleless. Lateral line of simple cutaneous mucoducts, arched abruptly over the pectorals. Ventrals of a spine and *two soft rays*; two dorsals approximated; rays of all the fins, except the caudal, unbranched; none free. Villiform bands of subulate teeth on the jaws, vomer, and palatines, and in hemispherical tufts on the pharyngeals, also on the tubercular rakers. Tongue smooth. No armature on the preorbitar, suboperculum, or interoperculum, nor on the cranium or suprascapulæ. Slight unevenness of the skull concealed by the soft parts. A narrow, thin process projects from above the corner of the preoperculum; and the operculum ends in a thin flexible point, but there is no pungent corner, and the integuments of the cheek conceal the second preorbitar as it crosses to the hollow of the preoperculum. One species has the aspect of *Centropomus*, another of *Cottus*, both are more compressed than *Cottus*. Two species, China seas.

Genus XIII. Aspidophorus, Lacép. Phalangista, Bloch., Schneid. Many of the characters of *Cottus*, such as the depressed head, simple rays, six branchiostegals, but with the body cuirassed by a series of large bony scales that extend from the head to the caudal fin, forming a pyramid with many faces. No vomerine teeth. Ten species.

Genus XIV. Platycephalus, Bloch. Head very much depressed; spiny. Body more or less depressed; elongated; scaly. Acute teeth on the palatines. Seven branchiostegals. A spine and five articulated rays in the ventrals, which are under the middle of the pectorals, and therefore abdominal in position, and are widely apart from each other laterally, owing to the breadth of the pubic bones. Dorsals contiguous or approximated. Thirty species.

Genus XV. Oplichthys, Cuv. Head depressed, and with the operculum very spinous as in *Platycephalus*. Body cuirassed as in *Aspidophorus*. *Ventrals more jugular*, and having a spine and *five soft rays*. One species, Japan.

Genus XVI. Hemitripterus, Cuv. Two dorsals, the first one deeply notched. Many cutaneous filaments on the uneven head and mandible. Large pectorals advancing far under the throat; the lower rays thickened, but none free; ventrals jugular of a spine, and three soft rays; rays of all the fins, including the caudal, simple. Teeth on the jaws, vomer, *palatines*, and pharyngeals in villiform bands. Tongue smooth. Branchiostegals six. Two species.

Genus XVII. Hemilepidotus, Cuv. Somewhat of the aspect of *Cottus*, but with the dorsals united, though notched between the spinous and soft portions. Teeth on the jaws, vomer, and palatines. Two ranges of scales on the sides with soft integument between them; scales round, finely denticulated, and rising into a little crest. Stomach small; pancreatic cæca five.

Genus XVIII. Bembras, Cuv. Head, serrated crests, and spines, nearly as in *Platycephalus*, but not depressed. Ventrals rather before the pectorals, with five articulated rays and the usual spine, and as in *Scorpæna* there are villiform bands of teeth

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on the jaws, vomer, and *palatines*. Dorsals separated, as in *Cottus*. Two species.

Genus XIX. Scorpænæ, Linn. Resemble the *Cotti* in many particulars, but are distinguished by their single dorsal. Head compressed laterally, and teeth on the palatines as well as on the vomer and jaws. Head large and very spiny, enveloped generally in a spongy skin; pungent or spinous points on the side of the head, and gill-cover generally on the same bones as in *Cottus*, and they vary in size and acuteness with the species. There are besides a spinous ridge on the second suborbitar, and crests on the top of the cranium, more or less prominent and acute. No scales on the head. Seven branchiostegals. A scaly body. Cutaneous filaments depending from various part of the head and flanks, and simple though jointed rays in the lower part of the pectorals. Eight or more pancreatic cæca; no air-bladder. Thirty species.

Genus XX. Sebastes, Cuv. Percoids, except for the connection of the suborbitar with the operculum and the simple inferior rays of the pectorals. *Scorpænæ*, but for the presence of scales on the snout, maxillaries, cheeks, and gill-covers, or on most of these parts. The head is less armed than that of *Scorpæna*, and the cutaneous filaments are absent, or very sparingly present. Transitional species exist, which may be placed in either of these two genera. Eighteen species.

Genus XXI. Pterois, Cuv. Head compressed and strangely shaped. Cutaneous filaments on the snout. Preorbitars and preoperculum simple. Very long rays in the pectorals, with the membrane deeply notched; long slender dorsal spines. Teeth on the jaws and front of the vomer, but none on the palatines. Seven branchiostegals. Small scales on the body and various parts of the head, smooth and round (cycloid?). Pores on the limbs of the mandible. Ventrals with five forking soft rays in addition to the spine. Three pancreatic cæca; a pretty large oval air-bladder. Ten species.

Genus XXII. Tænianotus, Cuv. Body extremely compressed. Dorsal very high, and united to the caudal, from which the anal is distinct; ventrals under the base of the pectorals of five soft rays and one spine. Scales very small. Cutaneous filaments on the orbit, nostril, and tip of the snout. Spinous points on the turbinals, three on the orbit, two on the cranial crest, one on the suprascapula, two on the operculum. Three teeth on the preoperculum, a small one on the crest of the second suborbitar. Radiating lines on the preorbitar, and teeth on its edge.

Genus XXIII. Blepsias, Cuv. Allied to *Scorpæna* by its compressed head, cheek cuirassed by the suborbitar, palatine teeth, simple fin-rays, short, and half free in the lower part of the pectorals, and cutaneous filaments on the snout and mandible; but distinguished from that genus by the *five branchiostegals* and high dorsal, divided into three unequal lobes like that of *Hemitripterus*: from the latter genus its compressed head separates it. All the rays of the fins, including the caudal, unbranched. Obtuse corners on the preoperculum, and acute turbinal spines, but no other sharp points on the head.

Genus XXIV. Agriopus, Cuv. One of the least armed of the family, and the second suborbitar does not articulate opposite the angle of the preoperculum, but to the upper part of the ascending limb of that bone. A long single dorsal, with strong spines advancing on the cranium to between the orbits, with its anterior rays flanked by elevated uneven cranial crests. Mouth projecting, small, furnished with scarcely perceptible teeth; no teeth on the palate or tongue. Five branchiostegals. Pectorals low down, the membrane between the lower rays deeply notched; ventrals with a spine and five soft rays; caudal rays subdivided; rays of all the other fins simple. Skin scaleless, smooth, or finely tuberculated. Stomach siphonal, without a dilatation to distinguish it from the œsophagus; *no pancreatic cæca*; air-bladder oval, occupying half the length of the abdomen. This genus and *Patœcus* seem to link the *Sclerogenidæ* and *Gobiidæ* to each other. Four species.

Genus XXV. Apistes, Cuv. *Scorpænæ*, having for their distinctive character one long spine on the preorbitar, and another on the preoperculum, which, from the mobility of these bones, can be raised to a right angle with the long axis of the fish, and become dangerous weapons. Soft part of the dorsal not separated from the spinous portion, but in some species rays are detached from the front, and form small separate fins. Some have a naked skin like *Cottus*, others are scaly like *Scorpæna*, and some have one or more free rays under the pectoral. Cuvier kept these various forms in one genus, merely giving the name of *Minous* to those which have some detached pectoral rays: subsequent ichthyologists have made genera of the groups that were indicated in the *Histoire des Poissons*. Stomach cæcal; four pancreatic cæca; pretty large air-bladder, swollen at the extremities, and somewhat depressed in the middle. Eighteen species, of which three are wholly without scales.

Genus XXVI. Minous, Cuv. *Apistes* with one free ray under the pectorals, and thereby allied to—

Genus XXVII. Choridactylus, Rich. (*Voy. of the Sulphur*, 1848). This genus combines the characters of various *Sclerogenidæ*: in union with the preorbitar spines of *Apistes* or *Minous*, it has the hollow cheeks, prominent orbits, tall, slender dorsal spines, filaments of the fins, three free pectoral rays, and ventrals adnate to the belly, and composed of five soft rays and a spine, all as in *Pelor*. It has not, however, the elongated body, depressed head, and horizontally protruding muzzle, nor the vomerine teeth of *Pelor*, and of the *Scorpænæ* generally; it is distinguished from *Synanceia* by its free pectoral rays, but resembles that genus in general form. Skin scaleless. Many filaments on the head, mandible, and fins. One species.

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Genus XXVIII. Sthenopus, Rich. (lib. supra cit.) Aspect of *Pelor*, with a less extraordinary-shaped, though large head, and three higher rays of the dorsal, advanced to the orbits, but connected at the base by membrane to the remainder of the fin. Only *two soft rays* and a spine in the small ventrals, which are under the base of the pectorals. No pungent points on the bones of the head and face, which are clothed with soft, thick, loose integuments. Skin of the body destitute of scales, but covered in many parts, especially along the lateral line, with small cutaneous filaments, which extend also to the head, pectorals, and dorsal. Pectorals attached differently from those of *Synanceia*. Teeth on the jaws and chevron of the vomer; none on the palatines. The second suborbitar, which traverses the cheek, is a narrow plate that descends from under the eye to the curve of the preoperculum; the preorbitar is subulate with a cartilaginous tip. One species.

Genus XXIX. Pelor, Cuv. Head as it were broken down above, with prominent orbits approximated to each other. High and almost isolated dorsal spines. No scales. Bands of fine villiform teeth on the jaws and front of the vomer; none on the palatines or tongue. Two free rays under the pectorals. The large moveable spine of the preorbitar of *Apistes* is absent, by which they are separated from the species of that genus with naked skins, but there are angular points on the preorbitar, and still more prominent ones on the preoperculum, operculum, suprascapula, and coracoid. Stomach cæcal; four thick pancreatic cæca; an air-bladder scarcely as big as a pea placed near the pylorus. Seven species.

Genus XXX. Synanceia, Bloch., Schneid. Destitute of spines on the head, which is not more compressed than that of many *Cotti*. Teeth on the jaws, but none on the *vomer or palatines*; no free rays under the pectoral, but the tips of some of the rays project considerably in some species. Mouth vertical as in *Uranoscopus*, the mandible being in front when shut; this form of the mouth, five soft rays in the ventrals, and the want of vomerine teeth, distinguish the genus from *Sthenopus*. Skin scaleless, smooth and slippery. Eyes in some lateral, though high on the head; in *S. asteroblepa* very small, and on the dorsal aspect of the head. Stomach oval, cæcal; four thick pancreatic cæca; air-bladder simple, small in the fore part of the abdomen. Twelve species.

Synancideum (Müll., Acad. Berl. 1839) is *Synanceia* with vomerine teeth. *S. trachynis* (Rich.) is an Australian species.

Genus XXXI. Aploactis, Schleg. Intermediate among the *Cotti*, *Synanceia*, *Apistes*, and *Agriopi*, resembling *Cottus* in dentition and in its ventrals, with two soft rays and one spine; *Synanceia* in the want of armature of the head and general physiognomy; *Apistes* in the compressed head and shape of the dorsal; and some *Agriopi* in its skin being studded with bristles springing from small tubercles. Two species.

Genus XXXII. Monocentris, Lacép. Very different in aspect from the other members of the family, but having the distinguishing character of the group in the suborbitar crossing the cheek to the preoperculum. Body thick and short, cuirassed by enormous rough angular and keeled scales. Four or five thick spines not connected with membrane form an anterior dorsal; ventrals having one enormous spine, and a few small, almost invisible rays in its axilla; Face bulging. Villiform teeth on the jaws and palatines; none on the vomer. Eight branchiostegals. Soft dorsal and anal opposite, and far back. One species.

Genus XXXIII. Trachichthys, Shaw. (*Hoplostethus*, Cuv.; *Hist. des Poiss.* iv., 470, and iii., 229.) Form oval, to which the tail behind the anal is to be added. Face very convex; mouth terminal, descending obliquely. Eye very large. Top of the head and cheeks cellular, from the prominence of branching bony crests, which on the cheeks radiate from the suborbitars. Operculum and disk of the preoperculum striated; a spine from the angle of the latter; a small spine terminating a ridge on the upper part of the operculum; a flat rough spine on the suprascapula, and one on the mastoid. One dorsal; ventrals under the pectorals of *six* soft rays and a spine; the soft rays of all the fins branched. Belly serrated behind the ventrals. Caudal deeply forked. Two species.

Genus XXXIV. Chirus, Stel. Pretty long compressed scaly fishes, with a small unarmed head. Scales ciliated. Cheek traversed

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by the second suborbitar, as in the other *Sclerogenidæ;* distinguished by having several (generally five) lateral lines at various heights. Mouth small. Dorsal nearly even, extending all along the back; its spinous rays slender; ventrals of five rays and a spine. No pancreatic cæca. Frequently a tufted filament on the eye-brows. Ten species. Pacific.

The genus *Stichæus* of Reinhardt (*Oversigt over det Kongelige, Danske, Vid. Sels.* &c., 1835-6) should come in here, but we have not at present access to Reinhardt's paper.

SCIÆNOIDS.

Several genera have been removed from this family as it was presented in the *Histoire des Poissons,* particularly the groups which have a lateral line broken or interrupted under the distal end of the dorsal fin. These form the *Ctenoid Labroids* in the order of Pharyngognaths already treated of. We have also associated the genera that have fewer branchiostegals than seven with the *Theraponidæ,* and *Cheilodactylus* with the *Polynemidæ.* These being removed, the remainder present a more perfect family aspect.

TABLE OF GENERA.

Two dorsals, or one dorsal deeply notched.
No mandibular barbels.
No strong canines.
Denticulated preopercula.
No large smooth rounded teeth.
Snout convex, bulging.
SCIÆNA, CORVINA, LEIOSTOMUS, JOHNIUS.
Snout not convex nor high and rounded.
LARIMUS, LEPIPTERUS
Large pavement-like teeth on the jaws.
BORIDIA, CONODON.
Preopercula not denticulated.
NEBRIS, ELEGINUS.
Strong canine teeth.
OTOLITHUS, ANCYLODON.
One or more mandibular barbels.
UMBRINA, LONCHURUS, POGONIAS, MICROPOGON.
One dorsal only.
HÆMULON, PRISTIPOMA, DIAGRAMMA.

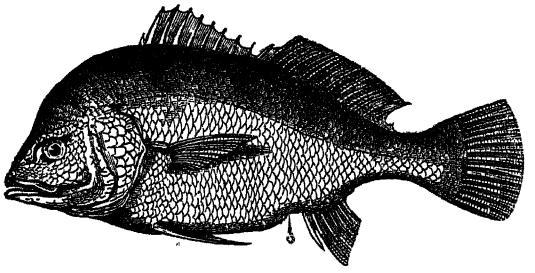


Fig. 100.
Corvina Richardsonii.

This woodcut represents a fresh-water *Corvina,* common in Lake Huron. We have, however, some suspicion of its belonging more properly to the *Theraponidæ* than to the *Sciænidæ,* notwithstanding Cuvier's weighty authority. It has only six branchiostegals.

Many members of this family have curious air-bladders with fringe-like appendages. The subjoined woodcuts represent that of *Corvina acoupa,* and of *Pogonias chromis.* One of the most remarkable of the *Sciænæ* is the *aquila,* called *Umbrina* by the Romans, and held in high esteem in the Mediterranean even at the present day. It is very rare on the British coasts. Dr Patrick Neill records one instance of its capture off Ugea in Northmavine, Shetland, in November 1819. When first seen, it caught the attention of the fishermen by its endeavours to elude the pursuit of a seal. It measured five feet four inches, and when lifted into the boat made its usual "purring sound." Mr Yarrell mentions some subsequent instances of its being taken on the Northumberland and Kentish coasts. It is much more common in the Mediterranean, and Paul Jovius says that many were taken at the mouth of rivers in the Roman states, along with Sturgeons. They swim in troops, and are said to utter at times a low bellowing sound. On one occasion, the fishermen, guided by this sound, dropt their net with such success as to secure twenty fine fish at a single cast. The noise may be heard from the depth of twenty fathoms, and is often very perceptible when the ear is placed upon the gunwale of the boat. Its tone seems to vary, as some have compared it to a dull buzzing, others to a sharp whistle. Some fishermen allege that the males alone are musical during spawning time, and that it is quite possible to capture them without any bait, merely by imitating this peculiar sound. One alluded to by Cuvier as having been entangled in a net spread along the shore at Dieppe, was at first found sleeping; but on being handled it roused itself so suddenly, and with such violence, as to precipitate the fisherman into the water, and force him to call for assistance before he could become its master. High, though of course imaginary virtues, were formerly attributed to the stones which occur in the ear of this, as of other osseous fishes. They were worn on the neck, set in gold; and Belon says they were called *colic-stones,* being renowned for the cure, and even prevention of that complaint. It was necessary, however, that they should be received as a gift,—such as were purchased being found to lose their virtue.

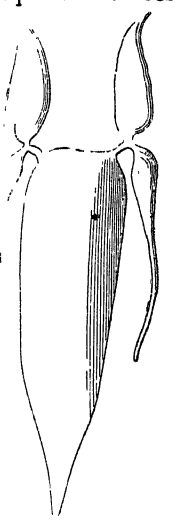


Fig. 101.
Air-bladder, *Corvina acoupa.*

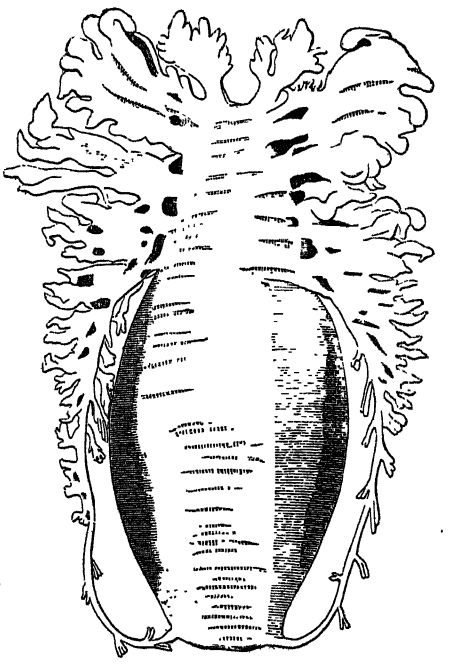


Fig. 102.
Air-bladder, *Pogonias chromis.*

The *Pogonias* grow to a great size, some of them weighing occasionally above a hundred pounds, and the singular sounds uttered by them have gained them the vulgar name of *Drums.* Mr John White, an American lieutenant, who (in 1824) published *A Voyage to the China Seas,* relates, that being at the mouth of the River Cambodia, himself and crew were greatly astonished by certain extraordinary sounds, which were heard from around and beneath the vessel. They resembled a combination of the bass of an organ, the sound of bells, and the guttural cries of a large frog, with certain tones which the imagination might

attribute to a gigantic harp. It might almost have been said that the vessel trembled at those uncertain sounds. For some time they increased, and finally formed a loud and universal chorus, the entire length of the vessel, and on either side. In proportion as they ascended the river the mysterious sounds diminished, and finally altogether ceased. The interpreter gave the information that they were produced by a troop of fishes of a flattened oval form, which possess the faculty of adhering firmly to various bodies by their mouths. A similar phenomenon was noticed by the illustrious Humboldt in the South Seas, although he was unable at the time to divine the cause. It would, as Cuvier has remarked, be an object of curious research to discover by what organ these sounds are produced. Lieutenant White need not have left his own country to become acquainted with the loud noises produced by the "Drums" or "Grunts," as *Pogonias chromis* is named in the United States. This fish, or a species similar to it in appearance and habits, abounds in the winter and spring on the coasts of Georgia and Florida, and drums so loudly on the bottoms of vessels that anchor there, as utterly to deprive the sailors of sleep, until several nights' use has accustomed them to the loud and disagreeable noise. The sound is better expressed by the word drumming than by any other, and is accompanied by a tremulous motion of the vessel. We caught several of the fish, and found them excellent food, but their tails were rejected as being full of parasitic *filaria*. It appeared to us that the uneasiness produced by these parasites might cause the fish to beat their tails against the bottom of the vessel, and that many individuals were employed in keeping up the sound which continued without the slightest intermission all the night through. The teeth of *Plectropoma dentex* have been shown by fig. 60. Fig. 103 represents a Sciænoid of the group having a single dorsal fin. This group corresponds in external appearance with the Percoids that have a single dorsal, being seemingly as much allied to them as to the typical Sciænoids with the two dorsals, and differing from the analogous Percoids chiefly by the presence of teeth on the roof the mouth, and a few pores on the mandible. The latter character, however, exists in some Percoids also.

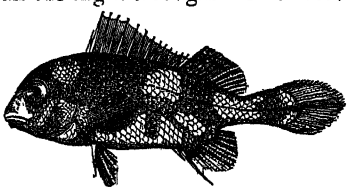


Fig. 103.
Diagramma orientale.

Family VIII.—SCLÆNIDÆ.

(*Les Sciænoïdes*, Cuv.) With many of the exterior characters of the Percoïdes, such as a spinous or denticulated operculum, a variously armed preoperculum, scaly body, a simple or double dorsal, or one deeply notched, and the same varieties in the combination of these characters, they have more or less of a peculiar family physiognomy, and differ from the Percoids in having no teeth on the vomer or palatines. The bones of the head and face are often full of muciferous cells or hollows, with external porous openings; and the face and snout are frequently gibbous. The vertical fins and parts of the head are occasionally scaly. Scales ctenoid, generally obliquely ranged. In their internal anatomy there is more variety than in the Percoids, and their air-bladders especially have branching appendages in many genera. The diagnostic characters are,—denticulations or spines on the opercular pieces; cheeks not cuirassed by the suborbitar; mouth little protractile; vomer and palatines toothless; seven branchiostegals.

(*a.*) *Two dorsals, or one deeply notched.*

Genus I. Sclæna, Cuv. Head convex, with cellular bones. Two dorsals, or one dorsal deeply notched, and the soft part much longer than the spinous one; a short anal. Preoperculum denticulated; operculum ending in points. Seven branchiostegals. Otolites larger than in most fishes, and the air-bladders large and complicated. The proper *Sciænæ* have feeble spines in the anal, and are destitute of canines and barbels. Stomach cæcal; ten pancreatic cæca or more. Four species.

Genus II. Otolithus, Cuv. *Sciænæ* also with feeble anal spines and no barbels, but having long curved teeth or *canines* among the others. Air-bladder having a horn-like projection on each side in front; four pancreatic cæca. Eighteen species.

Genus III. Ancylodon, Cuv. *Otolithes* with a very short snout, excessively long canines, and a pointed tail. Two species.

Genus IV. Corvina, Cuv. *Sciænæ* with wholly villiform teeth and no barbels, but differing from *Sciæna* and *Otolithus* in the great size of the second anal spine. Nineteen species.

Genus V. Johnius, Bloch. Considered by Cuvier to be like *Corvina* and *Otolithus*, a subdivision of *Sciæna*, and distinguished chiefly by the second anal spine being weak and shorter than the soft rays of that fin. Eighteen species.

Genus VI. Leiostomus, Cuv. *Johnii* in having a small anal spine or feeble denticulations in the preoperculum; but the teeth of the jaws so fine as to be with great difficulty seen; pharyngeal teeth pavement-like. Scales ciliated. Horns of the air-bladder smaller and more slender than in *Otolithus*. Two species.

Genus VII. Larimus, Cuv. One of several anomalous Sciænoid forms, which have characters different from those of the foregoing groups. Two dorsals. Villiform teeth. Forehead not arched; snout short; preoperculum slightly denticulated. Stomach cæcal, narrow; eleven pancreatic cæca; air-bladder large, simple. Two species.

Genus VIII. Nebris, Cuv. Sciænoids with two dorsals. Villiform teeth. Profile nearly straight; snout short; mandible ascending. Limb of the preoperculum membranous, and merely striated, and the fins all more or less scaly. One species.

Genus IX. Lepipterus, Cuv. Sciænoids with villiform teeth, prolonged snout, profile rather concave, and very scaly vertical fins. One species.

Genus X. Boridia. Cuv. *Corvinæ* with smooth blunt teeth on the jaws. One species.

Genus XI. Conodon, Cuv. Sciænoids distinguished from the others by having a row of conical teeth on the two jaws. One species.

Genus XII. Eleginus, Cuv. Sciænoids with an entire preoperculum. Mouth small. Anal long. Two short conical horns in the fore part of the air-bladder. Three species.

Genus XIII. Eques, Bloch. Resemble *Sciæna, Corvina, Johnius*, in their convex snout, scaly throughout, like the rest of the head; in the mucous pores and pits of the lower jaw; in the upper jaw being able to retire under the edge of the preorbitar; in the length of the second dorsal, and the shortness of the anal, both of them scaly as well as much of the caudal. Teeth villiform, and not elongated like those of the *Chætodons*. In *Eques* the body is compressed, and by the convexity of the nape assumes a cuneiform outline. Branchiostegals seven. Faint crenatures on the preoperculum; the bony frame of the operculum ends in two flat points. The first dorsal is high and peaked with mostly flexible rays; second dorsal low and long; caudal rhomboidal; ventrals longer than the pectorals. A small membrane in front of the snout, with a pit on each side between it and the high preorbitar. A small pore beneath the mandible on each side of the median line. A large silvery air-bladder; cæcal stomach; four pancreatic cæca. Three species.

Genus XIV. Umbrina, Cuv. Sciænoids having one barbel under the mandibular symphysis. Thirteen species.

Genus XV. Lonchurus, Cuv., Bloch. *Umbrinæ* with two mandibular barbels and a pointed caudal. Two species.

Genus XVI. Pogonias, Lacép. *Umbrinæ* with many small mandibular barbels. Lower pharyngeal teeth and middle upper ones large like those of *Labrus*. Two species.

Genus XVII. Micropogon, Lacép. Sciænoids with a prominent nape like *Corvina*. Moderate-sized anal spine, and very small and numerous barbels. Distinct denticulations on the ascending limb of the preoperculum, those at the angle being larger; operculum ending in two flat points. Membrane at the end of the snout four-lobed. Mouth moderately protractile; pretty broad bands of villiform teeth; pharyngeal teeth villiform, the middle ones being larger, with obtuse summits. Under the mandible at the symphyses two large pores and three small ones; three or four little barbels attached to the limb of the mandible. Scales slightly rough and oblique as in the Sciænoids in general. Dorsal spines not very strong; slender ventral spine, and the anal spine shorter than the soft rays; caudal nearly even at the end. Three species, America.

(*b.*) *A single dorsal; preoperculum always denticulated.*

Genus XVIII. Hæmulon, Cuv. Body oblong, pretty high anteriorly, somewhat compressed. Profile descending almost in a straight line, and forming a snout that projects tolerably. Preorbitar large, but not denticulated, covered with skin and scales, joining the cheek as in the *Sciænæ* in general, and forming a ledge under which the moderately protractile upper jaw retires. Lips fleshy. Mandible articulated under the eye, having an oval pit

Classification—Acanthopterous Fishes.

under the symphysis, and two small pores in advance of it. Villiform teeth on the jaws, with some bigger than the rest in the outer row (but much less so than in *Dentex*, which, moreover, has an entire preoperculum). Operculum ending in two flat obtuse angular projections, which do not show through the membrane; and the gill-cover is sometimes quite rounded. Palate without teeth; tongue smooth and free. Seven branchiostegals, the last three slender. No denticulations on the suprascapula. A triangular scaly appendage in the axilla of the ventrals; dorsal moderately notched; caudal forked, and covered with small scales like those on the soft parts of the dorsal and anal. Scales of the body large, finely ctenoid; none on the lips or snout before the eyes. Stomach cæcal, small, and pointed; seven pancreatic cæca; a long simple air-bladder. Fourteen species.

Genus XIX. Pristipoma, Cuv. Resembling *Hæmulon* in most characters, and in the mandibular pores, but having a more bulging snout, smaller mouth, less moveable mandible, and *no scales on the dorsal or anal.* Operculum ending in a smooth point, hidden under the skin. Villiform teeth, with the exterior row generally stronger. (Distinguished from *Diagramma* by the latter having four or six large pores on the mandible, and from *Lobotes* by the presence of mandibular pores and of seven branchiostegals.) Forty species.

Genus XX. Diagramma, Cuv. Wants the symphysial pit on the mandible, which exists in *Pristipoma*, but has the two small pores, and in addition, two large pores on each limb of the bone. Fins as in *Pristipoma*, together with the denticulated preoperculum, and the operculum destitute of a spine. Twenty-two species.

Genus XXI. Prionodus, Jenyns. Aspect of *Serranus*, but without the palatine and vomerine teeth. It enters the group of *Hæmulon*, *Pristipoma*, and *Diagramma*, from all of which it is distinguished by the want of pores under the mandibular symphysis.

Genus XXII. Pristipomoides, Bleek. Single, undivided, dorsal fin. Branchiostegals seven. Dorsal and anal without scales; caudal scaly. No conspicuous mandibular pores. Lateral jaw teeth uniserial; anterior ones pluriserial; the internal ones minute and setaceous; the external row formed of two to four larger conical canines. Preoperculum denticulated. Sumatra.

Genus XXIII. Cheilotrema, Tschudi. Upper lip protractile, with eight pores. Mandible with five pores. Operculum toothed; preoperculum having two spines. Peru.

SPAROIDS.

The *Histoire des Poissons* contains the following table of the genera:—

TABLE OF GENERA.

Teeth in part conical or molar.
Cheeks scaly.
Sargus, Charax, Chrysophrys, Pagrus, Pagellus, Dentex, Pentapus.
Cheeks scaleless.
Lethrinus.
Teeth wholly villiform.
Cantharus.
Trenchant teeth, no molars.
Box, Oblata, Scatharus, Crenidens.

By their dentition they may be arranged in tribes in the following order:—

Tribe I.—*Round molars and trenchant front teeth.*
Sargus, Charax, Chrysophrys, Pagrus, Pagellus.
Tribe II.—*Conical teeth with canines.*
Lethrinus, Dentex, Pentapus.
Tribe III.—*Teeth all villiform.*
Cantharus.
Tribe IV.—*Trenchant jaw teeth, with or without villiform bands.*
Box, Oblata.

The *Sargi* in general feed on shells and the smaller Crustacea, which they easily crush with their molar teeth, but Cuvier found fuci in the stomachs of some brought from the Red Sea and the Atlantic. Ælian and Oppian inform us that the male is polygamous, and fights with great fury with his own sex for the possession of many females. The same authors attribute to it a feeling still more extraordinary,—a lively passion for goats, which it exhibits by always swimming with great rapidity towards those animals, and indulging in playful gambols before them. So blind was this passion, that a fisherman (it was so alleged) might catch as many as he pleased by disguising himself with the skin and horns of a goat, and scattering in the water flour steeped in goats' broth.

Classification—Acanthopterous Fishes.

The best-known species inhabits the Mediterranean. It is the *S. Rondeletii* of Cuv. The American shores produce several others, one of which (*S. ovis*) is called the *Sheep's-head* by the Americans. Dr Mitchell speaks in the most eulogistic terms of the superexcellence of its flesh, and of the high esteem in which it is held at the tables of New York. It yields in his opinion to few fishes, and is worthy of being served at the most sumptuous entertainments. The price varies from a dollar to a dollar and a half for a middle-sized individual, and above that size the price ranges even so high as from L.4 to L.7 sterling. They sometimes weigh from 14 to 15 lbs. The fishery of this species forms an object of importance along the coasts of the state of New York. It approaches those of Long Island in the hot season from the month of June till the middle of September, after which it seems to seek retirement in the deep abysses of the ocean. As they swim in troops, they may be advantageously fished for with the net, and many hundreds are sometimes taken at a single cast. With the great nets used at Rayner Town, and the two islands, thousands are drawn ashore. They are immediately packed in ice, and despatched during the cool of the night to the markets of New York. It is difficult to take the *Sheep's-head* with a line, because it contrives to snap the very hooks asunder with its cutting teeth.

The species of *Chrysophris* are numerous, and extended through many seas. Those of the Mediterranean are only two in number, and are called *Daurades* by the French, no doubt from the Latin *Aurata*, a term applied to them by ancient authors. The Greeks named them Chrysophris, which signifies golden eye-brow, in allusion to the brilliant spot of gold which the common species bears between its eyes. That the *Aurata* of the Latins was identical with the *Chrysophris* of the Greeks, may be inferred from a passage in Pliny, which is obviously borrowed from Aristotle, and where the former word is used as the translation of the latter. According to Columella, the Aurata was among the number of the fishes brought up by the Romans in their *vivaria;* and the inventor of these vivaria, one Sergius Orata, is supposed to have derived his surname from the fish in question. Ælian tells us that the Chrysophris is the most timid of all fishes, and that branches of poplars planted in the sand so terrified a party of these fishes which had been carried upwards by the flood, that in the succeeding reflux they did not dare to pass the poplars, but allowed themselves to be taken by the hand. The *Chrysophris aurata*, or *Gilthead*, seldom quits the vicinity of the shore, and grows extremely fat in the salt ponds. We owe to Duhamel whatever information we possess regarding its habits. The fishermen informed that author that it agitates the sand forcibly with its tail, so as to discover the shell-fish which may lie beneath concealed. It is extremely fond of mussels, and its near presence is sometimes ascertained by the noise which

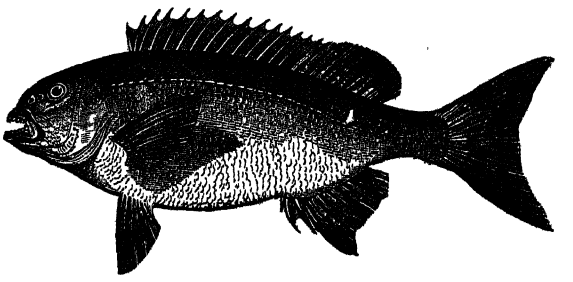


Fig. 104.
Crenidens tephræops.

it makes while breaking their shells with its teeth. It greatly

dreads cold, and many were observed to perish during the severe winter of 1766. The Gilt-head is a British species, but of extremely rare occurrence.

The *Dentex vulgaris*, a fish of a silvery hue, shaded into blue upon the back, with reddish pectoral fins, and sometimes attaining to the weight of 20 lbs., has occurred upon the Sussex coast. The specimen figured by Donovan (pl. 73) was obtained in Billingsgate market.

Fig. 31 represents a scale of *Lethrinus cynocheilus*, and may give some idea of the general character of a Sparoid scale, alluded to in the table of genera at the bottom of the page.

Family IX.—SPARIDÆ.

Sparoid scales; a large elongated scale in the axilla of the pectoral. Gill-cover shining, without proper spines or denticulations. Maxilla capable of being received in part under the preorbitar scale bone, which is generally high. Spinous rays of the dorsal and anal fins bare, mostly lodging in a furrow; pectoral and ventral fins sharp pointed; caudal fin notched in an angle at the end. The Sparoid scales are generally thin, broader than long, and the centre of growth is near the posterior border, the lines being parallel to the anterior border, and becoming straight laterally. Their peculiar structure is described more fully in Agass. *Poiss. Foss.* i., p. 86, and in Troschel's *Arch.* for 1849, p. 382. Snout not projecting nor protractile, destitute of palatine teeth, and distinguished from the Sciænoids by the want of any denticulations or armature of the gill-covers, and of cavernous or cellular structure in the cranium; from the *Chætodontidæ*, by the want of scales on the vertical fins; and by the size and nature of the scales from the *Scomberidæ* (*Hist. des Poissons*). Branchiostegals generally six, sometimes five, rarely seven.

(*a.*) *Round molar teeth, with trenchant or conical front ones.*

Genus I. Sargus, Cuv. Several rows of molars; incisorial front teeth. Cheek scaly. Sixteen species.

Genus II. Charax, Risso. One row of very small molars almost granular; incisorial front teeth. Cheek scaly.

Genus III. Chrysophrys, Cuv. Several rows of rounded molars; front teeth conical. Cheek scaly. Twenty-four species.

Genus IV. Pagrus, Cuv. Rounded molars in two rows; front teeth conical, with a villiform card-like band behind them. Cheek scaly. Fifteen species.

Genus V. Pagellus, Cuv. Two or more rows of rounded molars; front teeth villiform. Cheek scaly. Twelve species.

(*b.*) *Teeth conical, with larger ones, or canines.*

Genus VI. Lethrinus, Cuv. Teeth villiform, mixed with long curved ones, and occasionally one or two rounded molars. Cheek naked (without scales). Twenty-eight species.

Genus VII. Dentex, Cuv. At least four large canines among villiform or card-like teeth. Cheek scaly. Thirty species.

Genus VIII. Pentapus, Cuv. Cheek scaly. Teeth villiform, with only two canines; mouth small. Caudal more scaly than in *Dentex*. Eight species.

(*c.*) *Teeth all villiform.*

Genus IX. Cantharus, Cuv. Villiform teeth, the exterior ones stronger. Twelve species.

(*d.*) *Trenchant teeth without molars, sometimes accompanied by villiform bands, sometimes without them; no rounded molars.*

Genus X. Box, Cuv. A single row of thin vertical teeth notched or crenated on the edge. Six species.

Genus XI. Oblata, Cuv. Crenated cutting teeth as in *Box*, with a villiform band behind them. Two species.

Genus XII. Boxaodon, Guich. Body elongated, roundish, covered with small scales. Snout short; mouth small, not protractile. No teeth whatever. Opercular bones not denticulated nor serrated. Eyes large. Dorsals two, with many free spines between them; ventral fins minute, situated on the thorax. Branchial openings wide; branchiostegals six. Valparaiso.

Genus XIII. Scatharus, Cuv. Cutting teeth not crenated in a single row. One species.

Genus XIV. Crenidens, Cuv. (*Girella*, Gray; *Melanichthys*, Schleg. *Fauna Jap.*) Oval scaly fishes, with a nearly even dorsal having many spinous rays. Convex profile; terminal small mouth and head wholly unarmed. Ventrals consisting of a spine and five soft rays under the pectorals. Scales ctenoid, in some covering all the head except the disk of the preoperculum, mandible, and lips, in other species have more or most of the opercular pieces scaleless; narrow vertical bands of scales exist on the fins in some species, but are easily deciduous. Teeth compressed, curved, crenated with three or more disks, rarely entire, forming two rows on the jaws, and separated by a furrow from an interior band of minute teeth appearing to be granular, but when examined with a lens showing the same forms with the exterior older ones which they are destined to succeed. Vomer and palate generally toothless. In *C. simplex*, a species with *entire* incisorial teeth, the vomer is furnished with a patch of minute teeth invisible to the naked eye, and there is a similar plate on the front of the palatines. Pharyngeal teeth small, short, subulate, and densely crowded. Branchiostegals six. Six species.

Classification—Acanthopterous Fishes.

Mænoids.

This family is distinguished from the Sparoids by the protractility of the mouth, and by a greater thickness of the face and of the body generally. The Mediterranean species were known to the ancients, and their Greek name is Latinized by Pliny to *Mæna*, and adopted by Cuvier as a generic term. They are mostly small fishes, despised by the ancients, and held in no great esteem now.

> "Fuisse gerres aut inutiles mænas,
> Odor impudicus urcei fatebatur."
>
> Martial.

The following table of the genera is from the *Histoire des Poissons*, the source from which our observations generally are drawn:—

Table of Genera.

Mænides. Form sparoid, but having occasionally teeth on the palate, or denticulations on the preoperculum. Mouth in all cases very protractile.

No scales on the dorsal fin.
Mæna, Smaris.

Scaly dorsal.
Cæsio, Gerres.

The other genera are characterized by ichthyologists who have written subsequently to the publication of the volume of the *Histoire des Poissons*, which contains the *Mænidæ*. The genus *Emmelichthys* is one of those which combines

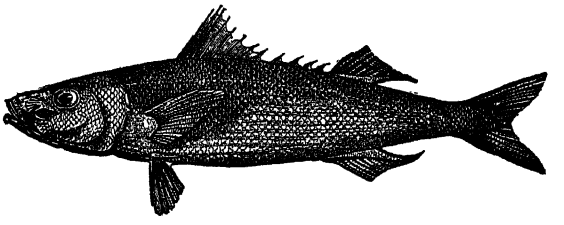


Fig. 105.
Emmelichthys nitidus

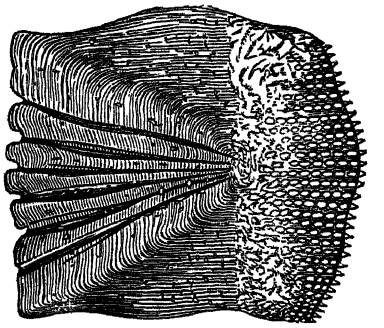


Fig. 106.
Scale of *Emmelichthys nitidus*.

the characters of several groups. It has much affinity to

Cæsio, but differs in having *seven* branchiostegals, a deeply and widely notched dorsal, approaching more nearly to two dorsals than *Gerres*, scaly sheaths to the vertical fins of a different character from the scales that invest the fins in these two genera; and the snout, gill-covers, and maxillaries more strongly and more completely scaly. It is not without a resemblance to several of the genera assembled under the head of *Theraponidæ*. To *Glaucosoma* it approaches in the extent of scaliness of the head and fins, but differs greatly in aspect, dentition, branchiostegals, and especially in its protractile mouth. From the typical *Percæidæ*, with which it agrees in having seven gill rays, it is kept distinct by its unarmed head; the want of mandibular pores will not allow it to associate with *Hæmulon*, *Pristipoma*, or *Diagramma*; and it bears little resemblance in its sparoid scales to the oblique-scaled typical *Sciænidæ*, from which also its elongated face distinguishes it. The want of teeth is a character which it has in common with *Boxaodon* and *Macquaria*, but the latter has only five branchiostegals. It is a genus recently discovered in the Japanese and Australian seas. Fig. 18 shows the protractile mouth of *Emmelichthys nitidus*, with the scales on the maxilla; Fig. 105 gives a figure of the entire fish, and Fig. 106 represents one of the scales.

Concerning the PSEUDOCHROMIDÆ we have almost nothing to say. The genera are not described in the *Histoire des Poissons*, and but little is contained in the *Regne Animal* concerning them. Indeed, a brief notice of the names of the genera composing the family given in the *Archiven für Naturgeschichte*, is our only authority for introducing it here. In the *Regne Animal*, *Plesiops* and *Cichlops* were placed among the Labroids, but M. Valenciennes states, in 1839, that having studied at Leyden the fish sent from Java, by Kuhl and Van Hasselt, he was convinced that the *Plesiops* and *Cirrhipteri* of these naturalists could not remain in the Labroid family. Willughby had already noticed the existence of two small pancreatic cæca in *Chromis* (*Sparus chromis*, Linn.); and M. Valenciennes finds it to agree so nearly with *Plesiops*, as not to be generically distinct. Their teeth, the interrupted lateral line, constitution of their scales, and the filaments of the spinous dorsal rays are alike in both. Cuvier, in stating that the Chromides had no pancreatic cæca, had in view the *Bolti* or *Labrus niloticus*, which, in fact, wants these organs. In conclusion, M. Valenciennes is inclined to place the genera in question with the *Glyphysodons* and their allies. Müller, finding a coalesced pharyngeal in *Chromis*, has introduced it as the type of a family among the *Pharyngognathi*, referring the *Pseudochromidæ* to the *Acanthopteri*.

FAMILY X.—MENIDÆ.

Les Menides, Cuv. Distinguished from the *Sparidæ*, which they resemble, by the protractility of the mouth. Villiform teeth on the jaws more or less short. Premaxillary pedicels long, admitting of the body of the bone being thrust out horizontally when the mandible is long in proportion, but when that bone is abbreviated then downwards. Some genera want teeth on the palate, others have small ones on the vomer. Body scaly. Ventrals situated under the pectorals; dorsal furnished with very fine scales. Stomach of moderate size; pancreatic cæca varying from four to seven; air-bladder large, simple, and rounded anteriorly, divided for the most part into two pointed lobes posteriorly.

GENUS I. MÆNA. Cuv. Aspect of a Sparoid, but occasionally having teeth on the palate, and a denticulated preoperculum. Mouth invariably very protractile. Four species.

GENUS II. SMARIS, Cuv. No scales on the dorsal. Palate toothless. General form of *Mæna*. Ten species.

GENUS III. CÆSIO, Cuv. Mouth but little protractile. Dorsal far back, and in a great part covered with scales. General shape inclining to fusiform. Twelve species.

GENUS IV. GERRES, Cuv. Mouth very protractile, descending when thrust out. Dorsal capable of being concealed in a basal scaly sheath. Small villiform teeth on the jaws, none on the palate. Preoperculum finely denticulated. Body compressed, elevated. Scales large, deciduous. Ventrals under the anterior third of the pectorals. Twenty species.

GENUS V. EMMELICHTHYS, Rich. (*Erythrichthys*, Schleg.) Form of the body that of *Smaris* or *Cæsio*. Dorsal more deeply notched than that of *Gerres*, the last two or three spinous rays being almost detached. Very slender setaceous pharyngeal teeth; none on the mouth. Jaws moderately protractile directly forwards. Head and body, and bases of the vertical fins, scaly. Scales ctenoid. No spines on the head. Preoperculum and suboperculum very minutely crenulated. Suprascapula irregularly dentate. Branchiostegals seven. Two species.

GENUS VI. DITREMA, Schleg. Jaw teeth minute, pluriserial, with a few conical ones in front; no vomerine or palatine teeth. Snout a horizontal protractile tube. Opercular pieces and suborbitar scale bones not denticulated. Dorsal single, low; anal and genital apertures apart; anal fin having three spines and numerous simple rays. Branchiostegals six.

GENUS VII. DIPTERYGONOTUS, Bleek. No teeth on the maxillaries, vomer, or palatines. Opercular bones not denticulated, there being a single flat spine on the operculum only. A horizontally protractile tubular mouth. Dorsal fins two, remote, not scaly. Cheeks scaly. Branchiostegals seven. Macassar.

GENUS VIII. APOGENOIDES, Bleek. Setaceous maxillary teeth; no teeth on the vomer or palatines. Opercular bones not toothed; no opercular spine. Mouth little protractile. Dorsal two, remote, not scaly. Branchiostegals six. Macassar.

GENUS IX. MENDOSOMA, Guich. Body oblong, compressed, scaly, with the aspect of *Mæna*. Head small; mouth protractile, with a very small opening; many conical teeth near the premaxillary symphysis only, none on the mandible or vomer. Dorsals two, contiguous, or one fin notched to its base. Ventrals thoracic, destitute of the long acute scales. Branchiostegals six. Valparaiso.

GENUS X. PENTAPRION, Bleek. Dorsal solitary. Mouth protractile downwards; teeth on the jaws only. Spinous anal rays five. Branchiostegals six. Batavia.

GENUS XI. VELIFER, Schleg. Near *Cæsio and Gerres*. Body very high and compressed. Dorsal and anal fins excessively large, and supported by soft, thick, unjointed rays. Japan.

GENUS XII. ACHARNES, Müll. and Trosch. Distinguished among the *Menidæ* by the interrupted lateral line. Teeth on the jaws card-like; no palatine teeth. Protrusive mouth. Five branchiostegals. Dorsal deeply notched; dissevered pharyngeals. No armature on the gill-cover or properculum; no accessory gills.

GENUS XIII. APHAREUS, Cuv. A genus of uncertain affinities, and placed by the authors of the *Histoire des Poissons*, after the *Menidæ*, merely because no more fitting position occurred to them. They were acquainted only with a dried specimen which seemed to have some resemblance to *Cæsio*, but differed from it in having an obtuse gill-cover and large mouth with an elevated ray at the ends of the dorsal and anal fins. A very narrow band of villiform teeth on the jaws. Palate smooth, but the vomer projecting and producing two rounded eminences. No scales on the forehead, the lips, or jaws; but the cheeks, gill-cover, and top of the head scaly. *Seven branchiostegals.* Suprascapula denticulated. Ventrals attached a little behind the base of the pectorals. One species.

GENUS XIV. CHÆTOPTERUS, Schleg. Comes nigh to *Aphareus* in habit, but is furnished with vomerine teeth, and possesses four branchiostegals.

FAMILY XI.—PSEUDOCHROMIDÆ, Müll. and Trosch.

Scaly fishes. Dorsal fin long. Jaw and palatine teeth; no armature of the opercular bones; interrupted lateral line; double under pharyngeals and hackle-formed pharyngeal teeth. Six branchiostegals; pectinated accessory gills.

GENUS I. CICHLOPS. Müll. and Trosch. Generic characters of *Pseudochromis*, only the card-like (or hackle-formed) teeth of the palatines are wanting; there is a row of vomerine teeth. The stomach is cæcal, the cæcal part short; pancreatic cæca absent; swim-bladder simple.

GENUS II. PLESIOPS, Cuv. Aspect of *Chromis*. Eyes approximated. Ventrals very long.

GENUS III. PSEUDOCHROMIS. Rüpp.

LABYRINTHIBRANCHS.

The peculiar structure of the pharyngeals in this family, by which a quantity of water can be retained in their complicated folds, is compared by Cuvier to the leaflets of a camel's paunch. The apparatus is covered by convex gill-covers that fit closely to the shoulders; so that even when the fish is out of the water the inclosed liquid cannot eva-

porate quickly, but remains falling drop by drop on the *branchiæ*, and keeping them sufficiently moist to carry on the oxygenation of the blood. In conformity with this specialty in the form of these organs, is the known habit of all the members of the family whose mode of life has been ascertained of issuing at times from the rivers and ponds, and travelling overland to considerable distances. We have mentioned in a preceding page the habit of the Siluroid *Doras* of travelling in bands from one pond to another as they dry up in succession by the heat of the sun, but they do not possess any peculiar branchial reservoir like the *Labyrinthibranchs*, or *Anabasidæ*, as this family is often called.

The roundness of the sides of the head caused by the convexity of the gill-covers, and the breadth necessary for lodging the branchial apparatus, gives a good deal of the aspect of a Mullet to this family. This likeness, and the general character of these curious fishes, was known to the ancients. Theophrastus, in his treatise *De Piscibus in sicco viventibus*, says that in India there are certain little fishes which leave the rivers for a time and return to them again, and that they resemble the fishes named by the Greeks

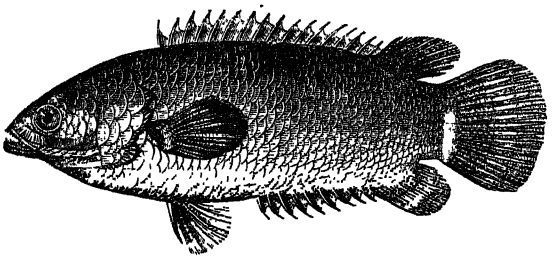


Fig. 107.

Anabas scandens.

Myxinos, or the Mullets. In 1797, M. de Daldorf, in a memoir communicated to the Linnean Society of London, mentions that in 1791 he had himself taken an *Anabas* in the act of ascending a palm tree (*Borassus flabelliformis*) which grew near a pond. The fish had reached the height of 5 feet above the water, and was going still higher. In the effort to do this it held on to the bark of the tree by the preopercular spines, bent its tail, and stuck in the spines of the anal; then released its head, and, raising it, took a new hold with the preoperculum higher up. The fish is named in the Malay language the "Tree-Climber." The fishermen keep these fishes five or six days in dry vessels, and carry them more than 150 miles to the Calcutta market. As the *Anabas* is often met at a great distance from any water, it is frequently reported by the natives of India to have fallen from the sky. The jugglers carry them about to amuse the people, and another of the family is reared for sport in the kingdom of Siam. It is the *Macropodus pugnax* of Cantor. "When the fish is in a state of quiet its dull colours present nothing remarkable; but if two be brought together, or if one sees its own image in a looking-glass, the little creature becomes suddenly excited, the raised fins and the whole body shine with metallic colours of dazzling beauty, while the projected gill-membrane, waving like a black frill round the throat, adds something of grotesqueness to the general appearance. In this state it makes repeated darts at its real or reflected antagonist. But both, when taken out of each other's sight, instantly become quiet. This description was drawn up in 1840 at Singapore, by a gentleman who had been presented with several by the King of Siam. They were kept in glasses of water, fed with larvæ of mosquitoes, and had thus lived for many months. The Siamese are as infatuated with the combats of these fishes as the Malays are with their cockfights; and stake on the issue considerable sums, and sometimes their own persons and families. The license to exhibit fish-fights is farmed, and brings a considerable annual revenue to the King of Siam. The species abounds in the rivulets at the foot of the hills of Penang. The inhabitants name it *Pla kat*, or the "Fighting-fish;" but the kind kept specially for fighting is an artificial variety cultivated for the purpose" (Cantor). The *Trichopodus trichopterus* is also very pugnacious; and the exquisite beauty of its varying iridescent metallic tints make it a great acquisition to garden tanks. The *Tr. nobilis* inhabits the rivers of Sikkim, in northern Bengal.

Classification—Acanthopterous Fishes.

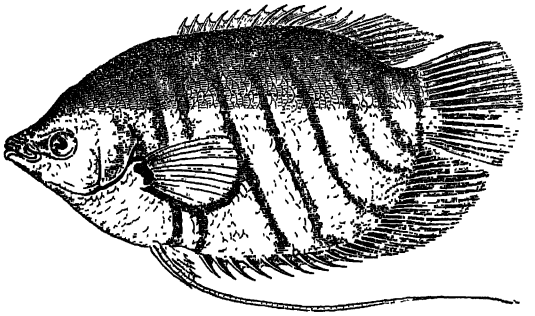


Fig. 1.

Osphromenus olfax.

The *Osphromenus olfax* is well known in Batavia under the name of *Gourami*, for its excellent flavour when brought to table. It attains the size of a large Turbot, and Commerson relates that he had never eaten anything more savoury and delicious, neither among fresh-water fish nor among marine ones. He adds, that the Dutch residents in Java rear this fish in large jars, renewing the water daily, and feeding it wholly on river plants, especially the *Pistia natans*. But M. Dupetit-Thouars declares that he saw those kept in a stew crowding to the mouth of a drain to feed on human excrement. The *Ophicephali* are very tenacious of life, and the Chinese bring them to market yet alive, though their entrails have been removed, and sell them in slices. When the irritability of the flesh is so much exhausted that it no longer quivers under the knife, its value is greatly depreciated. This Chinese practice, however much it may shock the feelings when described, is not worse than

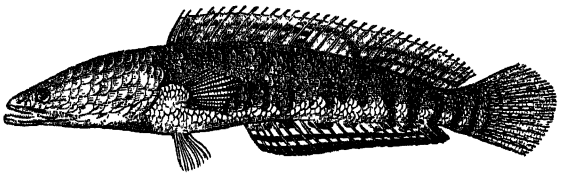


Fig. 109.

Ophicephalus striatus.

the crimping of Cod on the London fish-stalls. The *Ophicephalus marginatus*, Cuv. (*gachua* of Buchanan) is often seen travelling among wet grass in the beginning of the rainy season.

Family XII.—Labyrynthibranchidæ.

Poissons a pharyngiens labyrinthiformes, Cuvier; *Labyrinthibranchii*, Owen; *Anabantidæ*, Cantor. Upper pharyngeal bones furnished with leaf-like folds, inclosing cavities capable of retaining water. Gill-covers convex, and fitting tightly to the shoulder. Scales large, those on the head scarcely inferior in size to those on the body. Body in most rather elongated, in some an oblong oval. Mouth, cleft past the eye in one genus only, in most little more than half way to the eye, in all terminal. Gill-membrane generally shut up under the scales. Ventrals sometimes without a spine, of from one to five or six soft rays, generally under the pectorals, sometimes farther forward. Lateral line interrupted or continuous, curved, deflexed, or straight.

Classification—Acanthopterous Fishes.

ANALYTICAL TABLE OF THE *ANABASIDÆ* (Dum.)

Fin-rays much prolonged.
In the ventrals only.
A solitary one.
Dorsal short ....TRICHOPUS 9.
Dorsal long ....COLISA 6.
Several, one of them very long .....OSPHROMENUS 8.
In all the fins, except the pectorals .....MACROPODUS 7.
Fin-rays not elongated.
Palate toothless.
Opercula and subopercula acutely toothed ANABAS 1.
Opercula and subopercula not toothed.
Teeth on the lips .....HELOSTOMA 2.
Teeth on the jaws .....POLYACANTHUS 3.
Teeth on the palate.
Dorsal with spinous rays .. ..SPIROBRANCHUS 10.
Dorsal without spinous rays .....OPHICEPHALUS 11.

GENUS I. ANABAS, Cuv. Preorbitar, operculum, suboperculum, and interoperculum serrated, or strongly denticulated; preoperculum smooth-edged and not visible, being covered with the suborbitars and scales. Form anteriorly elliptical. Mouth small, terminal. Maxillary slender, and retiring under the narrow serrated preorbitar; the rest of the suborbitars, large and flat, cover the cheek, temples, and preoperculum. Many pores on the head and mandible. Villiform teeth on the jaws, the outer ones a little stronger; none in front of the vomer or on the palatines, but far back on the vomer among the three superior pharyngeals there is a group of teeth; pharyngeal teeth crowded, conical, and pretty large. Branchiostegals six. Dorsal and anal nearly of equal height throughout. Lateral line broken under the last two dorsal spines, recommencing two scales lower. Scales large, hard, and strong. Stomach small; pancreatic cæca few; air-bladder forked behind, its points filling recesses on the sides of the tail. Two supplementary upper pharyngeals, complicated for holding water. One species.

GENUS II. HELOSTOMA, Kuhl and Van Hass. Mouth small, compressed, and protractile, seeming to issue from, and recede under the preorbitar. Teeth seated in the lips. Branchiostegals five. Pharyngeal complications very curious.

GENUS III. POLYACANTHUS, Kuhl and Van Hass. Named because of the numerous dorsal and anal spines. Distinguished from *Helostoma* by the jaws being armed with teeth; from *Anabas* by the absence of denticulations on the operculum; and from *Colisa* by the existence of five soft rays in the ventrals. Stomach small, cæcal, placed vertically across the long axis of the fish; pyloric cæca two; air-bladder of moderate size. Three species.

GENUS IV. CTENOPOMA, Pet. Gill-cover with two crescentic notches, and three pectinated toothed lobes. Teeth on the vomer and palatines. Many spines in the dorsal and anal fins.

GENUS V. BETTA, Bleek. Teeth on the premaxillaries, maxillaries, and mandible. Palate smooth; mouth small. Opercular pieces and suborbitar scale-bones not serrated nor denticulated. Branchiostegals six. A small spine in the dorsal, anal, and ventrals; the other rays jointed, and flexible; short dorsal opposed to the long anal; ventrals under the pectorals. Java, 1500 feet above the sea.

GENUS VI. COLISA, Cuv. Body oblong, elliptical, compressed. Back and belly equally curved. Dorsal and anal long, the soft portions conical; ventrals before the pectorals, of one long, filiform, soft ray, without any membrane. Preorbitar pectinately toothed. Anus situated before the middle of the fish. Branchiostegals five. Scales ciliated. Stomach small; intestinal canal rolled up in a spiral; two pancreatic cæca. Ten species.

GENUS VII. MACROPODUS. (*Ctenops*, M'Clell.) Pharyngeal apparatus much as in *Colisa* and *Polyacanthus*. Anal long; its soft part and the dorsal also ending in a long tapering point; ventrals consisting of a spine and five articulated rays, the first a long simple filament, the others branched. Branchiostegals four. Two species.

GENUS VIII. OSPHROMENUS, Comm. Distinguished from *Polyacanthus* and *Colisa*, chiefly by the shortness of the dorsal and the more complicated upper pharyngeal leaflets. Ventrals situated a little behind the pectorals, of a moderate spine, and five articulated rays, the first of which is simple and very long. Branchiostegals six. Stomach cæcal, shaped like a retort; pancreatic cæca two, pretty long; air-bladder simple. Three species.

GENUS IX. TRICHOPUS, Lacép. (*Trichogaster*, Schneid.) Differs from *Osphromenus* in having a more convex profile, and an abbreviated dorsal of five spines only. Lateral line having a slightly sigmoid curvature. Anal long, with many small scales along its base; five ventral rays, one elongated. One species.

GENUS X. SPIROBRANCHUS, Cuv. The labyrinthiform pharyngeals less complicated than in other genera; approaching *Anabas* in form, and in the comparative fewness of the anal spines, but leading to *Ophicephalus* by its possessing palatine teeth. Stomach cæcal; two pancreatic cæca; no air-bladder. One species.

Classification—Acanthopterous Fishes.

GENUS XI. OPHICEPHALUS, Bloch. Resembling a snake somewhat in their elongation, and in their depressed but rounded head being covered with large scales. Acanthopterygians merely in having an anal spine, the other fins being destitute of spinous rays. They are distinguished from other Acanthopterygian fish with thoracic ventrals in the cranium and face being covered, as in the *Mullidæ* and *Anabas*, with polygonal scales or plates. Body elongated, nearly cylindrical anteriorly, somewhat compressed posteriorly. Head more or less depressed, a little wider than the body. Dorsal extending far along the back; caudal rounded. Lateral line continuous. Jaws, vomer, and palatines furnished with villiform or card-like teeth, some of them longer than others. Branchiostegals five. Ventrals with a spine and five soft rays. Stomach cæcal, long, and obtuse; intestines rather short; pancreatic cæca two. Twenty species.

MUGIL FAMILY.

The English name of Mullet, applied both to the *Mulli* and *Mugiles*, is apt to occasion some misapprehension; and we have therefore, in our notice of the *Mullidæ*, spoken of them always as *Surmullets*, an appellation hitherto proper to one species only. The two French names of *Muges* and *Mulles* are not so liable to be confounded. Cuvier traces the name from the Spanish *Mugel*, where the *g* sounds in the Castilian dialect like the Scottish or Irish aspirated *h*. This is softened on the shores of Biscay to *Meuille*, whence the English Mullet. They are mentioned by Aristotle and others of the ancient authors by the names of *Chalones* or *Chelones*, *Myxon*, *Kephalos*, *Spheneus*, and *Kestreus*. *Cefalo* remains in use at Naples to designate a species. There has been much confusion among British ichthyologists with respect to the proper application of the specific names to the species that frequent the British seas, but Mr Yarrell has thrown a flood of light on the obscurity by his excellent figures. Mr Yarrell, say the authors of the *Histoire des Poissons*, has given a charming figure of our *Capiton* (*Mugil capito*, Cuv.) on page 200 of his first volume, under the name of the Grey Mullet; and at page 207 a figure not less good of *Mugil chelo;* and a third distinct species of a different aspect, named by him *Mugil curtus*.

The *Mugil cephalus*, or Mediterranean Grey Mullet, is distinguished from the English species by its eyes half covered by two adipose veils adherent one to the anterior and the other to the posterior margin of the orbit, and by the peculiar concealment of the maxillary bone, which, when the mouth is closed, is completely hidden beneath the preorbital. The base of the pectoral fin is surmounted by a long carinated scale. This is the best and largest of the Mediterranean kinds. It weighs about 10 or 12 lb., and does not appear to have been yet detected in the seas or estuaries of Britain, nor along the oceanic shores of France. It is very common on the coast of Spain, especially around the island of Iviça, where the fishermen are said to recognise two varieties under the names of *Mugil* and *Lissa*. When surrounded by a net, it endeavours, and often successfully, to effect its escape, by leaping over the edges into the open sea.

"Its hearing is very fine, as has been noticed by Aristotle, and it feeds on worms and small marine animals; but it is doubtful, though it has been advanced, that it can live on vegetable substances. It appears to be of a stupid character, a fact which was known in the time of Pliny, for that author tells us that there is something ludicrous in the disposition of the Mullets; for if they are afraid they conceal their heads, and thus imagine they are entirely withdrawn from the observation of their enemies.

"When, towards the end of spring and the commencement of summer, the fishes of this species, excited by the necessity of living in the fresh water, approach the shores

Classification—Acanthopterous Fishes.

and advance towards the mouths of the rivers, they form such numerous troops that the water, through which they are seen without being clearly distinguished, appears to be bluish. This particularly happens in the Garonne and the Loire at these periods. The fishermen there adopt the plan of surrounding these legions of Mullets with nets, the inclosure of which they gradually contract, taking care to make a noise to frighten the fish and oblige them to press together, and heap themselves, as it were, one upon the other.

"Of the Mullets thus taken, some are eaten fresh, others are salted and smoke-dried. It is with their eggs salted, washed, pressed, and dried, that the preparation called *botarcha* is made, which is a condiment greatly in request in Italy and the southern provinces of France. The flesh of this Mullet is tender, delicate, and of an agreeable flavour; it is fatter and more in estimation when it is taken in the fresh water. The ancients, who from the time of Aristotle were acquainted with this fish, had it in great request; and the consumption of it is still very considerable in most of the southern countries of Europe. According to the report of Athenæus, those Mullets were formerly in very high esteem which were taken in the neighbourhood of Sinope and Abdera; while, as Paulus Jovius informs us, they were very little prized which had lived in the salt marsh of Orbitello in Tuscany, in the lagoons of Ferrara and Venice, in those of Padua and Chiozza, and such as came from the neighbourhood of Commachio and Ravenna. All these places, in fact, are marshy, and the streams by which they are watered are brackish, and communicate to the fish which they support the odour and the flavour of the mud."

A common mode of fishing in the sea for Mullet, practised at the present time on the shores of the Mediterranean, is to select a point of rock overhanging a considerable depth of clear still water. The fish are attracted to this place by being fed for some time with granulated macaroni, and then the fisherman in the gentlest manner lets down a small hook concealed in a pellet of paste and attached to a very fine line. Skill is exerted in withdrawing the fish, which is speedily hooked, without disturbing the others, but a practised fisher will soon obtain a good load. He must neither show himself nor permit his shadow to appear on the water.

In the *Histoire des Poissons*, *Tetragonurus* is placed at the end of the *Mugilidæ*, with an intimation that the true place of the genus in the ichthyic scale has not yet been ascertained. We shall mention it again when we come to speak of the *Notacanthidæ*.

Family XIII.—MUGILIDÆ.

Mugiloides, Cuv. (*Mugil*, Linn.) Body cylindrical; back broad. Scales large, and extending to the head like those of the *Ophicephali*. Two dorsals widely separated, the first one having only four stiff, acute spines; ventrals in general abdominal. Teeth, when present, so fine as to be almost invisible; maxillaries small, and mostly concealed by the thick premaxillary lip that presses against the preorbitar when the mouth is shut. Mandible shelving with a small symphysial cutaneous tubercle that fits a notch between the premaxillaries. Pharyngeals greatly developed, and closing the gullet so that only soft and thin matters can enter the narrow angular opening of the œsophagus. Branchiostegals four, five, or six, as in the *Pharyngobranchs*. Stomach cæcal like a gizzard, with a thick muscular ascending branch.

Genus I. Mugil, Cuv. Abdominal *Acanthopteri*, with two widely separated dorsals. External aspect somewhat like that of a Dace or Chub. Mouth small, with a transverse opening and a mesial fold or crest on the under lip which fits a corresponding notch in the upper one. Teeth excessively slender, often scarcely to be seen. Preorbitar on the side of the snout finely pectinated, and receiving a slender maxillary more or less completely beneath it. Gill-covers large and convex, covering a complicated pharyngeal apparatus, which prevents any coarse matters from reaching the œsophagus, through the tortuous channel. Stomach gizzard-like; gut long and folded; pancreatic cæca few. Sixty species.

Genus II. Cestræus, Cuv. Snout pointed. Mouth cleft longitudinally. Mandible short, without a mesial tubercle, and toothless; rudimentary teeth concealed in the thick lip of the upper jaw; no teeth on the roof of the mouth. General form of *Mugil*, with four spinous rays in the first dorsal, but with the last ray of the second dorsal elongated. Teeth in a narrow band on the upper jaw only. Stomach cæcal, large, not muscular like that of Mugil; two pancreatic cæca; air-bladder simple, with very thin coats. Two species. Celebes.

Genus III. Dajaus, Cuv. Snout projecting. Mouth a little more longitudinal than that of *Mugil*. No symphysial tubercle on the mandible. Villiform teeth on both jaws, the vomer, and palatines. Stomach less muscular than that of *Mugil*, the ascending branch being reduced to a tube, but little more fleshy than the cæcal portion; intestinal canal doubled five times; two pancreatic cæca. One species, Jamaica and St Domingo.

Tasmania possesses a species intermediate between *Dajaus* and *Mugil*, having the longitudinal mouth of the former, but the rough plates on the palate and tongue, which most of the *Mugils* have, very little coarser than in that genus, and scarcely deserving the name of teeth. It is the *Dajaus Diemensis* (Rich.)

Genus IV. Nestis, Cuv. Form of a Cyprinoid Barbel. Head more compressed than that of *Mugil*; gill-covers flatter. Preorbitar not covering the whole maxillary, which is not decurved so as to show itself below the mandible. Teeth on the two jaws, front of the vomer, and pharyngeals; none on the palatine bones. Lower lip very thick, doubled back, callous and trenchant. Stomach differing from that of *Mugil* in being wholly membranous and nowise fleshy; intestine long, six times folded; pancreatic cæca two; air-bladder simple with thin coats. Two species.

Atherine Family.

We are obliged, say the authors of the *Histoire des Poissons*, to leave isolated among the fishes a group composed of a single genus, which it is impossible to divide otherwise than into small tribes, and which does not associate closely with any other genus or family. Some species have teeth clearly visible on the jaws, vomer, and palatines, such as *Atherina Boieri*, and its allies, which have a large flat head; others, like *A. sauclet* have the teeth on the palatines so minute that they are barely perceptible; thirdly, there is a large number of extra-European species which have the roof of the mouth perfectly smooth and toothless; these are mostly American, and have a peculiar physiognomy resulting from the singular position of the pedicels of the premaxillaries and the curvature of the maxillaries. The latter bones are slender, and have a structure very uncommon among fishes, but which exists usually in the Mugil family, that is, to have the posterior end of the maxillary more slender than its anterior or articular end. Another affinity to Mugil may be found in the small number of rays in the spinous first dorsal, and in the abdominal position of the ventrals. We cannot, however, unite them to the Mugil family as Pallas advises, since none of the anatomical details which distinguish the Mullets from other fishes are found in the Atherines. They have neither the notch between the upper lips, nor the symphysial prominence of the lower jaw; nor the pectinated denticulations of the preorbitar; nor the unusual pharyngeal apparatus; nor the gizzard stomach. The premaxillary is much more protractile than with the Mullets, almost as much as in the Menoid *Smaris*. The teeth require to be examined through a lens to be properly seen, and the pharyngeals, which have the usual form of those of other fishes, are crowded with minute teeth.

The Atherines live in large shoals in all the localities that they frequent; and notwithstanding their small size, rarely more than six inches, they are esteemed as a delicate food. The young, for some time after they are hatched, cling together in dense masses, and in numbers almost incredible. These are taken and prepared in the lump by frying or by boiling in milk. The inhabitants of the Mediterranean coasts of France call these newly hatched Atherines *nonnat* (unborn). In some places the adult fish is so abundant that they are employed to feed animals; at Venice for instance, where they swarm by myriads in the canals that traverse that city, and are sold in the streets

Classification—Acanthopterous Fishes.

under the name of *Anguela*, for cat's meat. The *Atherina presbyter* is very common on the south coast of England, and is taken in quantities in Portsmouth harbour, and even in the salt-water ditches of the fortifications. In the markets of that place and of Southampton, the Atherines are sold under the name of Smelts, but they are full of sharp angular bones, and are very inferior in flavour to the true Salmonoid Smelt. They seem to frequent, from choice, the mouths of drains that convey the putrid washings of a large city into the sea.

FAMILY XIV.—ATHERINIDÆ, Bonap.

Atherinoidæ, Cant., sub-family. Dorsals two; ventrals abdominal. Upper jaw very protractile; teeth very slender and spare, sometimes existing also on the palate, in other species the palate is smooth. Body generally ornamented by a broad silvery band on the flanks. Stomach siphonal, membranous, a little wider than the rest of the intestinal canal, which latter is shorter and not so frequently doubled back as in *Mugil*; pancreatic cæca none; peritonæum generally lined with a black pigment; ova large; air-bladder large, often prolonged into a canal formed by the caudal vertebræ. Vertebræ more than double the number of those of the *Mugils*. Thirty species.

NOTACANTHS.

The family of *Notacanthidæ*, says M. Müller, includes those *Acanthopteri*, with or without abdominal ventrals, which have many isolated dorsal spines, and the coracoid bones suspended to the vertebral column and not to the head. The same structure exists in *Notacanthus* as well as in *Mastacemblus*, but it still remains to be ascertained whether *Tetragonurus* belongs to this group or not. There is little to add regarding the family to the facts collected in the table. The Notacanth or Campylodon of Otho Fabricius and Reinhardt is a Greenland species, and Bloch has been much blamed for describing it as an Indian fish; but the fact is, that a very similar species inhabits the Australian seas, and one of these may have come into Bloch's hands. *Tetragonurus Cuvieri* of Risso, the only known species of the genus, inhabits great depths in the Mediterranean, and is consequently more rarely seen. It is named *Courpata*, has a black colour, and hard scales, deeply chiseled and ciliated. Its flesh is said to be poisonous. We have seen no specimen, but think from the structure assigned to the scales, that it should be compared with the *Elopidæ* or *Amiidæ*.

FAMILY XV.—NOTACANTHIDÆ, Müll.

Scales cycloid, covering the head, body, and partially the fins. Snout prominent; mouth beneath, horizontal; nostrils near the eye. Branchiostegals seven or eight; gill-openings beneath, closed directly behind. Head slightly armed; opercular pieces nearly concealed by the integument. Body elongated, sword-shaped posteriorly. Spinous dorsal not continued by membrane; soft dorsal in some of one or two rays, or altogether absent, in others of many rays. Coracoids suspended to the vertebral column as in the Eels, and not to the head as in most osseous fishes. Ventrals abdominal, or wanting; when present composed of a spine and eight soft rays. Stomach cæcal; pancreatic cæca few.

GENUS I. NOTACANTHUS, Bloch. Dorsal spines free, with a divided soft ray in the axilla of the last one; anterior anal spines detached, each with a low membrane; anal joined to a distinctly-formed caudal. Body much elongated, sword-shaped, and tapering posteriorly. Snout prominent, obtuse. Small *cycloid* scales covering all parts of the body, head, and face, except the lips. Abdominal ventrals of two spines and seven articulated rays, united on the median line by membrane into one continuous fin. Branchiostegals eight; the membrane continuous across the throat with a free edge. No armature on the head except an acute spine issuing from the maxillary above its posterior extremity. Teeth slender, with lanceolate tips uniserial on the upper jaw, whose border is formed wholly by the premaxillaries; an interior concentric curve without a break is formed on the vomer and palatines by more subulate teeth, which in one species are pluriserial in front; the mandibular teeth are uniserial or pluriserial; all the teeth curve backwards. Two species, Greenland and Australia.

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GENUS II. RHYNCHOBDELLA, Bloch, Schneider. (*Macrognathus*, Lacép.) Body elongated, compressed. Snout pointed, projecting, fleshy or membranous, flexible and striated underneath, forming a proboscis used as an organ of touch. Branchiostegals seven. Teeth mere scabrosities on the premaxillaries, mandible, and fore end of the vomer. No armature on the head. Scales cycloid, covering the body, bases of the fins, gill-covers, cheeks, cranium, and borders of the eyes. Spinous dorsal not continued by membrane; soft one long and far back; anal corresponding to the soft dorsal, with two free spines in front. Stomach cæcal, obtuse; two pancreatic cæca; a long narrow air-bladder. One species.

GENUS III. MASTACEMBELUS, Kuhl and Van Hass. *Rhynchobdelli*, but with a less elongated snout, which is merely conical and not striated beneath. Teeth rather stronger than in *Rhynchobdella*. A few small spines on the rounded corner of the preoperculum. Vertical fins in some species united, in others the caudal is merely contiguous to the other two. Ten species.

GENUS IV. TETRAGONURUS, Risso. Ventrals a little behind the pectorals. Body elongated, fusiform. Snout obtuse. Mandible a little shorter than the premaxillaries. Upper lips thick, giving the face the aspect of *Mugil*. Teeth uniserial, conical, and a little recurved on the premaxillaries; mandibular teeth also uniserial, more curved, compressed and pointed posteriorly; vomerine teeth on the chevron and along the median line; tongue smooth; pharyngeal teeth in cardlike plates. No armature on the head. Body clothed in hard scales, lying in oblique rows, and exposing disks which are grooved as in *Lutodeira*, of the family of *Gonorhynchidæ*, to which genus this one has some other external similarity, especially in the remarkable character of two elevated scaly keels on the base of the caudal on each side. First dorsal composed of a series of very short spines, each with its membrane, which folds into a dorsal groove; soft dorsal more elevated, not long, opposite to an anal of similar height and shape. Stomach very long, cæcal, conical; pyloric cæca numerous, ranged along the sides of the ascending branch of the stomach, and along the duodenum; no air-bladder. One species. The proper place of this genus is undecided. M. Müller thinks it may be here.

SCOMBEROIDS.

In the periodicals of the day we read, that in 1855 the Herring-fishery of Scotland alone employed very nearly 70,000 people, made up as follows:—40,350 fishermen, 1913 coopers, 21,832 women employed as cleaners and packers, 3730 labourers, and 1127 fish-curers. What the Herring-fishery is to the northern nations, the capture of the Scomberoids is to the maritime population of the Mediterranean, and to the Mackerel boats of the British Channel, and both sides of the Atlantic, down to the 30th parallel of latitude. The Tunny, Bonito, and Mackerel fisheries are known, by report at least, to all. These well known fishes, remark the authors of the *Histoire des Poissons*, are easily characterized, if we regard the typical forms only. In regard to them, the detachment of the posterior rays of the second dorsal would suffice, but these are merely the chiefs of numerous genera and sub-genera, in which the characteristic forms pass by insensible gradations into others which retain little of the primary types. Scales in general very small, and so thin, that they cause the greater part of the skin to appear quite smooth. Vertical fins without scales; gill-covers destitute of spines and denticulations. Numerous pancreatic cæca;—and behold all is said that can be announced; yet a family aspect is recognisable in all, adhering to them in every modification, and we cannot subdivide them into separate families, but merely into groups of less value.

The following analytical table is not to be considered as separating the numerous genera into natural groups, but merely as a means of facilitating the labours of the student in discovering the generic name of any Scomberoid that he is investigating. The apodal *Rhynchobdellus* and *Mastacemblus*, and the abdominal *Notacanthus*, have been removed from the table as presented in the *Histoire des Poissons*, to form the family of *Notacanthidæ*.

TABLE OF GENERA.

TRIBE I.

A continuous first dorsal; rays of the second dorsal and of the anal detached in form of finlets. Tail tapering to a narrow end. Caudal large.
- An interval between the first and second dorsals.
  - *Scales equally small throughout.*
    - Two little crests on each side of the tail.....SCOMBER.
  - *Scales of the thorax larger, forming a corselet*....AUXIS.
- First dorsal reaching to the second one.
  - *A corselet.*
    - A keel on each side of the tail.
      - Teeth small, or moderate-sized, crowded.....THYNNUS.
      - Teeth strong, pointed, separated.....PELAMIS.
  - *No corselet.*
    - A keel on each side of the tail.
      - Teeth compressed, pointed, trenchant..CYBIUM.
    - No keel on the tail.
      - Pointed cutting teeth, the fore ones longest.....THYRSITES, GEMPYLUS.

APPENDIX TO TRIBE I.

A single continuous dorsal; no scaly armour on the lateral line. No corselet. No keels. All or many of the rays of the anal reduced to mere small spines. Teeth of *Thyrsites* and *Gempylus*.....LEPIDOPUS, TRICHIURUS.

Group of Sword-fish.

Snout elongated, ensiform, or dagger-pointed. Keels on the sides of the tail. Teeth close and short, villiform.....XIPHIAS, TETRAPTURUS, MAKAIRA, HISTIOPHORUS.

TRIBE II.

First dorsal represented by isolated spines.
- Thoracic ventrals.
  - A keel on each side of the tail.....NAUCRATES.
  - No keel on the tail.
    - Body elongated.....ELECATE.
    - Body compressed.
      - Second dorsal and anal continuous..LICHIA, TRACHINOTUS.
  - Jugular ventrals.....APOLECTUS.

TRIBE III.

Lateral line armed with keeled scales.
- Armature of the lateral line, strong and conspicuous.....CARANX.
- Armature of the lateral line visible merely because the other scales are small. Body elevated. Profile trenchant.....OLISTES, SCYRIS, BLEPHARIS, GALLICHTHYS, ARGYREYOSUS, VOMER, HYNNIS.

TRIBE IV.

No detached finlets; no isolated dorsal spines; no armature on the tail.
- Body moderately long, more or less compressed.
  - *Two dorsals.*
    - Villiform or card-like teeth on the vomer and palatines.....SERIOLA, TEMNODON, LACTARIUS, NOMEUS, NAUCLERUS, PORTHMEUS.
    - No vomerine or palatine teeth.....PSENES.
  - *One dorsal, running far along the back; rays flexible; ventrals thoracic*.....CORYPHÆNA, LAMPUGUS, CENTROLOPHUS, ASTRODERMUS, PTERACLIS.
- Body subrhomboid, high. Aspect Scomberoid. Scales small, or none.
  - No ventrals.....STROMATEUS, PEPRILUS, LUVARUS.
  - Two very small thoracic ventrals.....SESERINUS.
  - Two jugular ventrals.....KURTUS.

The fishery of the common Mackerel (*Scomber scombrus*) is described in detail, and with much accuracy, by Mr Yarrell, to whose pages we refer the reader, for we shall not now make lengthened quotations from a work which is in the hands of every one who is interested in British Ichthyology. We shall merely repeat from him, that on the 30th of June 1821, these fish were so abundant off Lowestoffe, that the catch on that day, by sixteen boats, amounted in value to L.5252, and it is supposed that the owners and men concerned in the Mackerel fishery on the Sussex coast, realised altogether L.14,000. The common Mackerel, though destitute of an air-bladder, takes a bait readily a few inches below the surface, and is a general inhabitant of all the northern seas, from Greenland and the Baltic, through the North Atlantic, to the Mediterranean, the Black Sea, and Sea of Azof. Very similar species exist in the Australian and Australasian Seas, the Cape of Good Hope, and Seas of China and Japan. Most of these have air-bladders.

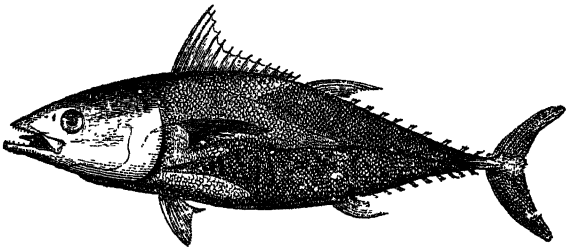


Fig. 110.
Thynnus vulgaris.

The Tunny (*Th. vulgaris*, Cuv.; *Scomber thynnus*, Linn.), fig. 110, is one of the largest fishes of the ocean. When it weighs only a hundred pounds, the Sardinians give it the name of *Scampirro*, a diminutive derived from Scomber. When above that weight, and onwards to three hundred pounds, it is called *Mezzo-tonno*, or Half Tunny. The larger individuals frequently weigh a thousand pounds; and Cetti asserts that old males are taken occasionally weighing eighteen hundred pounds. The fishery of the Tunny dates from the most remote antiquity; and the city of Byzantium was more especially enriched by it. The shoals which entered the Bosphorus were said to meet near Chalcedon with a white rock, which so terrified them that they turned into the Gulf of Byzantium, now the port of Constantinople. It was, according to Cuvier, in consequence of this abundance of Tunnies, that the gulf in question received the name of the *Golden Horn*; and the oracle of Apollo designated Chalcedon as the *City of the Blind*, because its founders did not perceive the inferiority of its site in relation to these valued fish. Gibbon, however, tells us that "the curve which the gulf describes might be compared to the horn of a stag, or, as it should seem, with more propriety, to that of an ox. The epithet *golden* was expressive of the riches which every wind wafted from the most distant countries into the secure and capacious port of Constantinople." The same prodigious quantities of the Tunny are still seen there as in ancient times. According to Syllius, twenty vessels might be filled by a single cast of the net; and they might frequently be taken by the hand without the aid of nets. When ascending towards the port, they might be killed with stones; and even women took them in quantities, merely by suspending a large basket by a cord from the windows. The Tunny fishery was of still more ancient practice in the West. The Phœnicians established it at a very early period on the coasts of Spain, both within and beyond the columns of Hercules. It is thus that we find the Tunny on the Phœnician medals of Cadiz and Carteia. Its salted preparation was known to the Romans as an esteemed article, under the name of *Saltamentum Sardicum*. The Tunny fishery does not seem to be now car-

Classification—Acanthopterous Fishes.

ried on at Constantinople on a great or systematic scale, but is chiefly concentrated in the interior of the Mediterranean. The species sometimes wanders along the British shores; and a fine specimen, measuring 9 feet in length, was killed in the beautiful Gairloch, opposite Greenock, in July 1831. It is preserved in the Andersonian Museum, Glasgow.

The fish known to navigators under the name of *Bonito* belongs to our present genus. It is the *Th. pelamys* of Cuv., and sometimes occurs along the British shores. Resembling the Tunny in form, it is a great deal smaller, seldom exceeding the length of 30 inches, and is celebrated in the tropical seas for its eager pursuit of the Flying-fish. The Bonito of the Mediterranean, however, is the *Auxis vulgaris*.

It is a singular thing, as Cuvier has observed, that a fish so generally met with as the great *Lepidopus argyreus* of the European seas, so handsome, and so large,

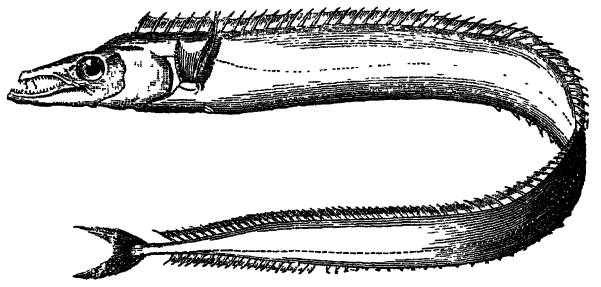


Fig. 111.
Lepidopus argyreus.

should have remained unknown to naturalists so recently as the end of the eighteenth century, and that it should have been afterwards successively described by various writers, under a new name, and by each in ignorance of the labours of his predecessor. If we figure to ourselves a large and broad riband of silver, swimming with a wavy motion through the water, and casting from it in its progress the most beautiful reflections of light, we may form some notion of the general aspect of this creature in its living state. Its length, as described by Montagu (under the name of *Zipotheca tetradens*), was 5 feet 6 inches, with a depth at the gills of 4½ inches; it gradually decreased from the vent to the commencement of the anal fin, where it measured only 2 inches in depth; at the end of that fin the form was nearly round, and the diameter only half an inch. The weight, without the intestines, was about six pounds. Montagu's specimen was taken in Salcomb Harbour, on the coast of South Devon, on the 4th June 1808. It was swimming with astonishing velocity, *with its head above water*, going, as the fishermen said, "as swift as a bird," and was killed by the blow of an oar. It occurs occasionally on most of the European coasts; is more frequent in some parts of the Mediterranean; and has been captured as far south as the Cape of Good Hope.

The very singular form, *Nemichthys scolopacea* (Rich.), captured in the Southern Atlantic by Mr Adams, surgeon, H.M. ship Samarang, seems to be more nearly allied to *Trichiurus* than to any other genus, but as its internal structure has not been investigated, its proper position in the system must remain for the present doubtful. It is remarkable, above all other fishes, for the extreme length of its thread-like tail and long jaws, compared to its abbreviated body, many times shorter than the gape of the mouth. It is apodal, with the anus on the thorax, a range of spinous rays, each with a triangular membrane, not connected to the following one, running along the whole back, and a ventral equally long, but with taller simple flexible rays, and a more connected membrane. There is no caudal, though, as the tip of the tail was slightly damaged, this fact was not fully established. When newly caught the fish had a dull white colour, with brown spots. The editor of the *Archiven für Naturgeschichte* is inclined to place this fish among the Tæniidæ, but it seems to us to associate better with *Trichiurus*, and we place it here without inquiring whether *Trichiurus* be a real Scomberoid or not.

Classification—Acanthopterous Fishes.

Naucrates ductor, the famous *Pilot-fish* of navigators (*Gasterosteus ductor*, Linn.), so named from its habit of keeping company with ships at sea, and frequently swimming beneath their bows. It would seem, from early indications of a similar instinct, to be the *Pompilius* of the ancients, described as pointing out the way to dubious or embarrassed sailors, and as announcing the vicinity of land by its sudden disappearance. It was thus regarded as a sacred fish. The other story of its serving as a guide to the Shark does not appear to have been transmitted to us from so remote a source. It is not mentioned even by the ichthyologists of the sixteenth century; and Cuvier regards as the first allusion to it, that of Dutertre in his *Description of the Antilles*, printed in 1667. Since that period it has been carefully repeated by all voyagers and compilers; and Osbeck even makes it a subject of pious reflection on the wonderful ways of Providence. We are told by a greater than Osbeck that "they that go down to the sea in ships, that do business in great waters; these see the works of the Lord, and his wonders in the deep:" but the fact in the present instance seems reducible to this, that the Pilot accompanies both ships and Sharks, sometimes swimming before, sometimes behind, for the sake of preying upon whatever may be thrown overboard in the one case, or left uneaten in the other. It is true that the Shark never attacks it; but it is also true that the hawk does not attack the swallow; and in both instances the reason is the same; the Pilot being too nimble for the unwieldy Shark in the water, just as the feebler but more agile bird is too swift in its movements for *falco* in the air. It is thus that the apparent alliance of these dissimilar fishes may be explained even upon general principles, to say nothing of Bosc's observation, who assures us that he has seen hundreds of Pilot-fish, that they always keep at a respectful distance from the Shark, and swim about swiftly in different directions, that they may more certainly avoid it. If any food be thrown overboard, the Pilot stops to seize it, and abandons both the Shark and vessel. Geoffroy no doubt tells a story of two Pilot-fish having been seen to take a great deal of trouble, swimming to and fro, in order to conduct a Shark towards a *baited* hook: but admitting the truth of the details, it is clear, that whatever advantage might eventually accrue to the conductors, the probable result to the Shark was a cruel death, and one is consequently the more inclined to admire how the narrative itself should find place in a Memoir *sur l'affection mutuelle* des quelques animaux! The Pilot-fish in question is chiefly a Mediterranean species, although it also spreads into distant oceans, having been found by Daldorf under the equator. A greta extent of geographical distribution may indeed be expected in reference to a species which is said to suffer itself to be led away immense distances in its eager pursuit of ships. Dutertre records that he saw one which followed his vessel for more than 500 leagues. Whether he kept his eye upon it night and day during all that time, or in what other way he ascertained it to be the same individual throughout so long a traverse, is what he does not state, and we therefore cannot explain.

In further illustration of the subject, we shall subjoin a short extract from a recent publication, Dr Meyen's *Reise um die Erde:* "The Pilot swims constantly in front of the Shark; we ourselves have seen three instances in which the Shark was led by the Pilot. When the Sea-Angel neared the ship, the Pilot swam close to the snout, or near one of the breast fins of the animal; sometimes he darted

rapidly forwards or sidewards, as if looking for something, and constantly went back again to the Shark. When we threw overboard a piece of bacon fastened on a great hook, the Shark was about twenty paces from the ship. With the quickness of lightning the Pilot came up, smelt at the dainty, and instantly swam back again to the Shark, swimming many times round his snout, and splashing, as if to give him exact information as to the bacon. The Shark now began to put himself in motion, the Pilot showing him the way, and in a moment he was fast upon the hook. Once we watched a Pilot for many days, who kept constantly swimming close before the keel of the ship. The sailors say, as of a thing well known and familiar, that such a fish so situated has lost his Shark, and is seeking another. Upon a later occasion, we observed two Pilots in sedulous attendance on a Blue Shark, which we caught in the Chinese Sea. It seems probable that the Pilot feeds on the Shark's excrements, keeps his company for that purpose, and directs his operations solely from this selfish view." The reviser of this article has seen many Sharks caught in the Bight of Benin. They were frequently accompanied by one or two Pilot-fish, pretty objects with their light-blue bands, more often by troops of the disgusting-looking *Echeneis*, and not seldom without either of these fishes. The Pilot-fish swam gracefully round the head of the fish, but quickly struck off on one side when the monster, urged by his voracious appetite, turned up to take the bait. This bait was approached both by the Pilot-fish and Remora—by the one with an easy and elegant motion, by the other with a wriggling of the taper tail that conveyed the notion of swimming with difficulty. It seemed to us that both these attendants had no other object than that of procuring food for themselves. The Remoræ very commonly deserted the Shark, even when it was not caught, and attached themselves to the ship's bottom, darting off when any greasy water was thrown overboard by the cook, to pick up the morsels of fat from the clear blue water, returning again to their resting-place to be borne through the water without trouble.

The generic term *Coryphæna* is derived from κορυφη, *vertex*, or top of the head, in reference to the height of the crest of the cranium. This division contains the famous *Dolphin* of the Mediterranean (*Cor. hippurus*, Linn.), so celebrated for the beauty of its versatile tints.

> . . . . . "Parting day
> Dies like the Dolphin, whom each pang imbues
> With a new colour as it gasps away,
> The last still loveliest, till—'tis gone—and all is gray."

The species are still in some measure indistinctly characterized. They occur in the Pacific and Atlantic Oceans, and the Mediterranean Sea, and are remarkable, among other things, for their keen pursuit of Flying-fish, which, in the first place, they force to leave their native element, and then following swiftly in a corresponding track, receive with open mouth the moment they descend exhausted to the surface. The Coryphænæ may be regarded as among the most brilliant inhabitants of the sea. It is necessary, according to Bosc, to have seen them following a vessel in troops, before we can form a proper estimate of their beauty. When they swim embodied near the surface, and beneath the light of a cloudless sky, they seem effulgent with the richest gold, combined with the sparkling lustre of the topaz, the emerald, and the sapphire,—and every brilliant hue in perpetual change, accordant with the vivacity and varied grace of their movements. It is indeed a spectacle sufficient anywhere to excite our unfeigned admiration; and when seen suddenly amid the waves of the lonely and monotonous ocean, it comes upon us like a glad surprise. The beauty of these fishes has in every age attracted the wonder

> "Of all who on the wide deep wandering are;"

and it is so far to be regretted, that their fugitive colours have been the chief object of attention,—their more precise description and specific discrimination having been greatly disregarded.

Classification—Acanthopterous Fishes.

The Coryphænæ are strong, active, and voracious fishes. While swimming rapidly, they seem rather as if impelled or projected forwards by some exterior force, than by any exertion of their own. But, on attentive examination, a strong and rapid muscular movement may be detected by the constant undulation of the long dorsal fin, a movement which greatly contributes to the throwing off of those lustrous metallic reflections for which they have so long been noted. The Mediterranean species, *Cor. hippurus*, if not the most beautiful, is the largest known. It sometimes attains to the length of five feet. Its colours, so far as they are capable of description, are silvery blue above, with markings of a deeper azure, and reflections of pure gold—the lower parts citron yellow, marked with pale blue. The pectoral fins are partly lead colour, partly yellow; the ventrals are yellow on their under surface, and black above; the anal fin is yellow. The iris of the eye is made of apparent gold. This description is from the recorded observation of the living fish by M. Biberon. Another eye-witness, Colonel Bory St Vincent, describes the back as being of a sea-green colour, sprinkled with orange spots; the abdomen silvery; the lateral line yellow; the dorsal fin celestial blue, with golden-coloured rays; the caudal fin surrounded by a green hue; the other fins yellow.

One or two other kinds, not so distinctly known, occur in the Mediterranean, and many others in more distant seas. The Portuguese name more than one species *Dorade*, a term which, from its similarity to *Daurade* (a frequent appellation of our Gilt-head, *Chrysophris aurata*), has produced some confusion. Not less ambiguous is the name of *Dolphin*, which appears to have been first misapplied to the Coryphænæ by the Dutch. It is scarcely necessary to observe, that the English word Dolphin, as synonymous with the Greek Δελφις, the Latin Delphinus, and the French Dauphin, was originally, and is still correctly, applied only to designate a group of cetaceous animals (allied in structure to the Whales), to which the classical Dolphin of antiquity assuredly belonged. But by some conversion, into the history of which it is not worth while to inquire, the term has been applied by most modern writers, particularly poets, to a creature of another class, a genuine fish, of the genus *Coryphæna*. No fault, therefore, can be imputed to the naturalist, if the general misapplication of the term is now found to occasion any misconception. There is no doubt, however, that the animal beloved by gods and men, the *Hieros Ichthys* of the heroic Greeks, and the revered symbol of the Delphic Apollo, was nothing more than a Pellock or Porpoise.

Xiphias (Sword-fish), though by no means uncommon, are seldom captured, owing to their extreme vigilance. Cap-

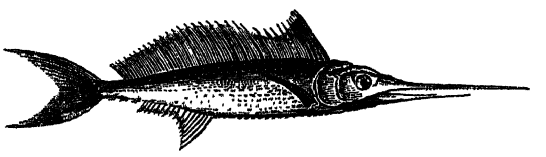


Fig. 112.

Xiphas Gladius, young.

tain Beechy informs us, that while in the Pacific Ocean, near Easter Island, "as the line was hauling in, a large Sword-fish bit at the tin case which contained our thermometer, but fortunately failed in carrying it off." Their mode of capture in the Mediterranean may be likened to Whale-fishing in miniature, and is said to be a very amusing and exciting sport. A watchman placed upon a mast, or

standing on the summit of a neighbouring rock, gives warning by signal when he sees a fish approach. The fishermen then row towards it; and, being so skilful as frequently to strike the fish from a great distance, they throw a harpoon into it attached to a long line. An arduous struggle then commences, during which the aggressors are sometimes pulled about by the fish for many hours before they can get it into the boat. The sword-like prolongation of the snout in *Xiphias* is formed of the confluent premaxillaries, firmly and immoveably articulated with the prenasal and maxillary bones as in the *Scomberesox*.

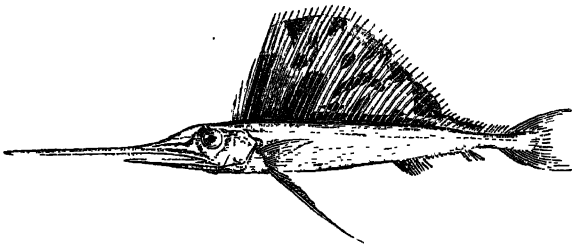


Fig. 113.
Histiophorus pulchellus.

We cannot give more space to the more remarkable forms of this large and important family of fishes. The peculiarities of their structure, such as the loose texture of their bones, the glandular-like assemblages of pancreatic cæca which they possess, and the papery-like scales, scarcely to be distinguished from the smooth skin, with the neat tapering tail and large crescentic caudal, together with the delicacy of the cutaneous fold or membrane, in which the other two vertical fins are developed, and which, from its early disappearance, leaves many of the rays detached in form of finlets, are all prominent characters of the more typical species, and give such an unity of aspect to the whole group, that it might rank as an order, and not as a mere family division. The family is generally distributed in all districts of the ocean, and the *Temnodon saltator* is especially a cosmopolitan fish, being found in all the temperate and warmer districts of the Atlantic and Pacific Oceans. In concluding, we must express our regret that M. Valenciennes should have adopted the word *Rhombus*, first used by Lacépède to distinguish a Scomberoid genus, but which has been generally employed by ichthyologists to designate the Turbots among the *Pleuronectidæ*. Cuvier had given the Scomberoid genus the name of *Peprilus* in the second edition of the *Regne Animal*, and this being also a Lacépèdian name of this genus, the continuance of it would have

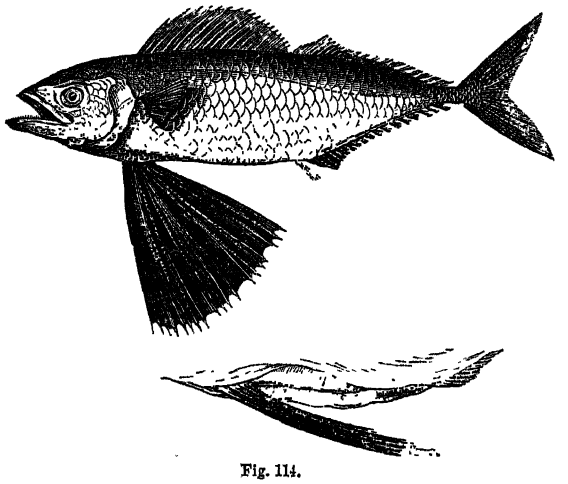


Fig. 114.
Gasterochisma melampus.

avoided the mistakes that are likely to arise from two very different genera retaining the same appellation.

FAMILY XVI.—SCOMBERIDÆ.

Scales generally small, tender, smooth, seldom extending to the vertical fins; bones less solid than in most other osseous fishes. The tail and caudal fin, generally, very vigorous. Pancreatic cæca numerous, and frequently united in bunches. No armature on the opercular pieces. In many, the sides of the tail are keeled and armed with keeled, often acute scales. The posterior rays of the second dorsal and anal are often detached from the rest of the fin. Sometimes the spines of the first dorsal are not connected by membrane. The front anal spines are detached in most; the caudal is very frequently large. These characters are variously combined, none being common to all, but they serve to divide this numerous family into tribes.

TRIBE I.—*Finlets, and no Armature on the Lateral Line.*

First dorsal continuous, the rays of the second detached, forming finlets. Body fusiform. Caudal large and vigorous. Tail becoming very slender, and more or less keeled. In some there is an interval between the first and second dorsal, in others these fins are contiguous; in some the scales of the thorax are large, forming a corselet. Most, or all, have seven branchiostegals.

GENUS I. SCOMBER, Linn. Detached finlets behind the dorsal and anal; a large interval between the dorsals. Tail with a slight ridge on each side, but no acute keel. Generally an air-bladder, though in some species that organ is absent. Fourteen species.

GENUS II. THYNNUS, Cuv. Mackerels, but with contiguous dorsals; the scales of the thorax larger and stronger, forming a corselet which ends posteriorly in points. Detached finlets more numerous; no free spine in front of the dorsal. An acute cartilaginous projection on the lateral caudal ridge. Thirteen species.

GENUS III. AUXIS, Cuv. Dorsals separated by an interval. Tail keeled on the sides; intermediate between, and connecting the Mackerels, having widely separated dorsals, to the Tunnies and Bonitos, with small teeth, numerous finlets, keeled tail, and contiguous dorsals. Three species.

GENUS IV. PELAMYS, Cuv. Differs from *Auxis* in having contiguous dorsals and strong pointed teeth, standing rather widely. Two species.

GENUS V. CYBIUM, Cuv. No corselet. Compressed lancet-pointed trenchant teeth. Detached finlets and long first dorsal of *Thynnus*. Elongated body, keeled tail, and no pectoral cuirass; this last character distinguishing them from *Pelamys*. Very short villiform teeth on the chevron of the vomer, palatines, tongue, and branchial arches. Sixteen species.

GENUS VI. THYRSITES, Cuv. No lateral caudal keel; no pectoral corselet. First dorsal contiguous to the second. Body elongated, much compressed. Small but perfect ventrals. Teeth pointed, compressed, trenchant; longer and stronger anterior premaxillary teeth; palatine teeth small, pointed. Four species.

GENUS VII. GEMPYLUS, Cuv. *Thyrsites* with rudimentary ventrals. No palatine teeth. Two species.

GENUS VIII. ROVETTUS, Bonap. (*Ruvetus*, Cocco; *Tetragonurus*, Lowe; *Aplurus*, Idem.) Body elongated, compressed. Head covered with a scabrous leathery skin. Belly keeled on the ventral edge. Tail compressed, without a lateral keel. Head unarmed; snout much abbreviated. Gill-openings very wide. Mandible shorter than the premaxillaries. A row of equidistant, compressed, slightly recurved, serrated teeth on the jaws; some of them long, especially the premaxillary ones near the symphysis, which are the longest; a uniserial range of smaller ones on the vomer and palatines. Two dorsals, with finlets above and below the tail. Caudal forked. Branchiostegals seven. Many pancreatic cæca; small air-bladder. One species.

APPENDIX TO TRIBE I.

GENUS IX. LEPIDOPUS, Cuv. (*Aphanopus*, Lowe.) Form of *Gempylus* and *Thyrsites*, even more elongated; but they have no soft dorsal or finlets, the spinous rays running all along the back. Vestiges of ventrals in form of a little squamoid appendage, with the styloid pubic bone felt through the skin. Teeth like those of *Thyrsites* on the jaws; none on the vomer, and very fine ones on the palatines. Branchiostegals six. A long cæcal stomach; twenty-three pancreatic cæca; air-bladder long and narrow. One species.

GENUS X. TRICHIURUS, Linn. Head, body, and dentition of *Lepidopus*, but without a vestige of ventrals. The dorsal, also, is spinous throughout like that of *Lepidopus*; while the anal consists of a series of spines that scarcely protrude through the skin, and the tail ends in a filiform point without a caudal fin. Four species.

GENUS XI. NEMICHTHYS, Rich. (*Voy. of the Sulphur*, pl. x., 1848.) Form greatly elongated, and tapering posteriorly into an exceedingly long filamentous-looking tail. Head longer than the

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body, excluding the tail. No ventrals. Elongated jaws formed as in *Scomberesox*; the edge of the maxillary touching the angle of the long gape of the mouth, which is bounded by the very slender premaxillaries and mandible. Branchiostegals nine or ten, as fine as a hair. Anus between the small pectorals. Eye large. Dorsal spines isolated, each with a membrane in its axilla, extending from the occiput to very near the point of the tail, where they can no longer be traced for their minuteness; anal fin with more numerous and taller spines, and apparently a continuous membrane, disappearing also near the hair-like point of the tail; no caudal. None of the spines strong enough to be pungent, but none of them jointed. Teeth arranged in very close, fine, file-like bands, on the premaxillaries and mandibles; individually, when viewed through a lens, they appear to be semi-lanceolate with the points turned backwards. One species.

Group of Sword-fish. Muzzle in form of a sword or dagger. No detached finlets.

Genus XII. Xiphias, Linn. Allied to *Thynnus* by their very small scales, the keels on the side of the tail, and interior organization. Their distinctive character is the elongation of the beak, composed chiefly of the premaxillaries and vomer, supported at the base by the frontals, nasal, and maxillaries, and which is a great offensive weapon. Their branchial laminæ are peculiarly formed. The caudal, having the distinctive form of the family, is a powerful instrument of natation. No ventrals. Branchiostegals seven. Stomach cæcal, conical; pancreatic cæca numerous: air-bladder large. Though the difference between these great Scomberoids and *Nemichthys* is so vast, as respects size, they seem with regard to the structure of the jaws to bear much the same relation to that small fish that *Hemiramphus* does to *Scomberesox*. One species.

Genus XIII. Tetrapturus, Rafin. Scomberoids with elongated and pointed bill as in *Xiphias*, but which have ventrals, and instead of a keel on each side of the tail, have little crests as in *Scomber*. Two species.

Genus XIV. Makaira, Lacép. With the pointed bill and the small lateral caudal crests of *Tetrapturus*, but without ventrals. One species.

Genus XV. Histiophorus, Lacép. (*Notistium*, Herm.) Approaches nearly to Xiphias. The bill, and lateral caudal crests of *Tetrapturus*, but the dorsal is very high; and their long slender ventrals are composed of two rays. Branchiostegals seven. Stomach cæcal, a great bag as long as the abdomen; cæca in a mass like a pancreas. Five species.

Tribe II.—Centronoti, Lacép. *Scomberoids, with the first dorsal composed of isolated spines.*

i.e., No continuous membrane to the spinous dorsal; with or without finlets behind the articulated dorsal or anal; and the lateral caudal keel present in some genera, wanting in others. Ventrals present in almost all.

Genus XVI. Naucrates, Cuv. A fusiform body, small uniform scales, and a keel on the side of the tail as in *Thynnus*. Two free spines before the anal, and the above characters of the tribe. Four species.

Genus XVII. Elecate, Cuv. *Naucrates*, except that the two spines before the anal are wanting, also the lateral caudal keel. The head, moreover, is depressed. Five species.

Genus XVIII. Lichia, Cuv. Body oblong, compressed, without keel or lateral ridges on the tail. Dorsal spines isolated, with each a membrane in its axilla, and a decumbent spine in front of all. Four species.

Genus XIX. Paropsis, Jen. Differs from *Lichia* in the total want of ventrals.

Genus XX. Chorinemus, Cuv. (*Scomberoides*, Lacép.) *Lichiæ* with the rays of the second dorsal or of the anal either wholly isolated or connected by a low membrane so tender that it disappears easily. Branchiostegals seven or eight, in some only four or five. Sixteen species.

Genus XXI. Trachinotus, Cuv. Differ from *Lichia* in having a more elevated body, and steeper profile before the eye, and in the anal and dorsal being more acutely falciform anteriorly. Some American species have the lower bodies of *Lichia*, and differ from that genus chiefly in the short, almost truncated snout. Twenty-four species.

Genus XXII. Apolectus, Cuv. *Trachinoti* with ventrals attached to the throat. One species.

Genus XXIII. Palinurus, De Kay. Rays of the dorsal not free, but connected by a low membrane; a spine before the anal. Preoperculum and operculum serrated. The last-mentioned character seems to remove this fish from the *Scomberidæ*, with which, however, its entire habit accords. One species (*Trachinotus argenteus*, Storer).

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Tribe III.—*Scomberoids, with a cuirassed lateral line;* The scaly shields being themselves keeled and acute. This kind of armour becomes feebler in certain genera, so that it would not be noticed but for the smallness of the other scales.

Genus XXIV. Caranx, Cuv. Keeled scales on the lateral line strong and acute. Two separate dorsals. A couchant anterior spine; two free spines before the anal. No appearance of the corset of *Thynnus*. Posterior dorsal and anal rays sometimes very slightly connected, or even forming detached finlets. Seventy-one species described in the *Histoire des Poissons*, and there divided into—

Trachurus, which have the whole lateral line strongly cuirassed.
Caranx, with only the posterior part of the line cuirassed. Body lanceolate. Finlets.
Carangus, low bucklers, low bodies, profiles nearly straight, and no finlets.
Citula, Carangi, with the tips of the dorsal and anal much prolonged.

Bleeker subdivides the genus into—*Megalaspis*, equivalent nearly to *Caranx*; *Decapterus*, of which *C. kurra* is a type; and *Caranx*, the type of which is *C. jarra*.

Genus XXV. Carangichthys, Bleek. Premaxillary and mandibular teeth pluriserial; those forming the external row longer, with some canines in front of the mandible; teeth on the vomer, palatines, and tongue. Preoperculum denticulated. Lateral line armed with spinous shields. Branchiostegals seven. Kema.

The genus *Caranx* is succeeded naturally by small groups of Scomberoids, having a compressed body and an elevated trenchant profile leading to *Vomer*, in which this compression and elevation are at a maximum. In these the keeled scales of the lateral line are comparatively feeble.

Genus XXVI. Olistes, Cuv. Resemble the *Citulæ* in their falciform acute dorsals and anals, and have in addition the middle rays of the dorsal and anal prolonged into long, simple, articulated filaments. Two species.

Genus XXVII. Scyris, Cuv. *Citulæ* with high trenchant profiles. The first or spinous dorsal concealed beneath the integuments; its spines lying against the interneurals. Anterior soft rays both of dorsal and anal prolonged. Two species.

Genus XXVIII. Blepharis, Cuv. Rhomboidal form. Spines of first dorsal very short; anterior rays of soft dorsal, and corresponding ones of the anal, prolonged into unbranched articulated filaments; long ventrals. A convex trenchant profile of moderate height. Three species.

Genus XXIX. Gallichthys, Cuv. Differs from *Blepharis* in having a higher profile, convex forehead, and vertical face. Body compressed, high. Ventrals long; caudal forked; first dorsal very low, in some reduced to a series of very short spines; anterior rays of the second dorsal and of the anal prolonged. Three species.

Genus XXX. Argyreiosus, Lacép. Profile descending in an oblique straight line from the occiput; not gibbous on the forehead. The dorsal line between the nape and the second dorsal, instead of ascending like that of Gallichthys, is almost horizontal, and on its posterior half it supports the first dorsal; the general form is therefore less rhomboidal. Ventrals, second ray of the first dorsal, and anterior part of the second dorsal and anal, long and pointed. Two species.

Genus XXXI. Vomer, Cuv. Oval form, but the gibbous profile of the forehead over the eye projects out of the oval, and the face is rather concave. From the forehead to the second dorsal the back is but slightly convex, being almost horizontal. The ventral curve is part of a regular ellipse. First dorsal very low and weak, and its posterior spines not connected by membrane; second dorsal and anal low and long, not pointed or falciform. One species.

Genus XXXII. Hynnis, Cuv. Like *Vomer*, but without a vestige of the first dorsal. Branchiostegals eight. Differs much from *Vomer* in its skeleton. Stomach siphonal, the pylorus being at the point of a dilated, compressed, triangular sac; pancreatic cæca numerous; very large air-bladder prolonged into two conical processes, one on each side of the tail. One species.

Tribe IV.—*Scomberoids, having no detached finlets, no isolated dorsal spines, and no lateral armature of the tail; divided into genera having two dorsals, and those which have only one.* (*a.*) *Two dorsals.*

Genus XXXIII. Seriola, Cuv. Differs from *Caranx* in wanting the armature of the lateral line, and from *Lichia* in the dorsal spines

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being connected by membrane. Villiform teeth on the jaws, vomer, and palatines. Ten species.

Genus XXXIV. Seriolella, Guichen. Body elongated, compressed; covered with very delicate scales. Head small, compressed. Jaw-teeth acute, compressed, moderately curved, distant, uniserial; vomerine teeth villiform; palatines smooth, edentate. Preoperculum ciliated. Two free spines before the anal. Two dorsals, the anterior one short, lower, spinous, but without a reclining spine in front; the second one extending far on the back; no spurious fins; ventrals thoracic. Lateral line not keeled. Branchiostegals six. Valparaiso, Juan Fernandez.

Genus XXXV. Temnodon, Cuv. *Seriolæ*, with thin lanceolate trenchant teeth, like those of *Cybium*, in the outer row; those on the vomer and palatines villiform. Body oblong. Small first dorsal; the two spines before the anal almost hidden. One species.

Genus XXXVI. Lactarius, Cuv. Differs in its dentition from *Seriola* in having two or four long canines among the villiform bands in front of the jaws. Vomer, palatines, and tongue rough. No free spines before the anal; two dorsals and an unarmed lateral line.

Genus XXXVII. Nomeus, Cuv. Differs from *Seriola* in having a smaller mouth. Teeth on the jaws curved, uniserial, widely set. No villiform bands behind. Ventrals large, exceeding considerably those of *Seriola*; no detached finlets. One species.

Genus XXXVIII. Gasterochisma, Rich. So closely allied to *Nomeus* that it is placed after it, though the detachment of the posterior rays of the second dorsal and anal would seem to send it to a different group, but the membrane of these fins is so delicate that it disappears in handling, and the normal condition may be that of continuous fins. Form of the body exactly that of a common Mackerel, but the scales are larger. Snout more pointed, and mouth larger than in *Nomeus*. No vestige of a crest or keel on the tail. Branchiostegals *five*. Ventrals one spine and five jointed rays; two dorsals contiguous, the first one higher than the second and rounded in outline; pectorals small; ventrals extremely large, folding into a deep slit on the edge of the belly, which is lined with scaleless integument. The anus, opening at the end of a short very slender tube, is included in this sheath. Teeth on the jaws, subulate, slightly curved, widely set in a single row; vomerine and palatine teeth more delicate and more irregularly placed. No detached spines before the anal; ventrals black, as in *Nomeus*. One species. New Zealand.

Genus XXXIX. Nauclerus, Cuv. Resembling *Naucrates*, but wanting the lateral keels on the tail, and with a preopercular spine.

Genus XL. Porthmeus, Cuv. Differs from *Nauclerus* in having a single dorsal, or rather in the spinous dorsal being absent, and in the whole edge of the preoperculum being denticulated; in the roughness of the mastoid bone, and in the presence of superorbital crests. Teeth on the vomer and palatines as in the preceding allies of *Seriola*. One species.

Genus XLI. Psenes, Cuv. Differs from *Seriola* and the groups which follow it, in having no teeth on the vomer or palate. Teeth on the jaws uniserial, short, thickish, standing widely apart, curved. Vertical fins partially scaly. Branchiostegals six. Two dorsals. Snout formed like that of *Trachinotus*. Five species.

(b.) One dorsal occupying most of the back, its rays flexible. Vertical fins partially scaly. Ventrals thoracic. Palatine teeth.

Genus XLII. Coryphæna, Linn. Thoracic Scomberoids, having elongated compressed bodies covered with small scales. Head trenchant above. Dorsal long, single, supported by flexible rays, most of which are not jointed. Head greatly elevated; facial profile convexly curved in the arc of a circle, descending rapidly. Eyes low. Mouth large. Teeth on the jaws and palatines card-like. Fifteen species.

Genus XLIII. Lampugus, Cuv. General form and dentition that of *Coryphæna*, but the head is oblong; forehead lower; the eyes of middle height. The dorsal low and equal. Six species.

Genus XLIV. Centrolophus, Lacép. *Coryphænæ* less elongated than *Lampugus*; a space between the nape and the dorsal; and no teeth on the palate. Five species.

Genus XLV. Astrodermus, Bonell. Allied to *Coryphæna*, *Scomber*, and *Zeus*. Head elevated and trenchant. Mouth small. *Four Branchiostegals.* Very small ventrals; *scales radiating like stars.* One species.

Genus XLVI. Pteraclis, Cuv. Differs from the general character of the family in having large scales, a low forehead, high dorsal, ventrals of few rays, and separated pancreatic cæca. The true position of the genus is still undecided. Body greatly compressed, with a long dorsal like that of *Coryphæna*, but so high that, in conjunction with the anal, it renders the fish higher than it is long. Ventrals slender, jugular. Scales much like those of *Brama*, but they do not extend to the branchiostegal membrane. Branchiostegals seven. Four species.

Genus XLVII. Stromateus, Linn., Bloch. No ventrals; a single dorsal with its spinous rays concealed in its anterior edge; vertical fins scaly. Scales small, lost in the skin. Pancreatic cæca scomberoid. Eleven species.

Genus XLVIII. Peprilus, Cuv., *Reg. An.* (*Rhombus*, Lacép.) American *Stromatei*, distinguished by the projection of the pointed and trenchant-edged pubic bones, thus forming a link with *Psettus*. Five species.

Genus XLIX. Luvarus, Rafin. Badly characterized. One species, said to have a small, flat, moveable appendix before the anus, serving as a kind of operculum. This distinguishes it from *Stromateus*.

Genus L. Seserinus, Cuv. Differs from *Stromateus* and *Peprilus* in having two very small ventrals, but has the internal structure of *Stromateus*. The ventrals composed of a spine and five soft rays. Branchiostegals six.

Genus LI. Kurtus, Bloch. Comes near *Peprilus*, from which the genus differs in having a shorter dorsal and well developed jugular ventrals. A long anal; and scales so fine as to become perceptible only by drying the skin. No scales on the fins. Branchiostegals seven. Pubic bones emitting a spine between the ventrals. Small trenchant plates before the dorsal, with a couchant spine at their base. Ribs dilated, convex, and forming rings which inclose the air-bladder in a tube that is prolonged under the vertebræ of the tail. Body high anteriorly, tapering posteriorly. One species.

DORY FAMILY.

M. Valenciennes described this group as the fifth great tribe of Scomberoids, distinguished from the other four by its members having all protractile mouths. He assigns as reasons for so placing them, that they are connected to the rest of the Scomberoids by many anatomical characters which they possess in common, by the similarity of their dermal constitution, and general family likeness. The *Zeides*, he says, have two dorsals, and some other osteological characters analogous to those of the Percoids; but the nature of their integuments, and the shields which arm their sides, ally them incontestably to the Scomberoids having a cuirassed lateral line. *Lampris*, which has also a protractile mouth, has viscera similar to those of *Thynnus*, and thus links the group closely to the rest of the Scomberoids. But he adds that the group is a natural one, which has relations to several others not less natural, and he divides it into two sections,—one in which the dorsal is so deeply divided as to appear like two; and a second in which the dorsal is continuous or single.

The best known example of the family, and one common enough on our western coasts, is the *Zeus faber*, or John Dory of Billingsgate. This was for long neglected in the London market, until Quin, whose gastronomic acquirements were well known, brought it into a repute which it still retains with city men; chiefly, we suspect, on account of the character which he gave it, for it is by no means a fish that adorns a table by its handsome aspect. The names of this fish, in the Bay of Biscay and the Mediterranean, have relation to the resemblance which its dorsals bear to a cock's-comb. In some places it is called "Sea-chicken," and in Gascony *Jau*, which signifies cock. In Spain, Languedoc, and Sardinia, it has the analogous names of *Gal*, *Gallo*, and *Gadda*. *Dory*, or *Dorée*, by which it is known on both sides of the British Channel, refers evidently to its yellow colour; and we suspect that the John which is prefixed in England is not *Jaune*, which would be merely a repetition of Dorée, but a corruption of the Gascon *Jau*, and, in fact, that it means the Gilt-Cock of the sea. The round black spot on the side has obtained for it, in common with the Haddock, the reputation of being the fish from which St Peter took the piece of money. In some of the Mediterranean ports it is called St Christopher's fish; and the modern Greeks call it *Christopsaro*, or Christ's fish, and hang it up in their churches. At the Canaries it is called *Gallo san Pedro* (St Peter's Cock).

Its excellence as an article of diet was known to Paul Jovius, who compares it to Turbot. Dories, very similar to the European fish, are found at the Cape of Good Hope, and

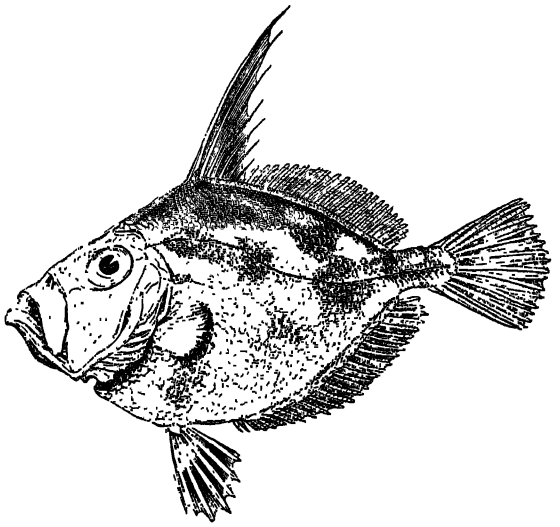


Fig. 115.
Capros australis.

in the seas of Japan. A distinct species exists in the Australian seas, which has the same black mark on the sides. The *Capros aper*, occasionally taken on the British coast,

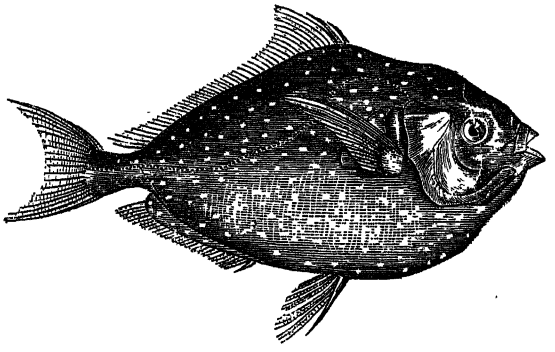


Fig. 116.
Lampris guttatus.

and more common in the Mediterranean, is also represented in the Australian seas. Indeed, the Scomberoids and the

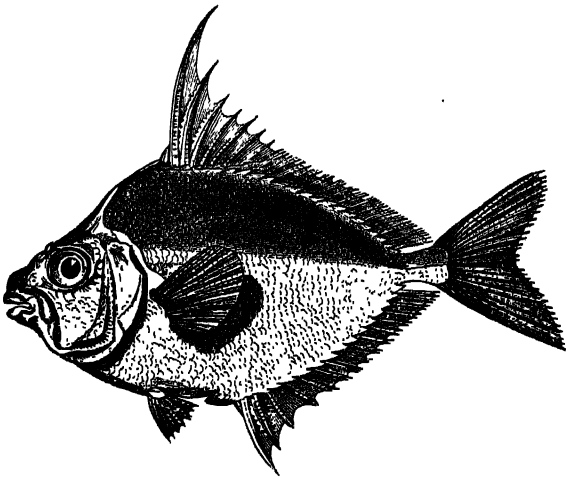


Fig. 117.
Equula serrulifera.

fishes most nearly allied to them, are very general in their distribution, appearing in almost precisely the same forms in the two hemispheres, and in both the Atlantic and Pacific sections of the ocean. The *Lampris guttatus* is a rare and beautiful fish of great size, whose headquarters seem to be in the northern seas. It is seldom taken on the British coasts, and still seldomer in the Mediterranean.

Classification—Acanthopterous Fishes.

The *Equulæ* are small fishes, very interesting from their forms, but of no great utility to man.

Family XVII.—ZEIDÆ.

Scomberoid fish, with protractile mouths, forming, in the *Histoire des Poissons*, the *fifth tribe of Scomberidæ*. Mouth very protractile. Feeble teeth, not numerous. Bodies oval, much compressed.

Genus I. Zeus, Linn. (*Zeini*, Bonap.) One dorsal deeply notched, or two contiguous dorsals, anterior one spinous, with filiform tips taller than the spines; ventrals rather before the pectorals; anal spines four. Caudal rounded. Dermal shields bony, along the bases of the dorsal and anal. A very protractile mouth. Branchiostegals seven. Teeth small and feeble. Stomach large, cæcal; pyloric cæca extremely numerous; air-bladder simple, oval, large. Six species.

Genus II. Capros, Lacép. Deeply notched dorsal, and a still more protractile mouth than *Zeus*; destitute of the spinous bucklers, but covered with very rough scales. Eye large. Caudal rounded. Branchiostegals five to eight. Spines of the anal two or three. Teeth very small. Two species.

Genus III. Caprophonus, Müll. and Trosch. Distinguished from *Capros* by a single row of upper and under teeth, by the roughness of the maxillary, and by the three spines of the anal forming a separate fin before the soft one.

Genus IV. Lampris, Risso. A single dorsal greatly elevated in front into a long falciform point, the low part running back to near the caudal; anal long and low; ventrals long, corresponding in form to the front of the dorsal under which they are attached; the dorsal has two small short spinous rays in front, and the anal only one. Scales small, very thin. Stomach cæcal, conical; pancreatic cæca above sixty, each dividing dichotomously several times; air-bladder very large, terminated behind by two short, horn-like processes. One species.

Genus V. Equula, Cuv. Small Scomberoids. Mouth small, protrusive as in *Gerres*, furnished with fine teeth like those of a *Chætodon*. One or two small spines on the anterior frontal; near to which are the two contiguous orifices of the nostril. A small osseous crest behind the nape in front of the dorsal, and a similar one between the anus and anal fin, sometimes spinous at the tip. Anal and dorsal fins long, higher in front, the second and third spines being strong and tall; ventrals under the pectoral consisting of a strong spine, and five soft rays. Body oval, much compressed; serrated along the bases of the dorsal and anal. Very small smooth scales. Branchiostegals generally eight, sometimes nine. Stomach cæcal, conical; two pancreatic cæca; air-bladder having two projections posteriorly. Twenty-four species.

Genus VI. Mene, Lacép. Body high; the dorsal profile being a flat curve, the ventral one very convex, with the ventrals at its apex under the pectorals, but at a great distance from the head; the intervening thoracic space presenting a trenchant edge, supported by the pubic bones and coracoids. Mouth protractile. Ventrals with a very short spine and five articulated rays, the first one being long. Dorsal, with four spinous rays, more elevated in front but low posteriorly, and extending to near the caudal; anal long and very low, its very short rays much branched; caudal forked. Skin smooth and satiny. Stomach siphonal; pancreatic cæca numerous, extremely slender, and having very delicate coats; air-bladder very large. One species.

CHÆTODONTS

Have received the name of *Squamipennes*, because the softer, and frequently also the spinous, portions of the dorsal and anal fins are covered with scales, which, as it were, encrust them, and render their discrimination from the rest of the body by no means easy. This is the most obvious character of these fishes, of which the form is in general much compressed. The intestines are rather long, and the cæca numerous. This family was comprised by Linnæus in his genus *Chætodon*, so called from the long, slender, and hair-like character of the teeth; and the species in general

Classification—Acanthopterous Fishes.

are alike remarkable for their singular forms and splendid colours.

The seas of the torrid zone have indeed no cause to envy the productions of those famous lands, the shores of which they have so long bathed with their translucent waters. If the equatorial regions of Africa and America possess, among their feathered tribes, the brilliant Souimangas, the lustrous Humming-birds, and the gorgeous Chatterers, the intermediate ocean and the Indian seas contain countless thousands of the finny race which surpass even these in splendour. The Chætodons, in particular, form a family on which nature has bestowed her ornaments with a lavish hand. The deep purple of the iris, the paler richness of the rose, the azure blue of the crystalline sky, the darkest velvet black, and deepest violet tint of the pansy, are seen combined with metallic radiance on the pearly bodies of this resplendent group. The eye of man receives the greater pleasure from their contemplation, in that, being of moderate or small size, and haunting habitually the coral basins of the transparent tropical seas, they disport themselves in the beams of a vertical sun, as if desirous of exhibiting their splendid liveries to the greatest advantage in the blaze of day.

TABLE OF GENERA.

No palatine teeth.
Brush-like teeth on both jaws. TRIBE I.
Preoperculum not spinous.
Dorsal single, wholly scaly.
None of the dorsal spines ending in filaments.
CHÆTODON, CHELMON.
Some of the dorsal spines with filamentous tips.
HÆNIOCHUS, ZANCLUS.
Dorsals two, the soft one alone scaly.
Three anal spines; scales large.
EPHIPPUS, DREPANE.
Four anal spines; scales small, imbedded.
SCATOPHAGUS.
Dorsal merely notched.
TAURICHTHYS.
Preoperculum bearing a strong spine.
HOLOCANTHUS, POMACANTHUS.
Exterior teeth tricuspid; interior ones villiform.
PLATAX.
Fine and short villiform teeth on the jaws.
PSETTUS.
Palatine teeth present.
Trenchant teeth on both jaws. TRIBE II.
PIMELEPTERUS, DIPTERODON.
Card-like teeth on both jaws. TRIBE III.
BRAMA.
Villiform teeth.
PEMPHERIS, TOXODON.

These genera are placed in tribes in the *Histoire des Poissons*. The first tribe being the Squamipennes with

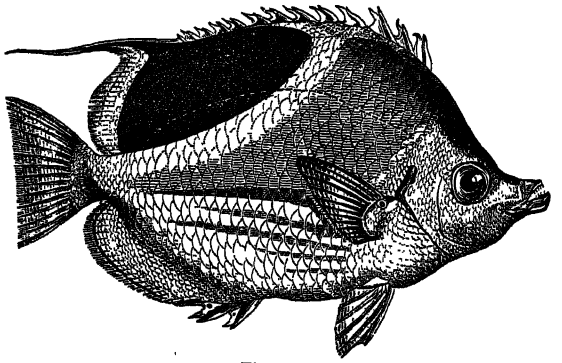


Fig. 118.
Chætodon ephippium.

brush-like teeth, forming the Linnæan genus *Chætodon*, whose name is framed to describe this kind of dentition, in which the individual teeth are longer and stouter than villiform teeth, and resemble the strong bristles of a clothes-brush. In fig. 53 the coarse brush-like teeth of *Histiopterus recurvirostris* are well shown. The tissue of the teeth of most Chætodonts is albuminous, they have a yellowish colour, and are flexible and elastic, but when dry easily broken.

When once a person has seen several typical fishes of this group, he readily recognises the family character. The dense scaliness of the fins, which gradually taper out of the thickness of the body, so that one cannot tell without dissection where the one ends and the other begins, is very different from the small scales which creep on the membrane or rays of the vertical fins of some Sciænoids, as *Nebris*, *Lepipteris*, &c., and these never have the flexible, bristle-formed teeth of horny texture with which the true Chætodons are furnished; and, moreover, show more or less of the muciferous development of the bones of the head and face characteristic of Sciænoids, giving them their blunt facial profile. The Hæmulons come nearer to the *Squamipennes*, but the bases of their vertical fins are set on abruptly on the back and belly, and do not slope off into the sides. The Chætodons of the Red Sea were known to the ancients. Ælian speaks of them under the name of *Citharœdus*. None of the species come into the seas of Europe, except the *Brama Raii*, which wanders occasionally to the coasts of England. The Chelmons are Chætodons with a tubular prolongation of the premaxillary and mandible, in form of a long, slender snout.

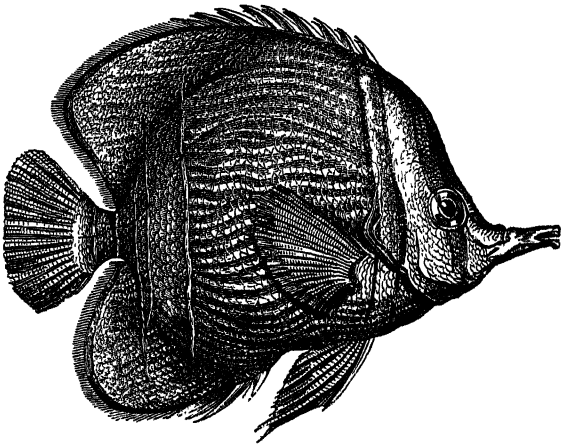


Fig. 119.
Chelmon marginalis.

The species here figured was unknown to the authors of the *Histoire des Poissons*, but its habits, from the great similarity of its conformation, may be considered as similar to that of the two species described in that work. *Chelmon rostratus*, or *enceladus*, is an inhabitant of the sea and rivers of Java, and has the instinct of throwing a drop of water from its bill, so as to light upon any insect resting on a leaf or blade of grass near the stream, and thus make it fall that it may instantly dart upon it. This was observed recently by M. Reinwardt, and an account to the same import is contained in the *Philosophical Transactions* for 1764. The Chinese residing in Java keep this fish in jars, and tempt it to practise its peculiar art for their amusement, by placing an insect on a rod or thread within range of its shot.

Zanclus cornutus of Cuv. has become, on account probably of its singular form and horned front, an object almost of superstitious reverence among the fishermen of the Moluccas. It is alleged, that when they happen to capture one of this species, they immediately salute it by certain genuflexions, and then cast it into the sea. It is, however, an excellent table fish, which attains a weight of 15 lbs.,

Classification—Acanthopterous Fishes.

and resembles the Turbot in flavour. It is rather widely diffused, occurring both in the Indian seas and Pacific Ocean.

Baron Cuvier has remarked, that among all the strange and fantastic fishes preserved in the representations of Ruysch, Renard, and Valentyn, and which have so long excited the mistrust of naturalists, none seems more likely to provoke that feeling than the species which these writers designate by the Malay name of *Skankarbauw*, or Buffalo-fish; and yet it now turns out that none is more accordant with the truth of nature. Its sharp recurved horns, the protuberance above the head, the compressed and unequal spines, and the singular distribution of colour,—all exist in a species recently received from the Indian Archipelago. It has accordingly been named *Taurichthys* by Cuvier—the Greek translation of the Malay name. The species here

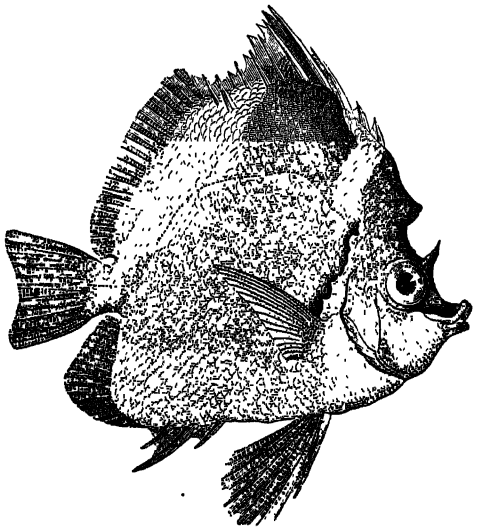


Fig. 120.
Taurichthys varius.

figured is *T. varius*, which is from four to six inches long, with a height almost equal to its length.

The species of *Holocanthus* are remarkable for the great beauty and symmetrical distribution of their colours, and for their excellence as articles of food. They are numerous

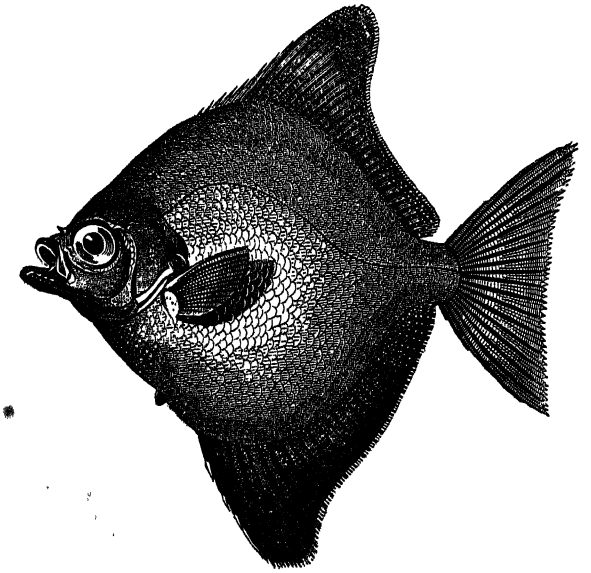


Fig. 121.
Psettus argenteus.

both in the Indian and American seas. One of the most celebrated for the splendour and singularity of its aspect is that named the *Emperor of Japan* by the Dutch, and the *Chætodon imperator* of Bloch, figured in many works. Its body is deep blue, traversed all over by about two and thirty narrow bands of orange yellow. The pectoral fins are black, and the entire tail bright yellow. It is a large fish of its kind, sometimes attaining the length of 15 inches, and, as an article of food, is one of the most esteemed of all the Indian species, resembling our own much-prized Salmon in flavour. Another and more recently discovered species is *H. semicirculatus*, Cuv. It occurs both at Timor and New Ireland. Its colours are white and blue; its length from 4 to 5 inches. The inhabitants of Waigiou call it *Mami*.

Many fish of this family are remarkable for bony enlargements of some part of their skeleton, very often of the interneural bones. In the *Ephippus gigas* the top of the skull is swelled out into a solid mass, which hangs forwards like the crest of a helmet, or like the skull of a Rhamphastos, and the interhæmal which supports the first two anal spines is also curiously swollen. *Platax arthriticus* is another member of the family which derives its name from these gout-like

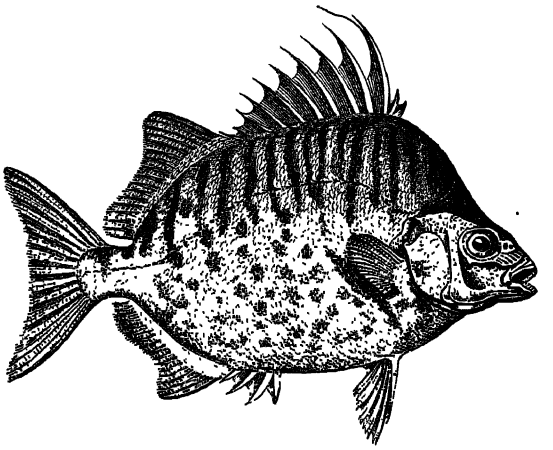


Fig. 122.
Scatophagus multifasciatus.

swellings of some of its bones. *Psettus argenteus* is a Chinese and Australian species, represented by fig. 116; and *Scatophagus multifasciatus* is another handsome fish of the southern seas.

The *Toxotes jaculator* (fig. 118) is a small Javanese species, measuring 6 or 7 inches in length, remarkable for

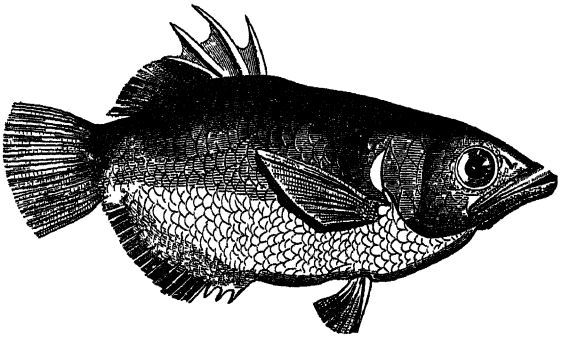


Fig. 123.
Toxotes jaculator.

possessing the same faculty as that mentioned in our notice of *Chelmon rostratus*. When it perceives a fly or other insect upon an aquatic plant, it dexterously drives it into the water by a shower of drops. Cuvier received a specimen from Batavia, the stomach of which was entirely filled with ants. This species has been erroneously multiplied in systematic works. It is twice described by Shaw under two

different names (*Scarus Schlosseri* and *Labrus jaculator*), neither of which is the right one; and there is no doubt of its being identical with Hamilton Buchanan's *Coius chatereus*, a supposed new species from the Ganges. It seems pretty widely distributed throughout the Indian Archipelago, and is known to the Malays by the name of *Ikan-sumpit*.

Family XVIII.—CHÆTODONTIDÆ, Bonap.

Squamipennes, Cuv. The most apparent character of this family is the incrustation of the soft portions of the dorsal and anal fins, and often of the spinous parts also, with scales. Scales strongly ctenoid. Body generally greatly compressed. Intestines long, and pyloric cæca numerous. Dentition various, giving rise to generic subdivisions.

(*a.*) Chætodontini, Bonap. Brush-like teeth on the jaws, none on the palate.

Genus I. Chætodon, Linn. Preoperculum not spinous. Dorsal single, entirely scaly; no prolongations of its spinous rays, but the soft dorsal sometimes ending in a long filament. Muzzle comparatively short, but more or less projecting. Teeth like long bristles densely crowded. Pyloric cæca long, slender, and numerous; air-bladder strong. Body compressed, elliptical, or nearly orbicular. Tail short. Caudal truncated. Head small. Branchiostegals six. Spinous rays, in most twelve or thirteen in the dorsal, and three in the anal. Sixty-five species.

Genus II. Chelmon, Linn. *Chætodons*, with a long slender bill, formed by the elongation of the premaxillaries and mandible. Maxillary roundish. Mouth very narrow, at the end of the bill; teeth short, villiform. Body very high. Dorsal and anal high and scaly; caudal square. Scales large. Three species.

Genus III. Megaprotodon, Guich. Distinguished from *Chætodon* by a cluster of longer teeth, with hooked points, situated on the end of the mandible. Algiers.

Genus IV. Heniochus, Cuv. No preopercular spines. Spinous rays of the single dorsal much graduated, the third or fourth one having a long filamentous tip, like a whip-thong. Body covered with large scales. Branchiostegals five. Body obliquely rhomboidal, the apex of the soft anal and the filamentous dorsal spine being at opposite angles, and the mouth and soft dorsal forming the other two corners. Profile nearly vertical. Preoperculum serrated. Five species.

Genus V. Zanclus, Comm. No preopercular spines. The filiform-tipped spinous dorsal ray of *Heniochus*, and nearly the same form of body, but the scales are extremely small. Muzzle more tubular and projecting, but not so much as in *Chelmon*. Posterior parts of the soft dorsal and anal low, with a straight inclined outline, so that the mouth and tail are the opposing angles of the rhomb; the other two being the long dorsal spine and apex of the soft anal, as in *Heniochus*. Stomach cæcal, of moderate capacity; fourteen pancreatic cæca. Two species.

Genus VI. Histiopterus, Schleg. Resembling *Heniochus* and *Taurichthys* in the form of the body. Dorsal fin very tall, with four strong spines, without scales. Cheeks scaly. Preoperculum, operculum, and top of the head and snout presenting the granulated surfaces of the bones. Snout more or less elongated and tubular, the elongation being chiefly in the nasal, vomer, and lower limb of the preoperculum and other bones supporting the jaws, which are at the extremity of the snout. Teeth coarsely bristle-formed, blunt, crowded, in a wide band on the jaws. Eye large. Three species.

Genus VII. Ephippus, Cuv. No preopercular spines. Dorsal deeply notched between the spinous and soft portions; the spinous part being destitute of scales, and capable of folding into a scaly furrow on the back as in the Sciænoids. Three anal spines. Body oval or nearly orbicular. Ventral profile almost horizontal. Pectoral fins short. Branchiostegals six. Four species.

Genus VIII. Drepane, Cuv. *Ephippi*, with long pointed pectorals. Bodies high and more rhomboidal, the ventral profile descending to the soft anal. Branchiostegals six.

Genus IX. Scatophagus, Cuv. Dorsal deeply notched between the spinous and soft part. No preopercular spines; four anal spines. Scales small, lost in the epidermis, but ctenoid in structure. Body a broad oval. Tail between the vertical fins very short. Stomach siphonal; many pancreatic cæca; air-bladder simple, pretty large. Six species.

Genus X. Taurichthys, Cuv. Dorsal less deeply notched. A protuberance on the occiput, and a horn opposite the middle of each orbit. Ventrals rather large. Form unevenly subrhomboidal, higher than long. The dorsal apex formed by the fourth or fifth spinous ray; second anal spine the largest. Preoperculum not spinous. Face concave. Two species.

Genus XI. Holocanthus, Lacép. Dorsal single, scarcely notched, or wholly even. A large spine at the angle of the preoperculum. Body a regular oval. Vertical fins all scaly. Border of the preoperculum generally serrated. Branchiostegals six. Twenty-six species.

Genus XII. Pomacanthus, Cuv. More elevated than *Holocanthus*, but still having a nearly oval form. Preorbitar and preoperculum always with entire edges, but with the strong spine at the angle of the latter. Dorsal spines generally fewer than in *Holocanthus* (nine, or rarely ten); anal spines three or more, deeply imbedded in front of the anal. Teeth furnished with two short lateral points, as in a few *Holocanthi*. Six species.

Genus XIII. Platax, Cuv. Setiform brush-like teeth, but in front of them a row of trenchant teeth trilobate at the points, as in a few *Holocanthi*, but more evident in this genus. Body very much compressed and elevated, so that it appears to graduate insensibly into the dorsal and anal, which taper to long points; the entire height of the fish much exceeding its length; these fins are scaly, and the spinous rays (which are few in the dorsal) are buried in their front edges. Ventrals long and pointed; caudal rounded. Branchiostegals six. Fourteen species.

Genus XIV. Psettus, Comm. Body compressed. Dorsal and anal scaly, with the points more or less falciform. Spines almost concealed; might form a group in the genus *Chætodon;* but the teeth are rather villiform than setiform Ventrals reduced to a single spine, the short rays being obsolete. Branchiostegals six. Some are more elevated, and others more rounded or oval. Dorsal spines eight; anal spines three. Three species.

Genus XV. Hypsinotus, Schleg. Ventrals close to the anus; soft dorsal low. Height of the body nearly equal to its length. Branchiostegals six.

Tribe II.—Pimelepterini (Bonap.) *Chætodontidæ, with palatine teeth and with trenchant teeth on the jaws.*

Genus XVI. Pimelepterus, Lacép. (*Dipterodon* and *Xysteres*, Lacép.) Distinctive character, uniserial teeth, each having a trenchant limb rising at a right angle from a horizontal heel. Body oblong. Head obtuse. Dorsal single. Fins thickish; the soft rays being densely covered with scales. General aspect much like that of *Crenidens*. Head scaly. Ten species.

Genus XVII. Dipterodon, Cuv. Much like *Pimelepterus*, but the dorsal is deeply notched anterior to the soft rays, and the incisorial teeth want the bony heel. Branchiostegals six. One species.

Tribe III.—*Chætodontidæ, with villiform or card-like teeth on the jaws and palate. Included in Pimelepterini of* Bonap.

Genus XVIII. Brama, Bloch, Schneid. Vertical fins covered with scales, the articulated dorsal occupying much of the back, and, as is usual in the family, higher in front, on the border of which three spinous rays are buried; becoming low posteriorly. Anal shorter, but similar in form. Mouth nearly vertical when closed. Teeth card-like on the jaws and palatines. Body compressed, ovate in outline, obtuse at the facial end, tapering into the tail. Snout very short and forming part of the obtuse profile. Branchiostegals seven. Stomach short; pancreatic cæca five. Three species.

Genus XIX. Nemobrama, Valenc. (*Polymixia nobilis*, Lowe.) Body oblong, covered with very rough scales. Head small, scaly. Snout and upper jaw naked. Mandible scaly, with two long symphysial barbels. Teeth on the jaws, palatines, vomer, and tongue, minute, densely crowded, villiform. Opercular bones unarmed and scaly, except the interoperculum, which is naked and skinny. Dorsal fins united; ventrals seven-rayed. Branchiostegals four.

Genus XX. Crius, Valenc. (*Leirus*, Lowe.) Body compressed, keeled anteriorly, clothed wholly with smooth scales. Head small, truncated, scaly. Preoperculum furrowed on the limb, with an entire margin without spines; operculum, subopercular, and interoperculum without spines or serratures, but sub-ciliated. A single series of very small setaceous teeth. Dorsal, anal, and caudal fins scaly. Branchiostegals six.

Genus XXI. Scorpis, Valenc. Unites the characters of *Trachinotus* and *Platax;* and, but for the teeth covering all parts of the roof of the mouth, might have entered the latter genus. Body compressed, oval. Muzzle short and rounded, forming part of the circumference of the oval profile. Broad band of villiform teeth on the jaws, vomer, and palatines; those on the pterygoid bones exceedingly minute. Most of the head scaly. Scales strongly ciliated. Ventrals, a spine, and five articulated rays. Two species.

Genus XXII. Pempheris, Cuv. Similar to *Brama* in outline, except that the occiput and shoulder are less convex, and the posterior parts taper more. The teeth are villiform. The short and

Classification—Acanthopterous Fishes.

high dorsal is over the posterior half of the pectorals, occupying but little of the back, while the long anal resembles that of *Brama*. Eye large. Air-bladder double as in *Myripristes*. Resembles *Kurtus*, but differs in the magnitude of the scales on the fins. Its short dorsal and scaly anal, with the existence of vomerine and palatine teeth, separate the genus from the *Sparidæ*. Eight species.

GENUS XXIII. TOXOTES, Cuv. A short compressed body, with the dorsal placed on the posterior half of the back. Very strong spinous rays; the soft parts and the anal scaly, and opposite to each other. Scales large. Snout depressed, short; mandible advancing beyond the premaxillary. Very short, close, villiform teeth on the jaws, end of the vomer, and palatines; also on the pterygoids and tongue. Minute denticulations on the border of the preorbitar and preoperculum. Stomach short and large; twelve pancreatic cæca; air-bladder large and thin-coated. One species.

GENUS XXIV. HOPLEGNATHUS, Rich. (March 1841.) (*Scarodon*, Schleg. 1844.) Compressed oval Chætodontoids, with the soft dorsal and anal opposite, and scaly; spinous portion of the dorsal longer, but lower than the soft part; ventrals a little behind the pectorals. Jaws and teeth of *Scarus*. Scales feebly ctenoid, imbedded deeply in the skin, few on the head, and confined to the temporal region. Branchiostegals seven. Three or four species.

RIBBON-FISH.

A natural family nearly allied to the Scomberoids, and having bones of a still looser texture than the Mackerels, in most little more solid than a fibrous net-work. Cuvier included *Lepidopus* and *Trichiurus* in this family, but we have followed M. Valenciennes in placing these two genera at the end of the first tribe of Scomberoids, and along with them *Nemichthys*, whose greatest affinity seems to be with *Trichiurus*. M. Valenciennes, however, considers the two genera in question to be a link between the families, and to be connected with the elongated Scomberoids by their strong compressed curved teeth; while they have an equal relationship to the Tænioids by the presence of ventrals merely in a rudimentary condition, or their entire absence.

The first tribe, being the Ribbon-fish, which have small mouths, includes those to which this family name applies best, because species exist which are nine or ten feet long, yet are not six inches high, and scarcely an inch thick. The *Trachypteri* have several rays in the ventrals; the *Gymnetri* only one or two filamentous rays; and *Stylephorus*, still imperfectly known, appears to be truly apodal. Few fish of so much interest, from the singularity of their appearance, and the peculiarities of their structure, are so imperfectly known. This arises in a great measure from the delicacy of their texture. They are constructed for inhabiting the still waters of great depths, and are seldom seen except when thrown ashore in tempests. Their tender fins are easily mutilated, their thin soft flesh rapidly decays, their bones have too little firmness to keep the skeleton together when rudely handled, and they almost never come before a naturalist in a perfect condition. M. Valenciennes had twenty individuals under examination when he drew up his history of the family, and he has done much to remove the confusion which the imperfect and contradictory descriptions of authors, framed on mutilated specimens, had created. The *Trachypteri*, he says, are extremely tender, and their fins brittle, and their entire form can be seen in very young individuals only. The woodcut fig. 4 represents one species, *Trachypterus falx*, which has 168 rays in its dorsal fin, and plumes of rays on the head and tail. This fish shines with the most brilliant silvery tints, and when moving freely in the water, its varying hues relieved by three large round black spots on the sides, must render it one of the prettiest of the many elegant fish that the seas produce. The anatomy of *Trachypterus leiopterus* is given in the *Histoire des Poissons*, and the stomach is there described as cæcal, long, and narrow, with a very short ascending pyloric branch arising from its lower third part. The pancreatic cæca are almost innumerable, and open into the intestine by two parallel rows of holes. It had no air-bladder. The *Vaagmaer*, or *Deal-fish*, has also been recorded by Dr Fleming as a British species. It is the *Trachypterus bogmarus* of the *Histoire des Poissons*, the *Gymnetrus* or *Gymnogaster arcticus* of previous authors, and is described in the *Natural History of Iceland*, written in 1658 by Jon Gundmunsen, a native of that island. Nilsson includes it among the Norwegian fish, but as one very rarely seen. The Supplement to Yarrell's *British Fishes* contains a figure and description of one taken in Iceland, translated from a memoir by Reinhardt, curator of the Museum at Copenhagen. The *Gymnetrus Hawkinsii* is another rare British Ribbon-fish. The *Stylephorus chordatus* of Shaw was taken in the Gulf of Mexico, and is known only by a single specimen in possession of the College of Surgeons of London, but which is not, unfortunately, in the best condition. The long filament from which it derives its name is considered by Blainville to be a prolonged ray of the caudal fin, and not a lengthened spine as in *Trichiurus*. The *Cepola rubescens*, Red-band Fish or Red-snake Fish, belonging to the second tribe of Ribbon-fish, though not common on the English coast, is sometimes taken in numbers, as was the case about twelve years ago in Torbay.

FAMILY XIX.—TÆNIIDÆ.

TÆNIOIDES OU POISSONS EN RUBAN, Cuv. Compressed, elongated, ribbon-shaped fish. Skin naked and silvery. Long dorsal often joined to the caudal; the anal when it exists similarly connected; the articulated fin-rays for the most part simple; soft rays of the ventral never exceeding five, sometimes reduced to one or two, attached to the throat. This character brings them near the Blennies, while the small mouth and protractile snout of *Trachypterus* indicate some analogy with the *Zeiides*.

ANALYTICAL TABLE OF THE *TÆNIIDÆ* (Dum.)

Dorsal conspicuous, and		
Long, without spines..	CEPOLA	4.
Short, and far back	LOPHOTES	5.
Dorsal none.		
Lateral line armed with spinous scales	TRACHYPTERUS	1.
Lateral line not scaly.		
Ventrals uniradiate	GYMNETRUS	2.
Ventrals none	STYLEPHORUS	3.

TRIBE I.—*Mouth not wide; jaw protractile.*

GENUS I. TRACHYPTERUS, Cuv. (*Bogmarus* and *Gymnogaster*, auct.) Pectorals of moderate size or small; ventrals often greatly developed, attached under the axilla of the pectorals, and having several soft rays (four to seven). Body elongated and compressed like a ribbon or blade of a sword; skirted along the whole dorsal edge by the dorsal fin, the anterior part of which, separated by a notch, rises like a tall slender fan. Mouth extremely protractile. Caudal having an upper lobe similar to the first dorsal in form and height, and a few very short rays on the lower lobe; between these there is a small filament. Lateral line armed with scales, each carrying a hook. Jaws with visible teeth. Skeleton fibrous, but extremely tender. Fins brittle and wearing down by age. Branchiostegals six or seven. Six species.

GENUS II. GYMNETRUS, Cuv. Ventrals reduced to a single elongated ray, which is often dilated at the extremity. Branchiostegals four, five, or six. Eight species.

GENUS III. STYLEPHORUS, Shaw. *Trachypteri* with the point of the tail prolonged in form of a slender cord twice the length of the body. Dorsal commencing over the operculum, and extending to very near the posterior extremity of the fish, on which is the caudal, placed so as to resemble a second dorsal; the long cord which terminates the tail is the lower ray of this caudal. No visible scales. No visible trace of ventrals. One species.

TRIBE II.—*Tæniidæ, with a moderately large mouth.*

GENUS IV. CEPOLA, Linn. Head much like that of *Amblyopus* and *Ophidium*, but with a large eye. Body greatly elongated and very much compressed, with a dorsal reaching from the head to the caudal, and an anal but little shorter. Caudal pointed; ventrals

Classification—Acanthopterous Fishes.

attached under the pectorals. Muzzle obtuse. Cleft of the mouth nearly vertical. Teeth acute. Only two or three of the very numerous dorsal rays are simple, and only two on the anal, and they are as flexible as the jointed ones. The only bony and pungent spine is that of the ventrals. Twelve species.

Genus V. Lophotes, Giorna. Head short, surmounted by a very elevated osseous crest, which inclines forwards beyond the mouth, and has a long and strong spinous ray articulated to it, bordered behind by membrane. The space between the spine and the caudal is occupied by a long, low, even dorsal, sustained mostly by simple rays. Caudal distinct, small; a very short anal close to the caudal, and just before it the anus, the abdominal cavity occupying nearly the whole length of the body; pectorals of moderate size; ventrals close behind them, excessively small, composed of a spine and five soft rays. One species.

Genus VI. Krohnius, Cocco. Snout short. Mouth deeply cleft. Body elongated. Head blunt; teeth on the jaws; a barbel on the chin. Anus near the head. First dorsal short and high, the second extending along the whole of the back to the end of the tail; anal similar to the second dorsal, also reaching to the point of the tail; ventrals tapering into long filaments.

Genus VII. Bibronia, Cocco. Lancet-shaped, compressed. Head declivous. Jaws toothless. Single dorsal extending forwards and connected through the caudal with the long anal; rays of the ventrals elongated.

Genus VIII. Pelori, Cocco. Distinguished from *Bibronia* by the dorsal and anal, being separated from the caudal. Teeth on the jaws.

Bibronia and *Pelori* belong to a sub-family of *Fœniidæ*, designated *Bibroninæ* by Cocco, but whose characters we have not been able to procure.

TEUTHYOIDS.

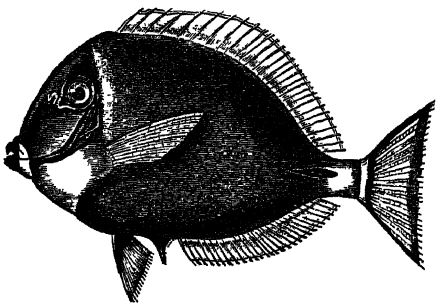


Fig. 124.

Acanthurus Delisianus.

This family is entirely strange to the European seas. Gronovius described the first known genus under the name of *Hepatus*, which Linnæus afterwards changed to *Teuthyes*, a name unfortunately used also to designate a genus of Cephalopods, and which on that account has been replaced in later times by Forskäl's term of *Siganus*. The name of the family has, however, been preserved in the *Histoire des Poissons*, as derived from the Linnæan appellation. The group is a natural one, having the characters assigned to it in the table, and a family physiognomy easily recognisable. They are common enough fish in the Indian and Pacific oceans. One species is known as the "coral shoemaker" at the Seychelle Islands. They feed on marine algæ, and must be pretty objects in the coral basins that they frequent, where the clearness of the water allows them to be distinctly seen. They are not the objects of any special fishery, and their history can be best studied in the detailed account of species contained in the *Histoire des Poissons*.

No. 16 represents *Naseus longicornis*.

Family XX.—TEUTHYDIDÆ, Bonap.

Teuthyes, Cuv. Oval forms, compressed. Small mouth, not protractile. Uniserial teeth on both jaws. Palate and tongue toothless. A single dorsal. Branchiostegals four or five. Scales cycloid. Pectorals moderate in size. Ventrals under the axillæ of the pectorals. Many of the genera have the sides of the tail armed, or a recumbent spine in front of the dorsal. Phytophagous fishes.

ANALYTICAL TABLE OF THE *TEUTHYDIDÆ* (Dum.)

Classification—Acanthopterous Fishes

Sides of the tail armed with—		
Several bucklers in one row	Prionurus	4.
Two immoveable plates with trenchant edges	Naseus	3.
A moveable blade in a furrow	Acanthurus	2.
A fixed blade, trenchant on both edges	Axinurus	5.
Sides of the tail unarmed.		
Dorsal deeply notched or double	Amphacanthus	1.
Dorsal single, spinous in front.		
One dorsal spine elongated	Keris	7.
Several (five) dorsal spines, of equal height	Priodon	6.

Genus I. Amphacanthus, Bloch. (*Buro*, Commer.; *Siganus*, Forsk.; *Centrogaster*, Houtt.) The peculiar character of this group is to have a *spine in the ventrals on each side of the articulated rays* which vary from three to five; in other respects they have the body oval. Mouth small and but little protractile. Teeth small, denticulated and uniserial. Five branchiostegals, the last one dilated and concealed in the isthmus. A recumbent spine in front of the dorsal; numerous spinous rays in the anal. The epicoracoid is cylindrical or prismatic, and is reflexed so as to be attached to the anterior interhæmals of the anal. The spines of the dorsal are thirteen, and only accidentally fourteen; the anal spines seven. Thirty species.

Genus II. Acanthurus, Forsk. *A strong moveable trenchant spine on each side of the tail.* Head elevated, compressed. Eye high up. Five branchiostegals. Teeth uniserial, incisorial, denticulated. A single dorsal. Skin thick, generally clothed with small scales. They want the additional spine in the ventrals which distinguishes *Amphacanthus*; and the epicoracoid is not developed as in that genus. Fifty species.

Genus III. Naseus, Commer. Tail armed with two osseous bucklers carrying trenchant spines, not moveable. Teeth conical, pointed, without denticulations; a horn-like projection above the muzzle. Four branchiostegals, more rarely five. Three articulated rays on the ventrals and a spine; spines of the dorsal five or six, and two in the anal; soft rays in both fins numerous. Intestinal canal extremely long; four pancreatic cæca; a pretty large air-bladder: Fourteen species.

Genus IV. Prionurus, Lacép. Teeth crenulated as in *Acanthurus*, in which the genus differs from *Naseus*. Tail armed by a series of horizontal, fixed, trenchant spines; a couchant spine before the dorsal. Branchiostegals five. Five pancreatic cæca. Two species.

Genus V. Axinurus, Cuv. et Valenc. Distinguished from *Naseus* by a more elongated form similar to that of *Thynnus*. A very small mouth, and excessively slender teeth. Armature of the tail consisting of a single blade cut squarely like the edge of a hatchet, and not springing from a buckler. It resembles *Naseus* in its general roughness, and in having three soft ventral rays. Branchiostegals five. Spinous rays of the dorsal four; of the anal two. One species.

Genus VI. Priodon, Cuv. Allied at once to *Naseus*, *Acanthurus*, and *Amphacanthus*, forming an intermediate link of union between them. Branchiostegals three. Spines of dorsal five, and of anal two. Teeth serrated as in *Acanthurus*. Ventrals having only three jointed rays as in *Naseus*. Forehead a little enlarged before the orbits, and the tail without armour as in *Amphacanthus*.

Genus VII. Keris, Cuv. The advanced position of the ventrals before the pectorals and immediately under the eye distinguishes this genus from the rest of the family; but it has affinities with them. The teeth fine, smooth, and pressed one against the other as in *Axinurus*. Tail without armature as in *Priodon*. Spines of the dorsal seven; of the anal three; ventrals of five soft rays and a spine. No scales, but the skin is granulated so as to resemble mosaic.

FLUTE-MOUTHS.

This family, established by Cuvier under the name of *Fistulares* or *Bouches-en-flute*, is not described in the *Histoire des Poissons*, the rich accumulations of species in the Paris Museum remaining still unpublished; and we are unable to add anything of moment to the account of the family contained in the *Regne Animal*, ii., p. 267. Specimens of several members of the family are imported in the insect boxes which the Chinese keep for sale to Europeans, and which contain many small fishes dried and pinned down like insects, often of curious forms, that reach our museums in no other way.

Fig. 12 represents one of the abbreviated forms of the family in the Australian *Centriscus humerosus*.

Classification—Acanthopterous Fishes.

FAMILY XXI.—AULOSTOMIDÆ, Müll.

Bouches-en-Flute, Cuv.; *Aulostomi* (*Röhrenmauler*), Müll.; *Aulostomatidæ*, Cant. Characterized by the prolongation of the nasal, vomer, preopercula, interopercula, pterygoids, and tympanics, into a long tube, with the mouth at the extremity, formed as usual of the premaxillaries, maxillaries, palatines, and mandible. The intestines have no great dilatations nor many folds, and the ribs are either short or wholly absent.

ANALYTICAL TABLE OF THE *AULOSTOMIDÆ* (Dum.)

Dorsal single, and
- Preceded by spines.....AULOSTOMA 2.
- Not preceded by spines.....FISTULARIDÆ 1.

Dorsals two.
- Conspicuous, the first ray stiff, denticulated.....CENTRISCUS 4.
- Sheathed beneath a kind of shield.....AMPHISILE 5.

GENUS I. FISTULARIA, Linn. Mouth of small extent, placed at the extremity of the tubular face, having a nearly horizontal gape. The elongated head constitutes a third or fourth part of the entire length of the fish, which is itself long and slender. Branchiostegals six or seven. Bony processes stretching from the head give support to the anterior part of the body. Stomach a straight fleshy tube; pancreatic cæca two. Dorsal single, opposite the anal, and composed mostly of simple rays. Small teeth on the premaxillaries and mandible. A filament sometimes as long as the body issues from between the lobes of the caudal. Rostral tube very long and depressed. An excessively small air-bladder. Invisible scales. Four species.

GENUS II. AULOSTOMA, Lacép. Dorsal preceded by some free spines. Jaws toothless. Body distinctly scaly and less slender than that of *Fistularia*; compressed and higher between the dorsal and anal. Tail short and finer, terminated by an ordinary caudal without the filament; the facial tube is also shorter, thicker, and more compressed than in *Fistularia*. Air-bladder very large. One species.

GENUS III. POLYPTERICHTHYS, Bleek. Separated from *Aulostoma* by possessing mandibular, vomerine, and palatine teeth. Ternate.

GENUS IV. CENTRISCUS, Linn. Body oval or oblong, compressed and trenchant on the belly. Two or three slender branchiostegals. A spinous dorsal pretty far back, with a strong first spine. Small ventrals behind the pectorals. Mouth very small, opening obliquely. No pancreatic cæca. Intestine folded three or four times; a considerable sized air-bladder. Large denticulated plates support the strong anterior spine of the first dorsal; the rest of the body is covered with small scales.

GENUS V. AMPHISILE, Klein. Back cuirassed by large scaly patches whose summit is crowned by the strong dorsal spine; in some, scaly pieces arm also the flanks and the spine, and the second dorsal and anal are crowded towards the base of the tail; in others, the cuirass covers only half the back, and the spine is farther forward.

GOBIOIDS.

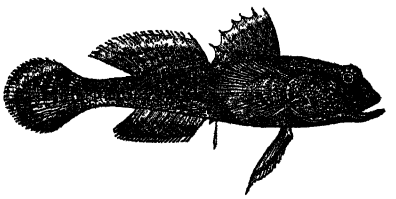


Fig. 125.
Gobius lentiginosus.

This family includes many very curious forms, differing greatly from one another in external aspect, and assembled together chiefly by the flexible nature of their spinous rays; but even that character is not positive, since in some the spines are pretty pungent. It has been made in some degree a receptacle for genera that could not be placed in other groups, though they exhibited no very marked affinity for the typical Gobioids. As first conceived by Cuvier, it included the Blennies also, but these have been since separated, and Müller has added the *Discoboli* of Cuvier, which cannot, he thinks, be kept apart from the Gobioids. The Gobioids have thoracic ventrals, and most of them have these ventrals united by their interior borders to form an oblique circular, infundibuliform disk, the front border of the disk being membranous and lower. This character does not, however, extend to all the genera. The *Kobioi* of Aristotle were not the Gobies of the moderns, since he describes his fish as having numerous pancreatic cæca, whereas our Gobies are destitute of these organs. The Goby of Ausonius is a Gudgeon, and reasons are assigned in the *Histoire des Poissons* for the Kobioi of Aristotle and the *Kothos* of Athenæus being the *Cottus gobio*, and not a Gobioid at all; while the *Phukis* of Aristotle is considered to be the name given by him to the real Gobies. He classes these fish with those which frequent rocky places, and live upon marine algæ and crustaceæ, which change colours with the season, and which are, according to his observations, the only fishes of the sea which make a nest of leaves, and deposit their eggs therein. In a preceding page, we have mentioned the Sticklebacks as having also this habit. M. Mertens relates, in fact, that the *Gobius capito* (erroneously considered by him as identical with *G. niger*) of the Mediterranean, makes a nest of algæ and *zostera*; that the male remains at it to impregnate the eggs of the females which come to lay there; and that he watches over the eggs and protects the young after they are hatched. The Black Goby, Double Spotted Goby, Spotted Goby, and Slender Goby, are enumerated by Mr Yarrell as British species. The Chinese waters nourish not only many Gobies similar to the European species in general aspect, but also some very peculiar forms. Among these is *Trypauchen vagina*, the *Hung-lae* of the Chinese, of which the generic character consists in a deep pit on each side of the nape, not however communicating with the branchial cavity; and *Amblyopus*, a genus of several species, and of a very curious aspect. The Chinese generic name is *Shay-king* or "Warp-snake;" *king* meaning the warp of a web of cloth, evidently referring to its long anguilliform body. The face is very strangely wrinkled, and the eyes exceedingly small.

The *Periophthalmi* and *Boleophthalmi* are lively fish of elongated forms, with the united ventrals of the Gobies, and large, gay dorsal fins spotted like the wings of a butterfly. They have narrow gill-openings, and spend much of their time out of water, hopping over the moist sands left by the retreating tide, and spending a kind of amphibious life, pursuing the Crustaceæ which live on the sands, and, when menaced by a bird of prey, diving into the mud. Their eyes are protected from injury, when they resort to this means of escape, by moveable adipose lids. The *Boleophthalmi* are named from the power they possess of thrusting out their eyes when they wish to look around them; when the eyes are retracted, the membranous cellular lid swells over them. The thick double lips of these fish, and their hunting habits, are expressed by the Chinese name *Peih kow-kow*, "Broken-mouth dog."

Eleotris has not united ventrals, and has the aspect of a Sciænoid, but with a smaller depressed head. Like most of the Gobioid family, organized for living on muddy or sandy bottoms, the mucigenous functions of the skin are called largely into action, and numerous mucoducts open on the surface. This gives them somewhat of the appearance of *Eleginus*, and of the Sciænoid genera that come nearest to it; also of *Bovichthys*, a Percoid form belonging

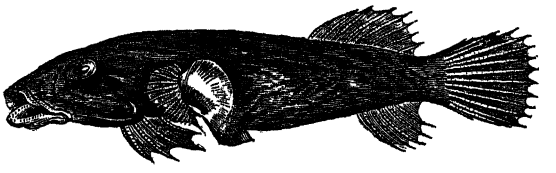


Fig. 126.
Gobiesox tudes.

to the *Uranoscopidæ*, and in fact to the ground-fish of

Classification—Acanthopterous Fishes.

several families. Allied to *Eleotris* and *Philypnus*, by family aspect, is *Notothenia*, of which numerous species inhabit the higher latitudes of the southern seas—the Falklands, Cape Horn, South Shetland, &c. *Gadus Magellanicus* of Forster, of which there is a drawing in the British Museum, is a member of this genus.

In Wiegman's *Archiven* (ix., p. 295), Müller has assigned his reasons for uniting Cuvier's *Cyclopteri* to the Gobioids. Two species of *Lepadogaster*, a *Cyclopterus*, and two of *Liparis*, are described by Mr Yarrell as British fish. The *Cyclopterus lumpus*, or "Cock-paidle" of the fishermen of the Frith of Forth, is mentioned with respect for its good qualities by Sir Walter Scott in his novel of the *Antiquary*, and it appears frequently in the Edinburgh fish-market. It is not very rare on the English shores, but its qualities are less appreciated there. The appearance of the dorsal fin, resembling the crest of a cock, is the evident origin of the first part of its Scottish name, and its mode of swimming or paddling of the second.

Callionymus is a genus of many species, some of them very gaily and handsomely coloured, with large dorsal fins, and bearing a considerable resemblance to the *Sclerogenidæ*, from the armature of the preoperculum. They are considered by M. Valenciennes to possess characters sufficient to erect them into a separate family; but he has abstained from doing so until he has studied the peculiarities of their structure by the examination of a greater number of species than he had collected at the date of the publication of the 12th volume of the *Histoire des Poissons* in 1837. One species is common enough on our sandy shores, and the female, which has smaller fins and duller tints of colour, is often described as a distinct species. *Harpagifer* differs from *Callionymus* in having wider gill-openings. *Comephorus* is an apodal fish of Lake Baikal, of very rare occurrence, since it inhabits the greatest depths of the lake. It is destitute of scales, has a small stomach, no pancreatic cæca, and no air-bladder. Its bones are soft and fibrous. It is obtained only when violent north winds cast it ashore in the spring time. So oily is its flesh that it cannot be eaten, and even the carrion crows refuse to touch it. *Chænichthys* is a southern fish, being an inhabitant of the groves of kelp which skirt the shores of Kerguelen's Land. It is a voracious fish that takes the hook readily, and has somewhat of the aspect of a Gurnard, but its cheek is not mailed. In the structure of its bones it comes nearer to the *Lophiidæ*.

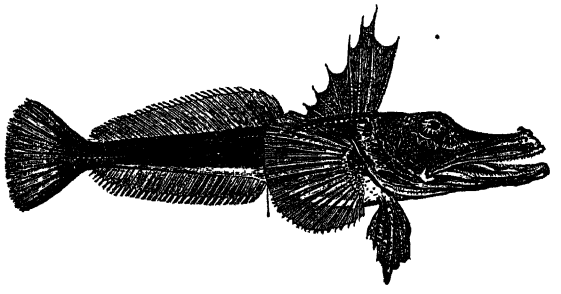


Fig. 127.

Chænichthys rhinoceratus.

Patæcus is another singular form, having somewhat of the aspect of an *Agriopus*, but differing in the development of its suborbitar bones, which do not cuirass the cheeks, and in the total want of anything like spines or serratures on the bones of the head and shoulder, from all the Percoid and Sciænoid groups, as well as from the Sclerogenids. Its internal anatomy is unknown, but, as far as can be seen from the dried specimen, the bones have little solidity. Its closest affinities seem to be Gobioids or Blennioids; perhaps it should stand next *Anarrhichas*, with which it agrees in being apodal. Fig. 8 represents this fish.

FAMILY XXII.—GOBIIDÆ, Cuv.

Classification—Acanthopterous Fishes.

Spinous rays of the dorsal slender and flexible. An intestinal canal of simple structure, having only slight dilatations, and no cæcal expansion of the stomach; no pancreatic cæca.

The family thus characterized was divided by Cuvier into two subordinate groups, the Gobies and Blennies, which are considered merely as sub-families by M. Valenciennes, but as distinct by Müller and others. The males of both have a small papilla at the opening of the seminal efferent tube, and many members of the family are viviparous, which implies internal impregnation in some way or other, though no intromittent organ has as yet been described.

The first subdivision or family of *Gobiidæ* have only five branchiostegals, and the more typical genera have the ventrals united into a hollow disk or funnel-shaped fin, more or less oblique, situated under, or a little behind, the base of the pectorals.

TABLE OF THE *GOBIIDÆ*.

Ventrals united, infundibuliform.		
Body sword-shaped.		
A cavity on each side of the nape.....	TRYPAUCHEN	4.
No nuchal cavities.....	AMBLYOPUS	5.
Body more or less cylindrical.		
Dorsal solitary, and		
Notched in the middle.....	APOCRYPTES	3.
Not notched.....	GOBIOIDES	2.
Dorsals two.		
Eyes near one another.		
Teeth equal.....	BOLEOPHTHALMUS	8.
Teeth unequal.....	PERIOPHTHALMUS	7.
Eyes farther apart.....	GOBIUS	1.
Ventrals united in a shallow basin.....	SICYDIUM	6.
Ventrals separated by		
A ventral disk, behind the pectorals.....	PLATYPTERUS	23.
The ordinary scaly thoracic integument.		
Vomerine teeth	PHILYPNUS	10.
No vomerine teeth.		
Lateral line continuous	ELEOTRIS	9.
Lateral line broken	NOTOTHENIA	11.

GENUS I. GOBIUS, Linn. Ventrals united a little posterior to the pectorals, forming a hollow disk; two dorsals, spines of the first one flexible, the second one pretty long. Body elongated. Head of moderate size, rounded. Cheeks convex. Eyes approximated. No air-bladder. Villiform or card-like teeth, often with a stronger exterior row, approaching to canines. Scaly fishes with or without filaments on the head. One hundred species.

GENUS II. GOBIOIDES, Lacép. Differ from *Gobius* in the spinous rays and articulated ones on the back being united into one long low fin, which reaches nearly to the caudal. One species.

GENUS III. APOCRYPTES, Valenc. (*Scartelaos*, Swains.) Teeth on the jaws uniserial, the mandibular ones almost horizontal, with two canines standing more interiorly and close together; in other respects *Gobii* with two dorsals. Elongated bodies. A long pointed caudal. Generally small scales. Five species.

GENUS IV. TRYPAUCHEN, Valenc. A deep hole on each side of the nape not communicating with the branchiæ; in general form like *Amblyopus*, having a single long dorsal and an anal united to a caudal with longer rays. One species.

GENUS V. AMBLYOPUS, Valenc. Elongated fishes, with the ventrals of *Gobius*. Mouth vertical, armed with strong curved teeth, not covered by the lips. Eyes extremely small. The long low dorsals united to the caudal. Scales small. Six species.

GENUS VI. SICYDIUM, Valenc. *Gobies*, with the ventrals forming a shallow round basin adhering almost equally throughout its circumference. Teeth on the jaws flexible in a close row, with some strong interior ones on the mandible. Four species.

GENUS VII. PERIOPHTHALMUS, Schneid. Head wholly scaly. Eyes close together, having an inferior eye-lid which can cover them. Pectorals scaly for more than half their length, giving them the appearance of having an arm like *Lophius*. Ventrals united as in *Gobius*. Teeth uniserial, more or less vertical. Narrow gill-openings. Profile descending rapidly, forming with the nape an angle, on which the pretty large prominent eyes are placed. Scaly fishes, with the four vertical fins distinct; in some the ventrals are deeply divided. Eight species.

GENUS VIII. BOLEOPHTHALMUS, Valenc. *Periophthalmi*, with teeth analogous to those of *Apocryptes*; those of the upper jaw being straight and pretty strong, especially towards the symphysis, while the mandibular ones are very fine, and disposed horizontally, with two more interior taller pointed ones. Head more oblong, and the profile less vertical than in *Periophthalmus*. Scales small, in some almost imperceptible. Five rays in the first dorsal. Pec-

Classification—Acanthopterous Fishes.

torals not always scaly in the lower part; resembling *Periophthalmus* in their double lips and lower eyelids. Ten species.

Genus IX. Eleotris, Cuv. Separate ventrals, but in general structure *Gobii*, resembling them in the other fins, intestines, and genital papilla. Branchiostegals six. Colours for the most part dull. Twenty-three species.

Genus X. Philypnus, Valenc. *Eleotrides*, with card-like teeth on the chevron of the vomer, in addition to the larger ones on the jaws. One species.

Genus XI. Notothenia, Rich. General form of *Eleotris*, with tumid reflexed lips. Premaxillaries but little protractile. Scales pretty large. Lateral line interrupted under the end of the second dorsal. Head unarmed, porous. Branchiostegals six. Teeth on the jaws acute, crowded, unequal. Tongue and palate toothless. Ventrals jugular, of a spine and five articulated rays; dorsals two; the first sustained by a few flexible rays; second long, near the first, even; anal like the second dorsal; the rays of both these fins divided at the tips as in *Trachinus*, with a notch in the membrane behind each. Pancreatic cæca five; no air-bladder; stomach cæcal. Eleven species.

Genus XII. Asterropteryx, Rupp. Scaly fishes with a compressed head and body, having considerable resemblance to *Eleotris*. Scales ciliated. Medium-sized mouth; teeth curved, conical, uniserial; vomer and tongue smooth. Gill-openings not approaching near each other. Branchiostegals three. Two dorsals, the rays of the first simple, but articulated. Ventrals not united, of six rays, all articulated. No visible lateral line. No genital papilla. No stomachal or cæcal dilatation of the intestine; no pancreatic cæca; no air-bladder observed. One species.

In this family Müller places the *Discoboli* of Cuvier, or *Gobiesocidæ* of later ichthyologists.

TABLE OF THE *DISCOBOLI*.

Form elongated, depressed, or subcylindrical.
- *Ventral disk single.*
  - Vertical fins united.....Liparis 20.
  - Caudal separated.
    - *Gills four*.....Gobiesox 15.
    - *Gills three*....Cotylis 16, Sicyases 17, Sicyogaster 18.
- *Ventral disks, two*.....Lepadogaster 13.

Form lumpish, thinner on the back; disk single. Cyclopterus 19.

Genus XIII. Lepadogaster, Gouan. Ample pectorals, which descend to the throat where their rays are stronger, and where the two fins are united by a transverse membrane extending forwards, and proceeding from the union of the two ventrals. Body smooth, scaleless. Head large and depressed. Mouth projecting, protractile. Gill-openings not wide. Branchiostegals four or five. One dorsal only, consisting of soft rays opposite to an anal fin of like form. Intestines short, straight; no pancreatic cæca; no air-bladder.

In the typical species (*Porte-Ecuelle*, "Regne Animal") there is a circular concave disk under the pubic bones formed by the otherwise little developed ventrals; and a second disk before it less complete, formed under the coracoid by the pectorals. Eight or ten species.

Genus XIV. Trachelochismus, Barn. In this genus, as in *Lepadogaster*, there are two ventral disks, by which they are distinguished from the allied genera in which there is only one lateral, single-notched disk. The gill-openings join, but in *Lepadogaster* they are separated. *Tr. Gouani, Candolii, bimaculatus, piger.*

Genus XV. Gobiesox, Lacép. Have not the double disks of *Lepadogaster*; but the pectorals and ventrals form a single large disk split on each side, and prolonged there by membranes; dorsal and anal short, and separated from the caudal. Gill-openings larger. *G. dentex.*

Genus XVI. Cotylis, Müll. and Trosch. (*Chorisochismus*, Barn.) Teeth of *Gobiesox*; a row of conical teeth on the jaws; behind the fore bigger ones a mass of smaller ones. They differ from *Gobiesox* in having only *three* gills; and by the branchiostegal membrane of both sides being attached to the isthmus, without covering it by an overhanging cuticular mantle or free border of skin. One species. *C. nudus.*

Genus XVII. Sicyases, Müll. and Trosch. (*Tomicodon*, Barn.) Resembles *Cotylis* in having only *three* gills, and in the insertion of the branchiostegal membrane, but it has only a solitary row of teeth in the jaws, the middle and bigger ones being incisorial, the lateral ones conical. One species. *S. sanguineus.*

Genus XVIII. Sicyogaster, Barn. Distinguished from *Sicyases* by the cutting mandibular teeth; the other teeth are conical. *S. marmoratus.*

Genus XIX. Cyclopterus, Linn. Ventrals encircling the pubic bones united into one by membrane and forming an oval concave disk, which is used as a sucker by the fish to attach itself to a rock. Mouth large. Teeth on the jaws and pharyngeals small, pointed. Opercula small. Gill-openings closed below. Branchiostegals six. Pectorals very large, and uniting nearly under the throat to embrace the ventral disk. Skeleton but slightly osseous. Skin viscous, scaleless, but containing small hard grains. A pretty large stomach; many pancreatic cæca; a long intestine; a moderate sized air-bladder. In the typical species the first dorsal is more or less visible, though very low, and is composed of simple rays; the second dorsal, having branching rays, is opposite to the anal. Body short and thick as well as high.

Genus XX. Liparis, Art. Differ from *Cyclopterus* in having an elongated body, compressed posteriorly, and a single pretty long dorsal with a corresponding anal. Skin smooth.

The eight preceding genera form the *Discoboli* of the *Regne Animal*. The following genera are said, in the *Histoire des Poissons*, to be manifestly related to the *Gobiidæ*, but to have characters which point to their being types of peculiar families.

Genus XXI. Callionymus, Linn. Gill-openings reduced to a small hole on each side of the nape. Ventrals widely separated, larger than the pectorals, and attached to the ventral surface of the throat. Head oblong and depressed. Mouth very protractile. A process more or less elongated issuing from the inferior angle of the preoperculum, and terminated by diverging points. Villiform teeth on the jaws, none on the palate. First dorsal elevated, its rays flexible and setaceous; second dorsal and anal long. Skin generally smooth. Stomach not cæcal; no air-bladder. A genital papilla Twenty-five species.

Genus XXII. Harpagifer, Rich. A Gobioid, with the ventrals of *Eleotris*, differing from *Callionymus* in having a pretty large gill-opening, which does not however descend to beneath the throat. Operculum and suboperculum bearing strong spines, none on the preoperculum or interoperculum. Two dorsals, the first sustained by four flexible rays. Teeth on the jaws slender, minute; none on the palate or tongue. Branchiostegals six. Stomach cæcal; pancreatic cæca three; no air-bladder. Lateral line crossing the nape to join its fellow, ending under the middle of the second dorsal.

Genus XXIII. Trichonotus, Bloch, Schneid. Agrees with *Callionymus* in the form of the ventrals, and in the simple intestinal canal, without pancreatic cæca. Body elongated, almost cylindrical, terminated by a large pointed caudal. Eyes almost touching on the dorsal aspect of the slightly depressed head. Villiform teeth on the jaws, palatines, and front of the vomer. Gill-openings very large, coming forward to beneath the eyes. Branchiostegals seven. Dorsal single, extending to near the caudal, its front rays simple, some of them elevated; anal also long, with simple rays in front. Scales. Lateral line straight, continuous. Stomach a long narrow sac, with the pylorus near its bottom; no pancreatic cæca; no air-bladder. One species.

Genus XXIV. Platypterus, Kuhl and Van Has. Two dorsals separated to some distance. A triangular horizontal head. Mouth under the end of the snout. Narrow bands of villiform teeth on the jaws, none on the palate. Large ventrals attached to the under surface of a flat breast, further back than the pectorals. Branchiostegals six. Some denticulations at the angle of the preoperculum. A genital papilla. Scales. Intestinal canal a simple tube, without dilatations; no pyloric cæca; no air-bladder. One species.

Genus XXV. Comephorus, Lacép. Elongated, scaleless, tapering fish, with a short depressed head, and large terminal horizontal mouth. Very wide gill-openings. Seven branchiostegals. Very long pectorals, and *no ventrals*. Teeth extremely short, in bands on the jaws, chevron of the vomer, and palatines. Mandible slightly longer than the premaxillaries. Branchiostegals six. Eight flexible rays on the low first dorsal; second dorsal higher, long, like the anal, and terminating with it not far from the forked caudal, leaving a very slender naked part of the tail between the three vertical fins. Stomach small, pointed, cæcal; no pancreatic cæca; no air-bladder. One species.

Genus XXVI. Chænichthys, Rich. Head large, depressed (but with flat vertical cheeks), wider than the elongated body, which tapers gradually in all directions to the caudal. Snout produced, flat, and wide. A large mouth, bordered above wholly by the premaxillary, the maxillary, which is articulated to the nasal, lying behind; the angles of the mouth are laterally protractile, giving a great extent to the gape. Teeth small, curved in crowded bands on the jaws; few on the pharyngeals; vomer and palatines smooth; preorbitar rough, radiated, of moderate size, the other suborbitars small. Cheeks naked. Ventrals situated before the pectorals, composed of a spine and five soft rays, the first three of which are enveloped in soft skin, and are very thick, the other two branched as usual. Eye large, lateral. Gill-opening ample, extending forward between the limbs of the mandible. Branchiostegals six. No scales. Lateral line running straight to near the caudal, where

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it is interrupted, and resumed a little lower down, terminating at the caudal. It is protected throughout by small scabrous shields, and there are a few scattered shields on the sides, the rest of the skin being smooth. Second dorsal long, sustained by simple tapering, jointed rays; anal similar in extent, its rays divided at the tips, which project like those of *Trachinus;* caudal rounded; all the rays of the pectoral branched. Stomach cæcal, ovoid; pancreatic cæca two; urinary bladder forked; ovaries in a sac, with an oviduct; a genital papilla, small in the female. No air-bladder. One species.

Genus XXVII. Patæcus, Rich. Very much compressed. Profile of the whole fish semi-parabolic; the forehead greatly overhanging, and the facial line descending obliquely backwards. Mouth small, almost horizontal. Mandible porous, with minute barbels. Teeth extremely minute, granular; none on the palate, vomer, or tongue. Eyes lateral, high up. Preorbitar a sculptured triangular disk with an ascending process. Suborbitar chain tubular, slender, running to the temples, not connected with the preoperculum. Cheek naked. No scales. Rays of all the fins simple; no ventrals; pectorals of eight rays, attached very low to the coracoids. Dorsal, like that of *Agriopus*, commencing before the eyes, and running backwards to the caudal, to which it is connected by membrane. Spines in dorsal and anal numerous, flexible, scarcely to be distinguished from the jointed rays by the naked eye; rays of the caudal ten only, not joined to the anal. Lateral line running high on the back; vertebræ thirty-five; bones of the head and shoulder showing through the skin, striated, fibrous. One species. *Vide* fig. 8.

BLENNIOIDS.

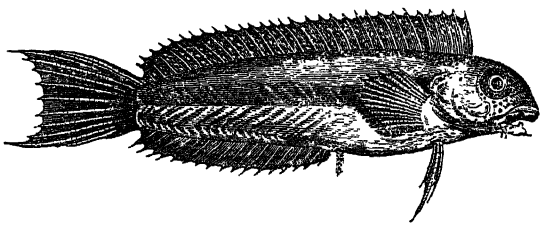


Fig. 128.
Petroscirtes Bankieri.

Mr Yarrell describes four species of the genus *Blennius* as having been detected on the British shores. The English seas also produce a species of *Pholis*. *Salarias* presents a singularity in its dentition, which distinguishes it from other fishes; its jaw teeth are implanted in the lips, and are very fine and slender, and so connected with muscular fibres that each can be raised or lowered independently of the others, or they can be moved in a mass by the motion which the fish imparts to its lips, as in some Sharks. *Clinus* is the modern Greek name for the Gobies, and has been applied by Cuvier to designate a Blennioid group, which is distinguished from most of the other Blennies by the large number of its dorsal spines, and other characters mentioned in the table. It is a viviparous genus, and the male possesses a pointed tubercle, with an aperture at its tip, and a bulbous dilatation within the abdomen behind the rectum, into which a very slender deferent canal from the milts is seen to enter together with the urethra from the urinary bladder. This structure has a similarity to a penis, but it is remarked in the *Histoire des Poissons*, that it ought rather to be considered as a modified cloaca than as an organ homologous with that of the viviparous Vertebrata. The *Tripterygions* are found both in the Mediterranean and in New Zealand, and have the same habit of hopping over the wet sands which is attributed in a preceding page to some of the Gobioids.

Bregmaceros is a very interesting fish, whose affinities seem to be with this family. It was first described by Dr Thompson in the *Annals of Natural History* under that generic name, from a drawing made in the China seas by Dr Cantor, and again, under a new generic name, by Sir John Richardson, from two examples of a different species brought home by Sir Edward Belcher from the same seas. In its ventrals it differs from all other known fish, but as a description will convey but an imperfect idea of their peculiar structure, the reader is referred to the

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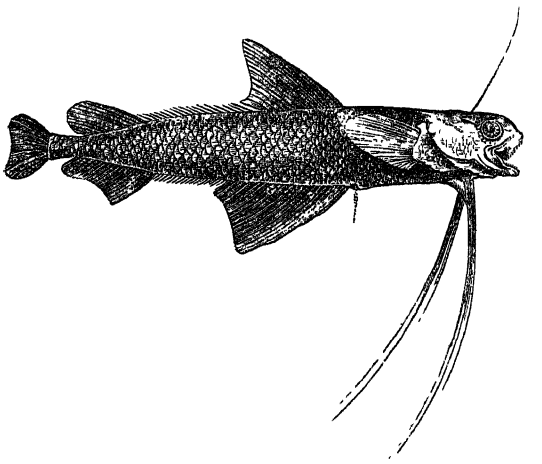


Fig. 129.
Bregmaceros mirus.

ichthyology of the *Voyage of the Sulphur*, where he will find a magnified representation of these fins. *Iluöcætes* and *Phucocætes* are two very nearly allied genera, described by Mr Jenyns in his account of the ichthyology of the *Voyage of the Beagle*. They were discovered at Cape Horn, and specimens have been since procured at the same locality by Sir James Ross. *Gunnellus*, owing to its compressed body, and the parallelism of its dorsal and ventral profiles, resembles a Ribbon-fish, and its name has a similar origin to that of Deal-fish, being from *gun-wale*, contracted into gunnel, the narrow board that forms the upper streak of a boat. In some species there is merely a minute, blunt spinous point to represent both ventrals. One species occurs on the British coasts abundantly, and there are others in all parts of the Arctic seas. There is much resemblance in form between some *Gunnelli* and the *Ophidia*, and perhaps a relationship.

The viviparous Blenny (*Zoarces viviparus*) is a well-known species, and has been long celebrated for a peculiarity which is chiefly observable among cartilaginous fishes, that, namely, of producing its young alive. These are so matured at the time of their birth, that on their first exclusion they swim about with the utmost agility. No fewer than 200 or 300 young are sometimes produced by an individual, and the abdomen of the mother is so distended before parturition, that it is impossible to touch it without causing them to be extruded. Full-grown individuals seldom exceed 12 inches in length; the body is slender and smooth; the colour yellowish olive, pale beneath, and marked on the upper parts with dusky spots. It is a littoral fish, and of frequent occurrence under stones. When boiled, the back-bone acquires a green colour. America produces a much larger species, which sometimes exceeds the length of 3 feet. It has been described under the name of *Blennius labrosus*.

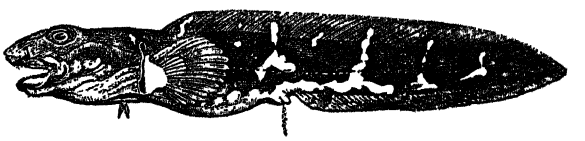


Fig. 130.
Lycodes mucosus.

The arctic genus *Lycodes*, instituted by Professor Reinhardt of Copenhagen, and of which the Greenland seas contain several species, has much general resemblance to *Zo-*

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arces. Sir Edward Belcher obtained some good specimens in Northumberland Sound to the north of Wellington Strait.

Notwithstanding the size of *Anarrhichas*, its thickness, the total absence of ventrals, and the extraordinary nature of its dentition, it is impossible, says M. Valenciennes, to overlook the affinity that exists between the genus and *Blennius*. The proportions of the several parts, the forms of the head, the disposition of the fins, the delicacy of the scales, imbedded in the thickness of a slippery mucoid skin, are the same in both genera. The internal anatomy is also alike: a short intestine, no pancreatic cæca, no air-bladder, and a similarity in the skeletons, ally them closely to each other, especially if we take for comparison the large American *Zoarces*. The most common species (*Anarrhichas lupus*) is of frequent occurrence in most of the northern seas, and is well known along the coasts of Britain by the names of *Sea-wolf* and *Sea-cat*. Its ordinary length is from 3 to 4 feet, but examples sometimes occur of nearly double that size. The colour is obscure livid brown, with several transverse stripes or bands of a darker hue. The dorsal fin, as already mentioned, extends along the whole length of the back, and is composed of seventy-three rays. The fore teeth project considerably, and diverge a little from each other, forming a powerful kind of armature, moved by jaws of such strength that the animal has been known to imprint the marks of its teeth on a bar of iron. The uninviting aspect of this fish has probably not been without influence in producing a prejudice against it as an article of food. Its flesh, however, is far from being unsavoury, and bears considerable resemblance to that of the Eel. It is in great request among the Icelanders, who eat it dry and salted; while the other parts of the fish are likewise converted to useful purposes, the skin forming shagreen, and the gall being used as soap. The vascular tubes of the teeth are very large in the Wolf-fish, and were early recognised as such by anatomists.

Opisthognathus is a genus of which one species has been found in the Indian Ocean, and another in the Gulf of Mexico.

Family XXIII.—BLENNIIDÆ, Müll.

Pars Gobioidarum, Cuv. With much of the structure of *Gobies*, the *Blenniidæ* have a character common to most of the genera in the jugular ventrals composed of two flexible rays, sometimes with a spine, but more generally without. Stomach thin, without a cæcal dilatation; no air-bladder. Body elongated, compressed. One dorsal, composed almost entirely of simple but generally flexible rays. Skin very muciparous, scaly or naked. A genital papilla.

ANALYTICAL TABLE OF THE *BLENNIIDÆ* (Dum.)

Body scaleless.
- Head crested.
  - *Gill-openings large.*
    - Teeth numerous, firm.....BLENNIUS 1.
    - Teeth labial, moveable.....SALARIAS 6.
  - *Gill-openings narrow.*
    - Teeth regular.....CHASMODES 5.
    - Teeth irregular.....PETROSCIRTES 3.
- Head destitute of crests or tentacula.
  - *Dorsal spinous*.....CLINUS 8.
  - *Dorsal soft, without spines*.....PHOLIS 2.

Body scaly.
- Dorsal solitary and
  - *United to the other two vertical fins.*
    - Continuous without a depression.....LYCODES
    - Suddenly depressed near the end of the tail.....ZOARCES
  - *Isolated.*
    - Ventrals distinct.
      - *Barbels, four of them mandibular*.....CIRRHIBARBIS 1.
      - *No barbels; maxilla prolonged*.....OPISTOGNATHUS
      - *No barbels; maxilla not prolonged*...MYXODES
- Ventrals none or rudimentary.
  - *Replaced by a spine*.....GUNNELLUS
  - *Apodal; crushing teeth*.....ANARRHICHAS

GENUS I. BLENNIUS, Linn. Body elongated. Skin soft, muciparous, scaleless. Gill-openings large. Branchiostegals six. Ventrals attached to the throat consisting of two rays externally, but the last of the two often divided under the skin; the flexible rays, termed spinous, differ little in their structure from the others, being many of them obscurely jointed, though simple and tapering; dorsal single, extending along the whole back. Filaments over the eyes. Nostrils or nape of various forms. Mouth small; cleft of the jaws a semicircle. Teeth uniserial, strong, simple, crowded, the row often terminated on each side by a canine. Intestinal canal simple; no pancreatic cæca; no air-bladder. Aperture of the ovary between the anus and urinary canal; and without a papilla in the female. A tuft of papillæ round the opening of the seminal duct in the male. Thirty-five species.

GENUS II. PHOLIS, Flem. *Blennies* destitute of supraorbitar cirrhi, or fleshy crests. Four species.

GENUS III. PETROSCIRTES, Rüpp. (*Blennechis*, Valenc.; *Omobranchus*, Ehren.) Blennioids, with the gill-openings closed beneath, and consisting merely of a small chink above the base of the pectoral; their dentition is a modification of that of *Blennius*. The inferior incisorial teeth, attached to the front only of the mandible in a transverse row, are terminated on each side by a canine, sometimes enormously large, strongly curved, and fitting into holes in the roof of the mouth when the jaws are shut. Dorsal undivided; cirrhi generally present. Fifteen species.

GENUS IV. BLENNOPHIS, Valenc. Near *Petroscirtes*. Body compressed, scaleless. Head obtuse. Mouth small. Four recurved, hooked teeth in each jaw near the symphysis. Dorsal single, notched; anal like the dorsal, but shorter; caudal distinct; pectorals ovate, broad; jugular ventrals two-rayed.

GENUS V. CHASMODES, Valen. Gill-openings above the pectorals, as in *Petroscirtes*. A mouth deeply cleft, armed with teeth in front only, uniserial, firm, and regular; an even dorsal, extending from the top of the head to be united to the base of the caudal; anal similar, but only half as long, and not connected with the caudal. Body oval, oblong, destitute of scales. Branchiostegals six. No cirrhi on the head. Three species.

GENUS VI. SALARIAS, Cuv. Blennies, with uniserial, almost innumerable, extremely slender, contiguous teeth, moveable together by the impulse of the lips, like the keys of a piano or harpsichord. Head strongly compressed above, wide transversely below. Intestine rolled on itself in a spiral, and longer than that of the Blennies; no air-bladder. Thirty-five species.

GENUS VII. PSEUDOBLENNIUS, Schleg. vel *Pseudoclinus*. Distinguished from the true *Blennii* by their general aspect and their card-like teeth.

GENUS VIII. CLINUS, Cuv. *Blenniidæ*, with elongated, compressed, scaly bodies. Exterior teeth conical, pointed, with a villiform band behind; teeth on the vomer, and occasionally on the palatines also. Spinous rays of the dorsal numerous. Snout less blunt than in *Blennius*. Stomach larger, and intestine shorter. First rays of the dorsal sometimes separated from the others by a notch, sometimes detached to the head, where they form an elevated plume; in others, the dorsal is continuous and even. Two spines in the anal. Branchiostegals six. Twenty-five species, some of which have Labroid lips.

GENUS IX. ACANTHOCLINUS, Jen. Distinguished from *Clinus* by the larger number of spines in the anal—upwards of twenty; a longitudinal band of small teeth on the tongue; the position of the ventrals under the pectorals; and by the existence of three lateral lines. Branchiostegals six. Three species.

GENUS X. MYXODES, Cuv. Scaly fishes intermediate between *Clinus* and *Gunnellus*. Head elongated. Snout pointed, projecting beyond the mouth. Teeth uniserial, as in *Blennius*, but without the canines; the larger teeth nearer the symphyses. Resemble *Clinus* in the great number of spinous rays in the dorsal; and differ from *Gunnellus* in having some soft rays in that fin. Three species.

GENUS XI. CRISTICEPS. Valenc. Blennioids, with the first three dorsal rays standing on the occiput, connected by membrane and forming a separate fin from the long dorsal which begins over the gill-opening and reaches to near the caudal, the eight posterior rays being articulated; anal shorter than the dorsal, and having only two spinous rays. Two species.

GENUS XII. CIRRHIBARBIS, Cuv. *Myoxodes*, with still more numerous spines in the dorsal, a few more soft rays; tentacles numerous on the snout, mandible, maxillary, and over the orbit. Teeth villiform as in *Clinus*. One species.

GENUS XIII. TRIPTERYGION, Risso. Distinguished from *Clinus* by the dorsal being divided into three portions. Conical teeth in an exterior row on the jaws, and villiform teeth behind; a small transverse band of short ones on the front of the vomer. Branchiostegals generally six; in one species only five. No anal spines. Six species.

GENUS XIV. BREGMACEROS, Thomp. (*Ann. N. H.*); *Calloptilum*, Rich. (*Voy. of Sulphur*). Body fusiform. Head short, obtuse. Mouth

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small, edged laterally by the maxillaries, above by the very small premaxillaries. Minute teeth round the margin of the mouth, moveable; none on the vomer, palatines, or tongue. Cheeks and gill-cover scaly; gill-opening large. A long ray on the occiput; dorsal and anal commencing opposite each other at the anus, and reaching to near the caudal, both alike, high at first, then reduced to very short simple rays, and then rising again posteriorly. Caudal small, forked, on a narrow tail. Scales small, cycloid. No accessory gills. Ventrals very long, of three jointed ones the third one much and curiously branched. No pyloric cæca; gut straight, without any distinction of stomach; no swim-bladder. China seas and Philippines. The complicated structure of the ventrals in this genus is not in accordance with the form of these members in the rest of the family. Two species.

Genus XV. Pharopteryx, Rüpp. Mouth small, rather oblique, armed above and below with fine brush-like teeth in a narrow band. Palate and tongue smooth. A symphysial filamentous barbel on the mandible. Gill-openings connected with each other above the isthmus. Four branchiostegals. Head and whole body scaly. Lateral line interrupted; body fusiform. Ventrals having five long simple rays situated before the pectorals, connected with each other by a short membrane; part of the ventral rays flat, lanceolate, and clothed with skin; rays of all the fins undivided and perfectly flexible. Anus not far from the base of the pectorals. Dorsal and anal long, but separated from the rounded caudal; a notch separates the first six dorsal rays from the remainder. Mediterranean.

Genus XVI. Iluocætes, Jen. Body elongated, compressed, dagger-shaped, scaleless. Snout projecting beyond the mandible. Teeth acutely conical, uniserial, on the jaws and palatines; two bigger ones projecting near the premaxillary symphysis; on the front of the vomer few, aggregated. Eyes large, prominent. Branchiostegals five; projecting muciferous tubes fringing the mouth, preorbitar and preoperculum. Ventrals minute, three-rayed, jugular; dorsal and anal fins long and low, uniting with the pointed caudal. Five branchiostegals. The jaws, suborbitar scale-bones, and preoperculum encircled by muciferous pipes. One species.

Genus XVII. Phucocætes, Jen. Similar in form to *Iluocætes*, but with the mandibular teeth biserial or triserial, and two or three strong vomerine teeth in front of smaller ones; uniserial palatine teeth. Eyes small. Branchial opening very narrow. Branchiostegals six. Pores on the jaws not tubular, but very conspicuous. Whole skin porous; vertical fins as in *Iluocætes*. One species. Cape Horn.

Genus XVIII. Gunnellus, Cuv. (*Murœnoïdes*, Lacép.; *Centronotus*, Schneid.) Ventrals jugular, very small, almost imperceptible, often reduced to a single ray. Head very small. Body compressed, elongated, ensiform. A long low dorsal extending along the back to the base of the caudal, and wholly sustained by simple unarticulated rays; anal about half as long, united to the base of the rounded caudal. Teeth as in *Clinus*. Intestinal canal simple, running nearly straight to the anus; no air-bladder, and no genital papilla. Eighteen species.

Genus XIX. Carelophus, Kroy. Distinguished from *Gunnellus* by the presence of pancreatic cæca and tentacles. No teeth on the vomer. Ventrals having one spine and three soft rays. No lateral line.

Genus XX. Zoarces. Cuv. Jugular ventrals of few rays. General form and most of the structure of *Clinus* and *Gunnellus*, without spinous rays in the front of the dorsal or anal, but near the end of the dorsal there are some short spinous rays, followed by articulated ones which unite with the small caudal; the anal also unites with the caudal, but its edge is even, without the depression of the dorsal. Conical teeth on the jaws, in several rows near the symphysis, uniserial towards the corners of the mouth; palate toothless; viviparous. No air-bladder. Five species.

Genus XXI. Lycodes, Reinh. Body elongated, thick anteriorly. Head conical, obtuse. Body compressed. Tail ensiform. Scales minute, imbedded in the skin. Stout teeth on the premaxillaries, mandibulars, vomer, and palatines. Branchiostegals six. Membrane united to the isthmus, aperture narrow, posterior. Ventrals merely a single very short rudimental ray, jugular. Tail surrounded by the long vertical fins; rays articulated, divided. No air-bladder. Intermediate between *Zoarces* and *Anarrhichas*. Five species.

Genus XXII. Dictyosoma, Schleg. Distinguished from *Gunnellus* and *Zoarces* by the entire want of ventrals. Branchiostegals six.

Genus XXIII. Anarrhichas, Linn. Blennies, without ventrals; dorsal sustained entirely by simple unjointed rays, destitute of stiffness, commencing at the nape and reaching to the base of the caudal, which is distinct and rounded; anal corresponding nearly to the posterior half of the dorsal, and also rounded off at the base of the caudal; pectorals rounded. Skin soft, scaleless, and mucoid. Jaws, vomer, and palatines, armed with osseous plates, that are crowned by small enamelled teeth; the anterior teeth being more long and conical. Branchiostegals six. A short fleshy stomach, with a very small cæcal part; no pancreatic cæca; no air-bladder. Three species.

Classification—Acanthopterous Fishes.

Genus XXIV. Opisthognathus, Cuv. Blennioids, with the simple flexible spines of the majority of the family, except the ventral spine which is pungent; ventrals of five soft rays situated under the base of the pectorals; dorsal and anal even, terminating at a little distance from the rather small rounded caudal. Scales small. Lateral line distinct. Branchiostegals six. In one species the maxillary is prolonged beyond the corner of the mouth to the coracoid bones, in another it scarcely exceeds the usual size, not passing the border of the preoperculum. Fine card-like teeth on the jaws. Resembling the Blennies in the large blunt head, and cirrhi at the nostrils; but differing in having an air-bladder. Two species.

LOPHIOIDS.

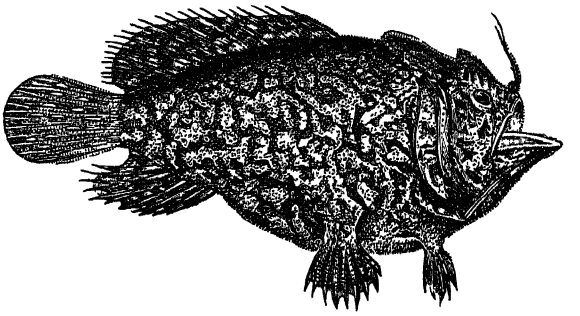


Fig. 131.

Cheironectes caudimaculatus. (*Vide* fig. 1.)

The *Lophioids* were, from the softness of their bones, placed among the branchiostegous fishes by Artedi; but Cuvier recognising the fibrous structure of their skeletons, brought them back to the *Acanthopterygii*, and since then Muller has shown that the Ostracions with which Artedi had associated them are themselves osseous fishes. In fact, the whole organization of the Lophioids is that of an Acanthopterous fish; their two dorsals, the composition of the auditory organs, the freedom of the semicircular canals within the cranium; the construction of the digestive viscera; that of the organs of generation in male and female, the connections of the premaxillaries and maxillaries, and of the teeth which they support, as well as the mandibular, palatine, and vomerine teeth, are all characters of true *Acanthopteri*. The skeleton itself, though not hard, is fibrous; and this is the case in the common *Lophius* with respect to all the cranial bones without exception, those also of the jaws, gill-covers, scapular chain, the spinal column, the fins, os hyoides, and gills, all of which have the fibrous structure.

Distinctive characters of the family are to be found in the almost general absence of scales, which are replaced in *Malthæa* by bony tubercles, and in many species of *Cheironectes* by small grains armed with spines; in the elongation of the ulna and radius into a kind of arm, whose fingers are represented by the rays of the pectoral; in the restriction of the apertures of the gills, and the absence of the suborbitar bones, on which M. Valenciennes places much value as a family characteristic. Cuvier, in his memoir on the *Cheironectes*, traces their affinity to the Blennioids and Gobioids as follows:—The advanced position of the first dorsal exists in *Cristiceps; Callionymus* has only a small gill-opening; *Gobius macrocephalus* of Pallas has the head depressed and wide; the *Periophthalmi* and *Boleophthalmi* have the pectorals supported on arms, and these fish walk and run over the mud in quest of their prey, like the *Cheironectes;* all these facts prove that the Lophioids are nearly allied to the Gobioids; most of them have, moreover, like these last, a simple intestinal canal, without pancreatic

Classification—Acanthopterous Fishes.

cæca. In quoting these remarks from Cuvier, M. Valenciennes adds that *Lophius* nevertheless has two pancreatic cæca near the pylorus, and shows some relationship to the Percoids, from which, however, he gathers that in natural families there are analogous repetitions or representations of genera in the several groups. Many wonderful things have been said of *Lophius*, or the Fishing-Frog. It has arts and schemes strange and various; it fishes with a line; it fishes with a bait; and not content with gathering a crowd of fish around it by the temptation of its baited filaments, it engulfs them in its vast branchial bags, which sacs, sustained by branchiostegals of proportional size, have no opercular bones, so that, in short, the *Lophius* is an isolated genus, differing from all others in organs connected with its respiration. But in truth the *Lophius* possesses exactly the same bones which enter into the composition of these parts in other fishes; the proportion alone differs, and the enormously large head has given rise to much of the marvellous in these descriptions. The organ of smell is that in which the *Lophius* differs most from other fishes, whether they are osseous or cartilaginous. It has two orifices to its nostril, as is usual, but they are not easily found, unless sought for at the extremity of the nostril tube in an uninjured specimen. This organ is supported on a membranous stalk, and when one opens its summit, it spreads out like the cup of a flower. The bottom of this cup is divided into projecting leaflets, on which the olfactory nerve is distributed, after traversing the axis of the foot-stalk. The fish erects these stilted nostrils, and turns them towards any object whose odour it wishes to ascertain, much as a Slug elongates its horns. In fishes in general the plaited pituitary membrane is fixed immoveably at the bottom of a cavity excavated in the bone. The opercular bone in this fish is long and strong, is suspended vertically from the convex epitympanic condyle (as in *Diodon* and *Anguilla*), and has a long slender fin-ray proceeding from the back part of the joint. The suboperculum is produced backwards, and is divided into slender branches towards its border-like fin-rays, as in the Plagiostomes. The anterior rays of the dorsal situated on the head are articulated at their bases by rings, as represented by Mr Yarrell. The spine is composed of thirty vertebræ, and the myelon terminates in a point at the twelfth, the rest of the neural canal being occupied by a long *cauda equina*, or bundle of nerves. Except in the Lophobranchs, there is scarcely another instance among fishes of a similar structure, the myelon being generally co-extensive with the neural canal. The *Lophius piscatorius* is common on the S. coast of England, and many are taken annually in Portsmouth Harbour. A second species is supposed to exist in the European seas, and a very similar one abounds in the China seas. Specimens of the young are generally pinned in along with other small fishes in the insect-boxes exported from Canton. The *Cheironectes* are small fishes, of frog-like aspect, and many of them have the faculty of distending their large membranous stomach with air, and so swelling out the body as the Tetraodons and Diodons do. The quadrupedal character which these fishes possess from the position of their pectoral and ventral fins is expressed by fig. 1, p. 206. The small hole in the axilla of the pectoral is the only gill-opening, and this structure, by retaining the moisture about their gills, enables these fish to remain long out of water, and to travel over sea-weed and sand in search of prey. Commerson considered them to be a kind of Amphibia. Many are curiously coloured, and have strange cutaneous appendages to the fins and other parts of the body.

Malthæa is a genus of fish of depressed forms, very wide in the pectoral region, and they are remarkable as being the only fishes of this family which possess a suborbitar bone. *Halieutea* is still more depressed in the body than *Malthæa*, and dried specimens are very common in the Chinese insect-boxes. The species named *H. stellata*, is of an aurora-red colour above, and bright lake-red beneath. Its back is curiously muricated.

Classification—Acanthopterous Fishes.

Batrachus is a genus of small fishes, of a disagreeable aspect, but which departs less from the ordinary piscine types in outward form than the preceding Lophioids. It has much the aspect of some *Cotti*, to which the armature of its head bears also a resemblance. It differs, however, widely from the *Sclerogenidæ*, in the cheek not only being not cuirassed by the suborbitar, but in that bone being altogether absent. The suboperculum is as large as the operculum, and is likewise armed with strong spines. The species are divided according to the naked or scaly condition of their skin, and by the presence or absence of barbels round the jaws.

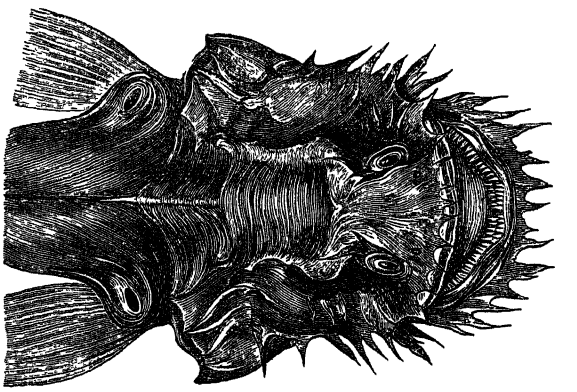


Fig. 131.
Batrachius dubius.

FAMILY XXIV.—LOPHIIDÆ, Cuv.

Pectorales pediculées, Cuv. *Armflosser* of the Germans. Skeleton fibrous, rarely much indurated. Scales almost always wanting, replaced in *Malthæa* by osseous tubercles, and in many *Cheironectes* by small grains which support spines. Forearm, that is the ulna and radius supporting the pectoral fin, prolonged, making a kind of arm. Gill-openings restricted to a round hole or vertical slit behind the pectoral, and not extending under the border of the suboperculum and operculum. No suborbitar bones.

GENUS I. LOPHIUS. Head, in comparison with the rest of the body, excessively large, broad, depressed, spiniferous. Infundibuliform pedicellated nostrils. Very wide mouth. Conical slender teeth on the jaws, palatines, and most frequently on the chevron of the vomer, on the superior and inferior pharyngeals, but not on the tongue. Branchiostegals six; branchiostegal membrane very extensive; branchial arches three only. No supplementary gill adhering to the operculum. The operculum, suboperculum, and interoperculum concealed by the muscles, but the preoperculum more visible. There is no suborbitar. Teeth moveable. Dorsals two, some of the rays of the first one far forwards on the head, detached from the others, produced into tall filaments which carry a cutaneous tag at their extremity; these rays are articulated by a ring to their interneural bones, a mode of articulation which exists also in the *Chætodontidæ*, *Siluridæ*, and some *Cyprini*. Nostrils campanulate and pedunculate. Stomach very large and very muscular; intestine short; two pancreatic cæca. Five species.

GENUS II. CHEIRONECTES, Cuv. Head and body vertically compressed. Three free rays on the head, sometimes united by membrane, but not followed by a spinous fin separated from the soft dorsal as in *Lophius*. Head neither very large nor the gape so enormous as in that genus. Most have the power of inflating the body by filling a large membranous stomach with air like a Tetraodon or Diodon. The relative position of their ventrals and pectorals gives them the appearance of possessing four feet (see fig. 1, p. 206), but it is the ventrals that here represent the anterior limbs. Gill-opening a small hole concealed in the axilla of the pectoral. Mouth cleft more or less vertically. Fine slender and pointed teeth crowded in card-like plates on the premaxillaries, mandible, vomer, palatines, and pharyngeals. Eyes small and far forward. Opercular bones wholly concealed by the integuments. Branchiostegals six. Branchial arches four. Body not tapering posteriorly in the same way with that of *Lophius*. Dorsal occupying much of the back; pectoral

Classification—Plectognaths.

pedicellated, as in *Lophius*, by the elongation of the radius and ulna, which are mostly concealed by the skin. Twenty-eight species.

Genus III. Malthea, Cuv. Body anteriorly, and the head much depressed; very wide at the pectorals, chiefly from expansion of the subopercula; posteriorly tapering and more or less compressed. Pectorals pedicellated. Gill-opening a small orifice in the axilla of the pectoral. Body covered with a tubercular skin; many cutaneous filaments. Mouth small, opening beneath the projecting snout, horizontal and protractile; a peculiar pedicel with soft tips attached to the snout, represents the three free rays of *Lophius*. This genus is the only one of the family in which a suborbitar scale-bone is present. Seven species.

Genus IV. Halieutea, Valenc. Body very flatly depressed, orbicular. Snout not prolonged. Palate smooth, toothless. Skin studded with small conical, acute, bony spines, having radiating bases. Branchiostegals six. One species.

Genus V. Batrachus, Schneid. A large flat head and wide mouth, bordered by cutaneous filaments. A very small first dorsal; pectorals pedicellated on short flat arms; ventrals jugular, of three rays, the first elongated and lanceolate. Teeth on the jaws, vomer, and palatines. Six branchiostegals. Gill-openings not extending quite under the throat. A long and low dorsal and anal. Suboperculum as large as the operculum, and emitting strong spines; preoperculum unarmed. No suborbitar; no cæcal dilatation of the stomach; no pancreatic cæca; air-bladder deeply forked anteriorly; and muscular laterally. Seventeen species.

Genus VI. Ceratias, Kroy. Form high and much compressed. Mouth cleft nearly vertically. Gill-opening below the pectorals, pretty large, round. Branchiostegals six. Teeth of moderate size, conical, moveable, slightly curved on the premaxillaries and mandible; none on the vomer or palatines; three branchial arches with two layers; the third pair of arches adherent to the gullet by their interior border. No ventrals; pectorals very small but supported on long arms; anterior dorsal of two free moveable rays, one on the head, the second near the middle of the back; posterior dorsal and anal very short, and close to the caudal fin. Tips of all the rays free from the connecting membrane, especially those of the caudal and ventrals, cartilaginous, not jointed, and with soft extremities. No true scales, but innumerable recurved spines rising from bony bases. No air-bladder. Two small pyloric cæca. Skeleton soft and cartilaginous. Greenland. *C. Holboli.*

Genus VII. Chaunax, Lowe. Body oblong, tetraedral, subinflatible, naked; skin of the belly lax. Tail abruptly attenuated, subcompressed. Head large, somewhat tetraedral, flat on the dorsal aspect. Mouth very large, transverse. Teeth on the premaxillaries, vomer, and palatines, small granular. Nostrils neither tubular nor pedicellated. Branchial openings behind the pectorals. Dorsal solitary; ventrals pedicellated, fleshy, jugular; anal far back. A single barbel in the internasal pit; no other elsewhere.

PLECTOGNATHS.

Artedi constituted an order named *Branchiostegi*, in which he included the Plectognaths with the addition of *Cyclopterus* and *Lophius*, attributing to the latter as well as to *Balistes* and *Ostracion* the want of a branchiostegous membrane. *Lophius*, however, has as ample branchiostegous membranes as any fish possesses, and six long branchiostegals; while *Balistes* and *Ostracion* have gill-covers and branchiostegals, though the thickness of the integument keeps them concealed. In *Diodon*, the operculum is not connected with the preoperculum, but is suspended to the outer angle of the epitympanic. The real cause of his assembling these genera into one group would appear to have been the tardy ossification of their skeletons, for which reason he placed the order between the osseous and the cartilaginous fishes. But though the bones of the Plectognaths differ in some degree from those of the great mass of osseous fishes, and there are fewer pieces in their skeletons, they belong to that division of the class by the fibrous character of their bones, as Cuvier mentions in his *Regne Animal;*" and Müller has shown that they agree with other osseous fishes, in having two valves at the origin of the arterial trunk, differing in that respect from the *Chondropterygii* or Plagiostomes, and from the Ganoids, all of which have many valves. The want of mobility in the upper jaw, through its union by suture with the cranium, is the character that distinguishes the Plectognaths most distinctly from the ordinary osseous fishes, though even this character is not universal in the group. Their dermal productions, scales, spines, roughness, and osseous plates, differ from ordinary fish scales. By Agassiz, they were on that account considered to be Ganoids, but Cuvier has assigned them a more correct place in our systems.

Classification—Plectognaths.

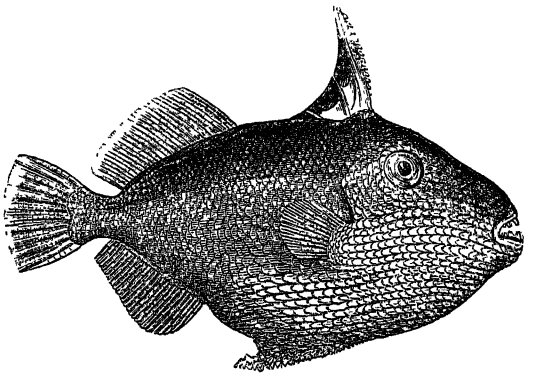


Fig. 133.
Xanthichthys curassavicus.

The Sclerodermids, or *Balistini*, are distinguished by the conical snout, a small terminal mouth, and distinct but not numerous teeth. In *Balistes* the first dorsal spine is articulated by ring and bolt to the broad interneural osseous plate. When the spine is raised, a depression at the back part of its base receives a corresponding projection from the contiguous base of the second ray, which fixes it like the hammer of the gun-lock at full cock, and it cannot be let down until the small spine has been depressed, as by pulling at the trigger; it is then received into a groove on the supporting plate, and offers no impediment to the progress of the fish through the water. (Owen.) This trigger-like fixing of the spine takes place also in the dead fish; and when a *Balistes* is removed from a bottle for examination, it is generally necessary to release the spine by pressing on the small trigger-ray. The spine of the *Balistes* is roughened with ganoid or enamel grains like a file, and the teeth of this fish consist of true dentine, with a thick layer of denser tissue that differs little from enamel.

In the Gymnodonts, or *Diodontidæ*, the maxillaries coalesce wholly or in part with the premaxillaries, and the teeth are incorporated with the bone of the jaws, so that the whole looks like one or two great teeth; but the teeth, individually small, are developed from pulps, are arranged in lamellæ, and approach the cutting edge of the compound tooth or jaw as their predecessors are worn away, much as in *Scarus*. The dental plates consist of hard or unvascular dentine. This kind of dentition is adapted to cut and bruise the food on which these fishes live—fuci and crustacea. None of them are used as food for man, and they are generally considered to be poisonous. An instance occurred a few years ago at the Cape of Good Hope of two sailors being poisoned by eating a Tetraodon, and dying from the effects thereof. A detailed account of the symptoms was drawn up by a surgeon in the Dutch navy, who attended them till they died, which was in less than half an hour after eating the deleterious fish. The Tetraodons and Diodons have the power of inflating their bodies by filling their stomachs with air. This viscus is very large, occupying the whole length of the abdominal cavity, and has very thin coats. When thus blown up into a globular form, the fins cease to play, and the fish turns over, and floats belly upwards, driving before the wind and waves, without being able to direct its course, until it has resumed its former shape, by expelling the wind. The inflation of the Diodons, however, causes the strong spines with which the skin is studded, and which resemble those of a hedgehog, to radiate on every

Classification—Plectognaths.

side, thus furnishing a good defensive armour. When taken, the Gymnodonts produce a sound, doubtless by expulsion of air from the stomach. Their air-bladder is deeply bilobate, and their kidneys, placed high up, have been mistaken for lungs. Differing from other fishes in the comparatively short tail, feeble as a locomotive organ, the myelon of the Gymnodonts is particularly short, and instead of being, as is usual in fishes, nearly as long as the spine, was found by Professor Owen to be only four lines long in a Diodon which measured 7 inches. It is still shorter in *Orthagoriscus*, and the neural canal is chiefly occupied by a long "cauda equina." In this respect they agree with *Lophius*, and they resemble that genus also in having only three branchial arches. In *Orthagoriscus* the processes of the pair of leaflets forming a gill are alternate, and not opposite as usual. Among the Diodons and Tetraodons there are genera which have no external openings to the nostrils, but merely cutaneous tentacles, on which the olfactory nerve is finally expended. *Tetraodon naritus* (Rich.) has only one nostril to each pituitary sac, but it is nearly as wide as the sac itself, and its membranous border can expand either in an infundibuliform way, or contract the orifice. The Tetraodons are remarkably tenacious of life, and have a disagreeable odour, which they retain for several years when preserved in alcohol. The Malays will not use them even as manure. For the arrangement and

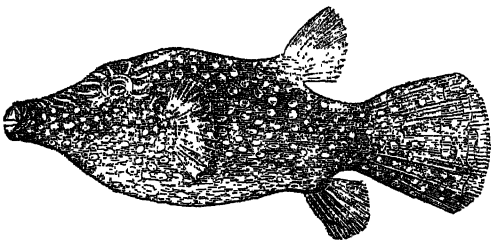


Fig. 134.

Tetraodon solandri.

generic characters of the Diodons, Ostracions, Balistes, and Lophobranchs, we are indebted to the labours of Dr Kaup. We refer to the *Philosophical Transactions*, vol. 76, for an account of *Tetraodon electricus.*

Order VI.—PLECTOGNATHI, Cuv.

Endo-skeleton partially ossified; exo-skeleton as ganoid scales or spines. Maxillaries and premaxillaries fixed together. Swim-bladder without an air-duct. No pancreatic cæca; merely vestiges of ribs; and no distinctly developed ventrals.

Family I.—BALISTIDÆ.

Sclerodermi, Cuv.; *Balistini*, Müll. Snout conical. Teeth incisorial, more or less conical, and few in number. Skin either with shield-like scales or with small rough ones. Swim-bladder ovate, strong.

Sub-family I.—BALISTINI, Kaup.

Whole body mailed in a cuirass divided into rhomboidal disks by cross lines, and commonly displaying varying tints of colour that are generally lost in the preparation of the specimen. First ray of the anterior dorsal very stout and bony, followed by one or two small ones, all of them falling into a dorsal furrow; pubic bones more or less projecting, and carrying the spinules of linear ventrals.

Genus I. Pyrodon, Rüpp. (*Xenodon*, Rüpp.) Profile slightly convex, with the chin projecting. Four blunt front teeth, whereof the middle pair are the broadest, and the side ones worn away interiorly; two longer red-coloured, conical corner teeth in the upper jaw, and four with notched crowns in the mandible. A canal before the eyes. Shields behind the gill-opening. No lateral caudal spines. One species. *P. niger.*

Genus II. Melichthys, Swain. The front teeth all equal in length standing in a semicircle, the middle ones broad and sharp edged, like human incisors, as in *Pyrodon*. Profile arched, with a broader forehead. Large scales at the gill-opening. Tail more or less forked. A canal before the eyes. Two species.

Genus III. Xanthichthys, Kaup. Naked furrows on the face; two rays in the first dorsal. No shields before the gill-opening. One species. X. *curassavicus*. Fig. 127. (Squamation badly shown.)

Genus IV. Canthidermis, Swain. A canal before the eyes. Teeth conical; no separate corner teeth. Broad forehead; arched profile. Small shields behind the gill-opening. No spines on the tail. Second dorsal and anal fins in the older fish very high; caudal slightly crescentic. Scales in the young very rough, but in the old there are only traces of roughness in the fore angle of the rhombs. One species, *C. maculatus.*

Genus V. Balistes, Linn., Kaup. Canal before the eye. Shields behind the gill-opening. Conical, elongated, cutting teeth; no jutting corner teeth.

(*a.*) Two to seven rows of spinules or elevated lines on the tail. Face scaly, without naked streaks. Caudal round or blunt. Four species.

(*b.*) Face naked, above which a row of scales. Two species.

(*c.*) A more or less hollow profile; face scaly. Tail destitute of rows of spines or raised lines. Second dorsal and anal more or less falcate. Tail more or less forked. Four species.

Genus VI. Balistapus, Tilesius. No furrow before the corner of the eye. Two or three rows of spines on the tail. Traces of ventrals; caudal round or truncated; the second dorsal containing from twenty-three to twenty-seven rays; the anal from twenty to twenty-four. Six species.

Sub-family II.—MONACANTHINI.

Very small scales which are scabrous, with stiff bristles as densely crowded as the pile of velvet. The point of the pubic bone projects, and is spiny as in the *Balistini;* but there is one spine in the first dorsal, and it is large and denticulated; or, if a second spine exists, it is almost imperceptible.

Genus VII. Monacanthus, Cuv. (*a.*) In one division the pelvis is very moveable, and is connected to the belly by an extensible dewlap; these have often strong spines on the side of the tail.

(*b.*) Another division is distinguished by a tuft of coarse bristles on the side of the tail.

(*c.*) A third group has the body covered with small pedicellated tubercles.

(*d.*) The skin in a fourth group is clothed throughout by slender hairs, which are often branched.

(*e.*) And there are some which have none of these distinguishing characters.

Genus VIII. Aluterius, Cuv. Body elongated; densely and minutely granular. A single spine in the first dorsal. The pelvic bones entirely concealed beneath the integument, without any bony projection.

Genus IX. Triacanthus, Cuv. Profile subtriangular. The first dorsal placed on one angle, and the tail, which is more slender and tapering than in others of the family, ending in a second, on which is the crescentic caudal; while the mouth occupies the third. Scales small, rough, with sharp spinules. Ventrals each consisting of a strong rough spine. Pubic bones long, narrow, not projecting, covered with scales like the rest of the integument. Two species. *Tr. aculeatus. Tr. strigilifer*, Cant.

Family II.—OSTRACIONIDÆ.

Ostraciones, Müll.; *Ostracioidæ*, Cant. Teeth ten or twelve, conical. Lips fleshy. Body mailed in a tuberculated cuirass, or "tessellated quincuncial pavement of dermal scale bones," out of which the lips and teeth, the pectorals, and three vertical fins, together with the tail, protrude. Exteriorly the gill-opening appears as a slit, bordered by a skinny edge, but interiorly composed of a gill-cover with six branchiostegals. Ventrals and pelvis wanting. Little muscular substance; a large oily liver. Stomach large, membranaceous. Vertebræ mostly coalescent.

Genus I. Cibotion, Kaup. (*Ostracion a corps quadrangulaire sans épines*, Cuv. *Reg. An.; Ostracion*, Swain.) Nostrils in a pit. No trace of spines. The completely naked tail destitute of shields or bony rings. Eight species.

Genus II. Doryophrys, Kaup. (*Lactophrys*, partim, Swain.; *Lactophrys*, De Kay.) Nostrils on the points of two small projections. Cuirass four-cornered, with spines above the eyes and on the edges of the belly. Three species.

Genus III. Ostracion, Linn. (*Rhinosomus* and *Tetrosomus*, Swain.) Body inclosed in a more or less quadrangular cuirass, with an acute dorsal ridge, which commences near the eyebrow. Nostrils situated in a flat membrane, also one or two prominences without apertures. No bony rings on the tail. 1. Some are without long

Classification—Plectognaths.

spines over the eyes, and on the angles of the body. 2. Some have spines on the end of the ventral edges only. 3. Some have spines over the eyes, and on the edges of the belly. 4. Lastly, in some the body is almost three-edged owing to the gable-formed elevation of the back. Six species.

GENUS IV. ARACANA, Dr Gray. (*Acarana* and *Platycanthus*, Swain.) Roundish compressed bodies, with a short tail, which is encompassed by bony plates or rings.

Sub-Genus I. Aracana, Gray. Having three pairs of flat compressed spines on the dorsal aspect (viz., one over each eye, and two pairs on the edge of the rounded back); one spine on the side, and two or three on the edge of the compressed belly. Six species.

Sub-Genus II. Capropygia, Kaup. Back and belly elevated in the middle; a pair of flat pointed spines on the line which incloses the back; another pair on the border of the belly before the anal. The dermal plates very rough, with small radiating tubercles. One species, *A. unistriata*.

Sub-Genus III. Kentrocapros, Kaup. No orbital spines; back concave, with two flat pointed spines on the middle of the dorsal border; border of the belly rough and denticulated with one spine. One species, *A. hexagona*.

Sub-Genus IV. Anoplocapros, Kaup. No trace of spines on the orbit. Body compressed, and acutely sloped on the back and belly. No spines developed on the borders of the back or belly. One species, *A. lenticularis*.

GENUS V. CENTAURUS, Kaup. A large rough tapering acute spine, standing forwards before the large eye; a still longer one pointing backwards from the end of the cuirass over the caudal, replacing the second dorsal. Two projections from the border of the back laterally; four from the border of the belly. One species. *C. boops*, South Shetland, fig. 18.

FAMILY III.—DIODONTIDÆ.

Gymnodontes, Cuv., Müll. Upper and under jaws with which the teeth are incorporated, without a mesial division, resembling the beak of a parrot; behind the jaw is transversely forked. Skin wholly armed with spines of greater or smaller size. The *Diodons* and most of the *Tetraodons* have the power of inflation.

SUB-FAMILY I.—DIODONTINI.

GENUS I. DIODON. Linn. One nostril at the base of a leaf-like cutaneous process, and the other at the point of the same. Spines subulate, long, thin, and sharp pointed, with two radical processes, and capable of erection or depression. Nine species.

GENUS II. DICOTYLICHTHYS, Kaup. Each tentacle two-lobed. *No nostril.* Spines with three radical processes, which prevent motion; in the middle of the forehead a spine with two processes. One species, *D. punctulatus*.

GENUS III. CYCLICHTHYS, Kaup. Two nostrils, one at the base of a tentacle, the other at its point. Spines with three fully developed radical processes, which prevent all motion. Two species.

GENUS IV. CYANICHTHYS, Kaup. Nostrils squeezed together on the forehead in a leaf-like tentacle; one aperture on the inner border next the forehead; the other one, which is scarcely perceptible, on the border next the eye. Forehead concave, without a spine in the middle. Body armed with short immoveable spines. One species, *C. cæruleus*. New Guinea.

GENUS V. CHILOMYCTERUS, Bibr. (Wiegm. *Arch.* 1847.) Nostrils at the extremity of an extended tentacle. Three large radical processes to the immoveable spines. Body flat. In most instances a spine on the forehead, and two or three above the eyes. Three species.

SUB-FAMILY II.—TETRAODONTINI.

Tetraodon, Linn., Cuv. Upper and under jaws divided by a mesial suture, so that they appear to have two teeth above and two below. Spines of the skin much shorter than those of *Diodon*. The head and tail are generally smooth, but the rest of the body is, with a few exceptions, rendered rough by the presence of minute spines. A species which possesses electric powers is destitute of spines, in obedience to a law ascertained by observation, that none of the electric fishes possess scales or spines.

The following groups are indicated in the *Regne Animal*, and are likely to receive generic names from the first ichthyologist who publishes descriptions of all the species.

GENUS I. TETRAODON, Cuv.

I. Head short, body inflatible.
   1. Body rough throughout.
   2. Body smooth throughout.
   3. The sides only smooth; lateral tubercles.
   4. The sides smooth; no lateral tubercles.

II. Head oblong.
   1. The sides only smooth.
   2. Back and sides smooth; the belly alone rough.

III. Back keeled.

Classification—Lophobranchs.

Müller has proposed the following sub-genera:—

Sub-Genus I. Physogaster, Müll. In the nasal depression a hollow papilla, with a nostril that is not lengthened out into a tube. A dermal keel on the side of the belly from the throat to the tail. *T. oblongus, lunaris.*

Sub-Genus II. Chelonodon, Müll. *No trace of a nostril*, but in place of it a skinny funnel-shaped tentacle.

Sub-Genus III. Cheilichthys, Müll. A shorter or longer nostril-tube, and no ventral keel.

Sub-Genus IV. Arothron, Müll. On each side of the nose *solid tentacles*, on which the *olfactory nerve* is expended; also a muscular ring round the eye, and a kind of eyelid.

SUB-FAMILY III.—ORTHAGORISCINI.

GENUS I. ORTHAGORISCUS, Schneid. (*Cephalus*, Shaw. Sunfish.) Jaws of *Diodon*. Body compressed, generally destitute of spines and incapable of inflation, and with the tail so short and high that the fish appears as if its hinder parts were sliced off. Dorsal and anal both high and pointed, and joined to the caudal. No air-bladder; stomach small, entered directly by the bile-duct. A gelatinous layer immediately under the skin. The abbreviation of the tail is accompanied by a very reduced myelon, looking like a mere ganglionic process of the brain. *O. spinosus* has pointed tubercles on the body.

LOPHOBRANCHS.

Fishes of this order possess an osseous skeleton, and complete and free jaws, but the ultimate divisions of their branchiæ, instead of being pectinated, are divided into small tufts, which are ranged by pairs along the branchial arches. The armour in which these fishes are mailed up, their want of flesh, and their generally angular forms, give them a peculiar aspect. The tubular elongated snout is formed by the nasal, vomer, tympanals, preopercula, and subopercula. The nasal bone is a short compressed vertical plate.

Notwithstanding the odd and stiff appearance of many of the Sea-horse Fish and other small members of this order, some have prehensile tails (*Hippocampus*), like those of an American monkey (*Cebus*), and when kept in vases furnished with slender twigs, to which they can suspend themselves, they form pleasing objects of study. The *Hippocampi* resemble the Chameleon, in being able to direct one eye backwards and the other forwards, and Professor Lichtenstein observed a circular movement in the water near their gill-openings; on the right side the whirl revolved to the left, and on the left side to the right, the rotation being symmetrical and constant, like that of a *Rotifer*. The *Hippocampi* inhabit all parts of the ocean. Others of the order are remarkable for the singularity of their shapes, or of their cutaneous appendages, or for the brilliancy of their colours. The *Phyllopteryx foliatus*, from the seas between Australia and New Guinea, yields to no fish in the intensity of its red and purple tints, and in the variety of the leaf-like lappets that adorn it. A very beautiful drawing, by Bauer, of the recent fish taken on Flinders' voyage is in the possession of Mr Brown.

The most interesting peculiarity, however, in the economy of the Pipe-fishes is that of the males of most species carrying the eggs about with them until they are hatched. Dr Kaup considers that they show an analogy in this respect to the Marsupials, or the Wandering Penguin (*Aptenodytes Patagonicus*), which transports its solitary egg in a fold of its skin. In some the egg-pouches are on the breast or belly, in others on the tail, or the eggs are merely glued on in rows, and not covered in by membrane.

Classification—Lophobranchs.

ORDER VII.—LOPHOBRANCHII, Cuv.

Endo-skeleton partially ossified; exo-skeleton ganoid. Gills tufted; opercular aperture small. Swim-bladder without an air-duct. Body almost fleshless, protected by bony rings. In most the male carries the eggs till they are hatched.

FAMILY I.—SOLENOSTOMIDÆ, Kaup.

Breast and belly distinctly separated. Oral aperture at the end of a long, compressed, leaf-like snout. When the gill-plate is raised the whole gills are exposed.

GENUS I. SOLENOSTOMUS, Seba, Lacép. Snout sharply edged on its dorsal and ventral aspects. A sharp denticulated ridge, passing from the occiput over the eyes and nostrils, disappears in the acute rostral crest. Back and breast acutely ridged. Pectorals broad and short. Belly down to the caudal fin divided into rings and armed by three longitudinal rows of short spines. First dorsal very long; the second and the anal rudimentary. Egg-pouch of the males formed by the union of the inner borders of the ventrals to the skin of the belly; the females have free ventrals. One species.

FAMILY II.—PEGASIDÆ.

Breast very greatly expanded, much broader than high. Pectoral fin long, with nine or ten firm spine-like rays. Gill-opening lateral; gill-plate flat, depressed to the ventral plane. Mouth inferior, like that of a Sturgeon, at the base of the rostrum. Body having three knobbed or spinous rings; breast ring unusually broad, extended between the gill-plates, bispinous. Ventrals two-rayed, filamentous. Tail flat, quadrangular, spinous. Dorsal and anal occupying two to four rings; caudal ten-rayed.

GENUS I. PEGASUS, Linn. Three species.

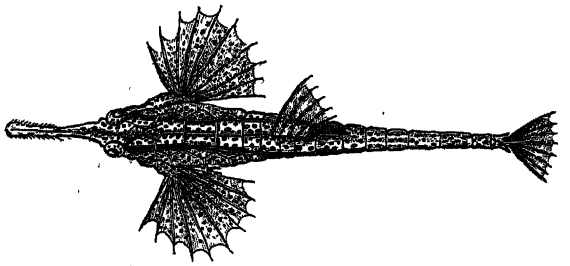


Fig. 135.
Pegasus natans.

FAMILY III.—SYNGNATHIDÆ, Kaup.; Bonap.

The small gill-opening circular and high up. One dorsal only, near the anus. Form elongated. First dorsal and ventrals wanting; pectorals in some present, in others absent; anal fin very small, in some wholly wanting. The males have egg-pouches varying in position with the genus. *Solenognathus* and *Phyllopteryx* have no egg-pouches.

SUB-FAMILY I.—HIPPOCAMPINÆ, Bonap.

Tail generally prehensile at the tip; destitute of a fin. Occiput more or less elevated.

GENUS I. HIPPOCAMPUS, Cuv. Head more or less elevated posteriorly; an occipital coronet with spines or knobs. Orbits spiny. Pectoral ring with two or three spines. Body with ten to thirteen rings, more or less spiny. Tail-pouch of the male opening at its commencement only; tail prehensile. Eighteen species.

GENUS II. ACENTRONURA, Kaup. Edge of the back forming one line with the upper tail-ridge. Gill-opening at the point of the occiput. No protuberances either on the body or tail. No coronet. Egg-pouch of the male on the tail as in *Hippocampus*. One species, *A. gracillima*.

GENUS III. GASTEROTOKEUS, Heck. (*Syngnathoides*, Bleek.; *Solegnathus*, Bleek. *nec* Swains.) The lateral lines forming the edges of the expanded belly. No nuchal shield. Tail prehensile. Dorsal standing in a furrow and occupying ten to twelve tail rings. No coronet. One species, *G. biaculeatus*.

GENUS IV. SOLENOGNATHUS, Swains. Body laterally compressed, higher than broad. Lateral line confluent with the upper angle of the tail, forming an arch. Twenty-two to twenty-six body rings; fifty-five to sixty tail rings. Dorsal fin in a furrow occupying ten to eleven tail rings. Tail prehensile. One species, *S. Hardwickii*.

GENUS V. PHYLLOPTERYX, Swains. Body much compressed. Neck elongated, slender; back arched; belly prominent. Dorsal fin placed on an elevation. Flat denticulated bones, supporting leaf-like cutaneous appendages on the body and tail. Tail finless, not prehensile. One species, *Ph. foliatus*.

Classification—Lophobranchs.

SUB-FAMILY II.—SYNGNATHINÆ, Kaup.

Males possessing a caudal egg-pouch which is open throughout. Tail never prehensile.

GENUS I. HALICAMPUS, Kaup. Snout thin and short, set with three rows of small spines and distinctly separated from the high forehead and elevated spinous orbits. Eyes projecting. Hind-head, nape, and pectoral shield crested; pectoral ring broader than the body. Dorsal fin standing on an elevation formed by three rings only. Body rough-edged, filamentous. One species, *H. conspicillatus*.

GENUS II. TRACHYRHAMPHUS, Kaup. Resembling *Halicampus*, but with a longer head; the snout denticulated on its dorsal aspect only, and not so distinct from the head. Dorsal fin elevated on five or six rings, three of which belong to the body. Pectoral ring no wider than the head; form more elongated than that of *Halicampus*. Three species.

GENUS III. CORYTHOICHTHYS, Kaup. Body tolerably long. Fins small; caudal diminutive. Snout half the length of the elevated head. Orbits large. Dorsal fin commencing in a concavity of the tail over the anus, and not on an elevated base like that of *Hippocampus* or *Trachyrhynchus*. Breadth greatest just behind the dorsal. Body varied by light cross-bars. Six species.

GENUS IV. ICHTHYOCAMPUS, Kaup. Edges of the concave back and tail running in the same line to the caudal fin. Head short. Tail almost as thick as the body, suddenly pointed at the base of the rudimentary caudal; more tetragonal than *Corythoïchthys*. Three species.

GENUS V. SYNGNATHUS, Linn. No spines on the straight cylindrical snout. Body heptagonal. Dorsal fin on the plane of the back, not on an elevated base. Upper border of the back never in the same line with that of the tail; upper border of the tail either continuous with the lateral line or interrupted where that line terminates. Dorsal surface of the body flat or flatly concave, and never much compressed or bent into an arch. Body rings never amounting to twenty-four or twenty-seven. Twenty-two species.

GENUS VI. LEPTONOTUS, Kaup. In the females the body is much compressed, and the back is acute like the edge of a knife. Belly also acute, and in old fish the height of the body is five times its breadth, but in the young the body is not so high. Dorsal profile suddenly rising behind the pectoral fin. Tail nearly twice the length of the body. Two species.

GENUS VII. SIPHONOSTOMUS, Rafin. Pectoral ring cleft on its ventral aspect in the middle of its length. Long and pretty thick, with a greatly compressed snout that projects evenly in the plane of the forehead. Five species.

GENUS VIII. LEPTOICHTHYS, Kaup. Snout very long, thin, and much compressed; extended in the same plane with the finely shagreened head. Body unusually elongated; hexagonal, with a flat back and belly without intermediate scales. All the fins large, especially the caudal. Gill-opening longer than usual. One species, *L. fistularius*.

GENUS IX. STIGMATOPHORA, Kaup. A pectoral fin; no caudal. Snout acutely ridged; prolonged. Mouth turned upwards. Anal fin three-rayed. Two species.

SUB-FAMILY III.—DORYRHAMPHINÆ, Kaup.

Males with their egg-pouch on the breast and belly, not on the tail.

GENUS I. DORYRHAMPHUS, Kaup. No pits on the nuchal shield. Rows of spines on the snout, and two projections on its under part. All the angles of the body serrated. The border of the egg-pouch developing two tender membranes which completely cover the eggs. Tail shorter than the body. One species, *D. excisus*.

GENUS II. CHÖEROICHTHYS, Kaup. Body short; arched above and below. Snout without spines or projections beneath; slender and rising upwards near the mouth. Lateral line unusually projecting, and uniting with the under edge of the tail. No pits on the small nuchal shield. Egg-pouches furnished with a membrane. Fins not much developed. One species, *Ch. Valencienni*.

GENUS III. DORYICHTHYS, Heck. Snout elongated, compressed, spineless. Two long thin bones near the gill-cover, joining the occiput, and bounding a slit-like opening. Tail quadrangular, shorter than the body; hexangular to the end of the dorsal. Nine species.

GENUS IV. HEMITHYLACUS, Kaup. Snout exceeding the body in length, with a two-edged border on its dorsal aspect, rounded beneath. Body compressed. Egg-pouch of the males reaching from the pectoral ring to the anus. One species, *H. leiaspis*.

Classification—Lophobranchs.

SUB-FAMILY IV.—NEROPHINÆ.

The eggs distributed in rows on the breast and belly of the males, not covered by membrane.

GENUS I. MICROPHIS, Kaup. Body heptangular, composed of very rough rings, and of equal thickness to the setting on of the elongated tail. Five fins. Two species.

GENUS II. NEROPHIS, Rafin. Neither pectoral nor anal fin. Body cylindrical without distinct edges. Nine species.

GANOIDS.

Müller remarks that the difference between Cycloid and Ctenoid scales is slight, and its systematic application is consequently confined to narrow limits; but that the case is very different with regard to *Ganoid* scales. These are bony, generally of a rhombic form or quadrangular, seldom rounded in outline or imbricated in position, and their surface is always smooth and coated with a layer of enamel; they are generally arranged in oblique rows, those in each row being usually united to one another by a hinge-like prolongation of the anterior angle. The Ganoid scales are imbedded, like ordinary scales, in depressions of the skin; but the epidermis is extremely thin, and adheres closely, so as to appear wanting. This is the case in *Polypterus*, but in *Lepidosteus* the epidermal covering is more evident. The living Ganoids have completely bony skeletons, but in the fossil ones many have had skeletons soft and cartilaginous like those of the Sturgeons. Müller sums up the Ganoid character in the following words:—Fishes provided with either tabular and angular or round enamelled scales, or with bony plates, or a perfectly naked skin. Their fins frequently, but not always covered on their anterior border with a single or double row of spiny plates or laminæ (*fulcra*); their caudal fin sometimes involving in its upper fold the extremity of the vertebral column, which may continue to the end of that fold; their nasal apertures double; their gills free and lying in an operculated cavity, as in the osseous fishes. Several have an accessory organ in form of an opercular gill, which is different from a pseudobranchia, and may occur at the same time with it; many have also *blowing holes* like the *Plagiostomi*. They have several valves in the arterial trunk, like the latter; their ova are conveyed from the abdominal cavity by tubes; their optic nerves do not decussate, but merely cohere laterally; their intestine often contains a spiral valve, like the *Plagiostomi*; they have a swimming bladder with an air-tube, like many osseous fishes; their skeleton is either bony or partly cartilaginous; and their ventral fins are abdominal. If, however, reference be made to the absolute characters only which are never absent, the Ganoids are *fishes with numerous valves in the arterial trunk, no decussation of the optic nerves, free gills and opercula, and with abdominal ventral fins.*

Agassiz included the *Sclerodermi*, *Gymnodontes*, *Loricarini*, *Siluridæ*, and *Lophobranchii* among the Ganoids; but, according to Müller, all these groups belong to the ordinary osseous series, and have only two valves in the arterial trunk. The existence of an accessory opercular gill is a character of the Ganoids and Sturgeons, and does not occur in other osseous fishes. Müller further observes that the Ganoids resemble the *Selachii* in having a thymus gland. This organ was described by Dr Simon as it exists in the Sturgeons, and it is found in the same position in *Polypterus* and *Lepidosteus*; that is, between the anterior basibranchials and the sternohyoid muscles. It was considered by Retzius to be a sublingual salivary gland, but it is a vasoganglion; and Professor Owen is of opinion that Dr Simon's view of its homology with the thymus gland is more in accordance with its nature; but he also thinks that Dr Simon has described as a thymus gland in various osseous fishes the same parts which Müller has called pseudobranchiæ in those fishes.

Characters distinguishing the *Polypteri* from *Lepidostei* exist in the solitary arrangement of the rays of the vertical fins, the want of accessory gills, and the incompleteness of the fourth gill, which has only one layer of leaflets, and wants also the slit behind it. There is only one pancreatic cæcum, whereas the *Lepidostei* have many; both have muscular coats to the air-bladder, but in the *Lepidostei* that viscus is cellular, and the muscular fibres are in bundles between the folds of the bladder. The air-tube or *trachea* in the *Lepidostei* is wide, and opens through the dorsal wall of the œsophagus, its orifice being regulated by a sphincter muscle. But the *Polypteri* differ from all other known fishes in the air-duct entering the beginning of the œsophagus or gullet on *its ventral side*. The arteries of the swim-bladder of the *Lepidostei* arise in great numbers from the aorta, and the veins empty themselves into the two subvertebral veins. In this case, therefore, the cellular swim-bladder cannot be considered as a lung. In the *Polypteri* the artery of each of the two air-bladders is formed by the union of the bloodvessels coming from the last gill, and therefore carrying blood already oxygenized. The *Lepidostei* have sacciform ovaries, with oviducts issuing from the middles of the sacs. These fish are by no means rare in the North American waters, and a few years ago the researches of Agassiz had raised the number described to ten. It is probable that since then more have been discovered; as he was of opinion, from what he had then observed, that every separate river, basin, or watershed, had its peculiar species. The *Lepidostei* frequent shallow, reedy, or grassy places, and bask in the sun like Pikes.

Polypterus is an African genus. Dr Baikie, in his late ascent of the Tchadda, obtained specimens of what he thinks will prove to be a new species, but he has not yet been able to compare it with the one that exists in the Senegal. The thymus gland is double in *Polypterus*; and the spiral intestine valve, which in *Lepidosteus* is but slightly developed, attains its maximum size in this genus, extending upwards to the entrance of the bile-duct.

Amia is a genus of American fishes, existing in the fresh waters of almost all parts of the United States, but chiefly abounding in the muddy streams and lakes of Georgia and Florida. At New Orleans the *Amiæ* are named "Mud-fish." M. Valenciennes describes the genus among the Malacopterygians, and says that it exhibits numerous affinities with other families of that order, agreeing with the *Cyprinidæ* in the simplicity of the intestinal canal and want of pyloric cæca, though no Cyprinoid resembles it in having a spiral valve in the intestine. Like *Elops* and *Megalops*, it possesses a sublingual buckler. By the large size of its suborbitars, it is allied to *Erythrinus*; in its dentition, and in the structure of its ovaries, it has marked connections with the Salmonoid fishes; lastly, in its general aspect, the length of the dorsal, the form of the scales, and in the length and flexibility of the body, it evinces close similarity to *Ophicephalus*. These remarks of M. Valenciennes are enough to show that ichthyologists were at a loss to find the proper place of this genus when Dr Vogt, in 1845, discovered it to be a Ganoid, for he found in its arterial trunk two oblique rows of five or six valves each, and the arterial trunk itself covered with a well-defined layer of muscular fibres, as in other Ganoids. It has, moreover, a spiral valve of several turns in the intestine, though it does not ascend so high up as in *Polypterus*. But the scales of *Amia* are not Ganoid, and have not the slightest resemblance to those of that genus or of *Lepisosteus*; and from this Müller infers that the structure of the scales is not to be trusted as an ordinal character. The scales of *Amia* are not osseous plates; they are flexible and rounded, and destitute of enamel. Similar scales belong to the fossil *Megalurus* and *Leptolepis*, which are considered by Agassiz to be Ganoids. In habit *Amia* resembles the osseous fishes rather than the Ganoids. As *Amia* agrees

Classification—Lophobranchs.

with the other Ganoids in the valves and muscularity of the arterial trunk, and in the spiral intestinal valve, Müller infers that it will be found also to possess a *chiasma* of the optic nerves (no decussation), a thymus gland, and an uncleft retina. He concludes by saying that it cannot be referred either to the *Lepidosteini* or *Polypterini*, being separated from the former by the absence of *fulcra*, and from the latter by not possessing the dorsal polyptery; and he therefore regards it as the living representative of a peculiar family of Ganoids, and finds analogous genera in the fossil *Megalurus*, *Leptolepis*, *Thrissops*, and their allies. All of these have soft scales, an osseous vertebral column, and a similarity in form of body and structure of fins. Questions of such interest to ichthyologists have doubtless long ago been solved by Agassiz, who has such ready access to many species of *Amia*, but the results of his investigations have not reached us. Cuvier compared the air-bladder of *Amia* to the lung of a reptile on account of its great cellular subdivision; and in his list of affinities or analogies above quoted, M. Valenciennes might have added the similarity of the air-bladder of the *Amiæ* to those of *Erythrinus*, or of the Siluroid *Bagrus*, which have that viscus subdivided by transverse septa.

The Sturgeons are very abundant in the rivers of Siberia which flow to the southward, and no less so on both sides of North America. They do not inhabit any of the rivers of that country which flow into the Arctic Sea, and consequently are not found to the N. of the watersheds between the 53d and 54th parallels of latitude, where the mean temperature of the year is about 33° of Fahrenheit's scale. They seldom enter clear cold streams, but in the season ascend the muddy rivers in vast numbers, so that many populous native tribes subsist wholly on the Sturgeon fishery during the summer. In most localities two forms are readily recognised by the comparative length and acuteness, and shortness and bluntness, of their snouts; but every watershed has its own species, varying in the osseous shields, positions of the rostral barbels, form of the tail, fins, and other characters.

Order VIII.—GANOIDEI, Müll.

Endo-skeleton in some osseous, in some cartilaginous, in some partly osseous partly cartilaginous; exo-skeleton ganoid. Fins usually with the first ray a strong spine. A swim-bladder and air-duct. Numerous valves in the arterial trunk. No decussation of the optic nerves. Free gills and opercula, and abdominal ventral fins.

Family I.—LEPIDOSTEIDÆ.

Lepidosteini, Müll. Upper jaw composed of several pieces; the vomer divided in two by a median cleft; the basisphenoid is confluent with the basioccipital; the nasal bone dentiferous; the mandible composed of as many pieces as in Reptiles; the vertebræ articulated by ball and socket; the olfactory organ, situated at the extremity of the greatly elongated jaw, contains the ordinary nasal folds which are arranged simply; a respiratory opercular gill is present as well as a pseudobranchia, but no blowing hole. The gills on the four arches have the perfect bifoliate structure, and behind the last arch and the hyoid bone there exists, as usual, a fissure. Branchiostegals three, the membrane passing from side to side like a mantle, and undivided. Anterior edge of all the fins protected by two rows of spinous scales. Fin-rays all articulated; caudal fin abruptly truncate, its rays inserted partly at the extremity of the vertebral column, partly beneath it. Stomach not cæcal; several pancreatic cæca; no spiral valve in the intestine; swim-bladder cellular, containing *trabeculæ carneæ* between the cell divisions, and opening by a long slit into the upper wall of the throat.

Genus I. Lepidosteus, Lacép. An elongated snout varying in breadth in different species, formed of the premaxillaries, maxillaries, palatines, nasal, and vomer; mandible equal to it in length; both covered on their surfaces with raduliform teeth and bordered by a row of long pointed ones. Ten species, American.

Family II.—POLYPTERIDÆ.

Polypterini, Müll. The upper jaw is not divided into pieces, the vomer is single, and the mandible and skull generally are constructed as in other osseous fishes. A labial cartilage exists at the corner of the mouth, supporting the upper and under lips. The fourth gill is only unifoliate, and there is no slit behind it.; the opercular gill is wanting, and no pseudobranchia ever occurs; but there is a blowing hole on each side, covered by an osseous valve. The inferior pharyngeal bones are wanting. A series of separate fins extends along the back, each consisting of a spine and a plume of articulated rays behind it. The rounded caudal and the anal are composed of jointed rays, which in the former are inserted above as well as below the spines; the pectoral has a somewhat elongated scaly limb. The nostrils are more complicated than in any other fish. In a large cavity there is a labyrinth of five nasal passages, each with a gill-like arrangement of folds; anterior nostril prolonged into a membranous pipe; the posterior one a small cleft anterior to the eye. The stomach is cæcal, and there is a pancreatic cæcum. The intestine contains a spiral valve; swim-bladder double, consisting of two sacs differing in length, and opening into a short common cavity that communicates with the ventral floor of the throat by a long fissure.

Classification—Sirenoids.

Genus I. Polypterus, Geoff. Three species, Nile, Senegal, Tchadda.

Family III.—AMIIDÆ.

Genus I. Amia, Linn. Excepting in the absence of lingual teeth, the mouth of an *Amia* is that of a Trout. Head covered with a very thin mucous skin, easily removed, and then the naked cranium, supratemporals, suborbitar scale bones, and operculum appear as sculptured bony plates. The sublingual bone is naked and furrowed. Upper part of the snout smooth and fleshy; inferior lip large and thick. Cheek almost wholly covered by the suborbitars. Each nostril with two openings, the anterior one a projecting tube like a barbel, the posterior one an aperture near the eye. Upper arch of the mouth formed by small premaxillaries and large moveable maxillaries. Teeth on the jaws; vomer, pterygoids, palatines, and large double branches of the mandible, mostly in rows of conical teeth, with small tesselated patches behind; on the pharyngeals the teeth are cardiform, and rough granular patches exist on the internal face of the operculum, a singular piece of structure which M. Valenciennes regards as the rudiment of an accessory branchia. The tongue is edentate, thick and fleshy. Large gill-openings. Branchiostegals eleven to twelve; broad and flat. Scales of the body thick, but not osseous. Caudal coming farther forward on the upper edge of the tail than below; ventrals median; dorsal long; anal small. Stomach cæcal, with a large pyloric valve. No pancreatic cæca; a very large air-bladder, forking anteriorly, and communicating with the œsophagus; cellular within, in the upper and lateral parts, but not below. Ova dropping into the cavity of the abdomen. Fresh waters of America. Ten species.

Family IV.—STURIONIDÆ.

Sturiones, Sturioniens ou Chondropterygiens, abranchies libres, Cuv. *Chondrostei*, Müll.; *Accipenserini*, Müll.; *Accipenseridæ*, Bonap. Skeleton partly cartilaginous, vertebral column a soft chorda instead of vertebræ.

Genus I. Accipenser, Linn. Form squaloid. Body more or less protected by rows of bony shields. Head cuirassed. Mouth beneath the snout, small and toothless. The premaxillaries form the anterior inferior border of the upper jaw; the maxillary is a small oblong plate articulated to the outer process of the premaxillary, and by the whole of its inner posterior side to the palatine bone. The mandible consists principally of a single bony limb, which is joined to its fellow at the symphysis, and its joint is formed by a trochlear cartilage attached to the pterygoid process of the palatine. The mouth thus formed is more protractile than that of the Sharks. Rostral barbels on the ventral aspect. Labyrinth in form and position resembling that of the osseous fishes. No vestige of an external auditory opening. An aperture behind the temples conducts merely to the gills. Dorsal and anal opposite, behind the ventrals; caudal encircling the extremity of the spinal column, the upper lobe the principal one, a smaller and shorter one beneath. Spiral intestinal valve, and conglomerated pancreas as in the Sharks; a very large swim-bladder communicating with the œsophagus by a large hole.

Genus II. Polyodon, Lacép. *Spatularia*, Shaw. *Planirostra. Scaphirhynchus.* Technically distinguished from *Accipenser* by the naked skin destitute of bony shields; recognisable at once by the enormous leaf-like expansion of the snout. In general form Sturgeons, but the gill-openings are larger, and the membranous tip of the gill-flap reaches the middle of the body. Mouth very wide, with a multitude of little teeth. A gelatinous chord in the spine like that of the Lamprey. A spiral intestinal valve; pancreas partially divided into cæca; an air-bladder. Müller says that the opercula are absent in *Polyodon*. (*Osteol. der Myxin.*)

Classification—Sirenoids.

SIRENOIDS.

Two distinct species of this order, family, and genus are known; one an inhabitant of the River Amazon, whose structure has not been so fully investigated, and the *L. annectans* from the Gambia, which has been minutely dissected by several of the first comparative anatomists of the day, and been the subject of much scientific controversy as to its station in the animal scale, whether it ought to be ranked with the reptiles or fishes. Professor Owen from the first advocated its ichthyic constitution, and Bischoff maintained its reptilian character; but Owen's reasoning appears to us to be perfectly conclusive. In a preceding page we have briefly noticed the habits of the Siluroid Hassars (*Callichthys*) in taking shelter in the muddy bottoms of marshes, and when these dry up, digging burrows for themselves to a considerable depth. They can live long out of the water and make overland journeys in quest of it; but if we understand the accounts given by travellers, they can, in the event of being cut off from water, pass the dry season in an inactive state in their burrows, from whence they are dug out by the natives, who use them for food. Some moisture will, doubtless, always remain about them in their subterranean abodes, but still their condition until the rains commence must be analogous to the hybernation of animals in higher latitudes; they enjoy but a torpid kind of existence, and use no exhausting muscular exertion until the refreshing water flowing in recalls them to an active employment of all the organs they possess as fishes. The conditions of existence of the *Lepidosiren annectans* must, as far as regards external circumstances, be similar during the dry season, though that internal organization which enables it to pass much of its life out of water is of a very different kind. This fish inhabits the Gambia, which in the rainy season floods extensive tracts of country. On the waters retreating after the rains have ceased to fall, the Lepidosirens that are left behind burrow into the mud, which a tropical sun soon converts into a hard cake. An aperture is left, however, that admits air, and they remain in their chamber, torpid and clothed in a thick secretion of mucus, until the water again overflowing the muddy lands, releases them to the enjoyment of the swimming powers, which they employ in search of food to allay the cravings of a keen appetite. They have been brought to this country imbedded in clay round the roots of plants imported from the Gambia, and their presence only became known after the plants were placed in the stove and well watered. It is by a modification of the air-bladder rendering it analogous in function to the lungs of an Amphibian, and also by a peculiarity in the gills, that the Lepidosiren is adapted to the alternate conditions of an active tadpole-like fish, and an air-breathing dweller on the dry land. As a general rule, all fishes more highly organized than the *Dermopteri* have, in their embryonic stage, five branchial arches and five branchial arteries. In osseous fishes the anterior or hyoid arterial arch developes either a gill of a single layer only, or a rudimentary gill consisting of a network of vessels, or both, or neither. The normal number of branchiæ, with double pectinated lamellæ in osseous fishes is four;—most of the Labroids, the genera *Cottus, Scorpæna, Sebastes, Apistes, Zeus, Cheironectes, Gobiesox, Lepadogaster,* and *Polypterus* have three bilamellated or biserial gills and one uniserial one; *Lophius, Batrachus,* and the *Gymnodonts* have three biserial gills; and *Malthæa* and *Lepidosiren* have two biserial gills and one uniserial gill. Two of the arterial arches, which in other fishes supply a pair of branchiæ, remain undivided in Lepidosiren, and in their primitive condition of vascular hoops, which end directly (in a manner analogous to the *ductus arteriosus* of young mammals) in arterial trunks going to the air-bladders, and ramified over their cellular surface. While passing through the ultimate twigs of these arteries, the blood is sufficiently oxygenized to sustain life during the dry season, supplies of air being introduced into the air-bladders by a trachea whose œsophageal orifice is kept open by a laryngeal cartilage. Mr Owen sums up in the following words the particulars of structure which induced him to consider the Lepidosiren to be a fish:—"It may be presumed," he says, "that its gelatinous chorda dorsalis, its vertebral inferior transverse processes (parapophyses), the normal attachment of the scapula to the occiput, the branchiostegal covering of the permanent gills, the opercular bones, the absence of a pancreas, the presence of a spiral intestinal valve, the relative position of the anus, the extra-oral nasal sacs, the scaly integuments, the mucous tubes and pores on the head, the 'lateral line,' and, in short, the totality of the organization of the Lepidosiren, will be deemed fully to prove its true ichthyic nature." This passage gives, in fewer words than we could have employed, the reasons for introducing the order of Sirenoids into our table of the class of fishes. In a discussion which took place at a meeting of the British Association soon after the publication of Mr Owen's paper on the Lepidosiren in the *Transactions of the Linnean Society*, the debate turned much on the presence of a posterior nasal orifice in the cavity of the mouth, but the Lepidosiren has an elongated nasal sac, with the biserial pituitary folds usual in fishes, and two apertures, neither of which communicate with the mouth; and Owen attributes to the position of the nasal sac in the under part of the thick lip the mistake of those naturalists who affirmed that the posterior opening was within the mouth. We have in a preceding page mentioned an instance in the *Synbranchidæ* of the posterior nasal opening being as much on the interior side of the lip as in Lepidosiren. Though the homology of the air-bladder of Lepidosiren with the lungs of Batrachia is undeniable, and by a legitimate train of reasoning, the air-bladders of other fishes are also proved to be homologous with the lungs of the higher classes of vertebrals, there is no ground, Mr Owen remarks, for asserting that the air-bladders of fishes in general perform the functions of a lung. Such oxygenation of the blood as a fish requires is effected through the agency of gills, though the relationship of these organs to the tracheæ and lungs of the higher vertebrals is one of analogy merely. The branchiæ of fishes are, however, homologous with the persistent or deciduous branchiæ of *Batrachia*, and with similar organs in embryos.

In Lepidosiren the optic nerves do not cross each other, agreeing in this respect with the same parts in *Polypterus*, the Sturgeons, and the Plagiostomes. In ordinary osseous fishes the nerves cross, but without an intermixture of nervous fibrils.

Order IX.—PROTOPTERI, Owen.

Sirenoidei, Müll. Endo-skeleton partly osseous, partly cartilaginous; exo-skeleton as cycloid scales. Pectorals and ventrals as flexible filaments. Gills filamentary, free. No pancreas; swim-bladder as a double lung with an air-duct; intestine with a spiral valve.

Family I.—SIRENIDÆ.

Sirenoidei, Müll. General form resembling that of an *Ophidium*, with a more tadpole-like tail. Pectorals and abdominal ventrals single, slender, tapering barbels, supported internally by a soft cartilaginous ray. Gills operculated.

Genus I. Lepidosiren. (*Protopterus*, Owen.) Two species, *L. annectans*, Gambia; *L. paradoxa*, Amazon.

Order X.—HOLOCEPHALI.

Endo-skeleton cartilaginous; exo-skeleton as placoid granules. Most of the fins with a strong spine for the first ray. Ventrals abdominal. Gills laminated, attached by their margins; a single external gill-aperture. No swim-bladder; intestine with spiral valve. *Copula gaudent.*

Family I.—CHIMÆRIDÆ.

Chimæroidei. Interiorly five gill-apertures which communicate

Classification—Chondropterygians.

with a single common passage, having only one external opening. Rudimentary operculum concealed by the skin. Upper jaw represented by the vomer, the palatines, and tympanals, rudimentary on the sides of the snout. Hard bony plates supply the place of teeth on the jaws, four above, two below. Snout projecting, with regular rows of pores; a fleshy club-shaped process with spiny point between the eyes. First dorsal armed by a strong spine placed over the pectorals. Claspers of the males trifid; eggs large, leathery, with flat velvety borders.

Genus I. Chimæra, Cuv. Snout conical. Dorsals contiguous, the second reaching to the point of the filamentous tail; caudal like that of the Sharks under the end of the tail.

Genus II. Callorhynchus, Gronov. Snout ending in a fleshy hatchet-shaped appendage. Second dorsal commencing over the ventrals, and ending opposite the beginning of the caudal.

CHONDROPTERYGIANS,

Or Cartilaginous fishes, are called by Cuvier the *second series* of the class, and he considers them to be neither inferior nor superior to the Osseous fishes forming the bulk of the first series, for many of the genera come near the Reptiles in the structure of the acoustic organ, and in the genital apparatus, whilst others have so simple an organization, and such imperfect skeletons, that they can scarcely be classed with confidence as vertebrals. He therefore looks upon them as a parallel series to the ordinary fishes analogous to the relationship that exists between the Marsupials and the ordinary Mammals. It is right to observe, however, that the very low organization of some Chondropterygians here alluded to has reference to the *Cyclostomi* placed at the commencement of our table, and their exclusion, leaving only the Sturgeons, Sharks, and Rays, presents the organization of the Chondropterygians, as of a higher and more equable general character, by which strength is added to Cuvier's reasoning. Yet there are many embryonic characters persistent in the Chondropterygians of which the cartilaginous and confluent vertebræ, as departing most from the indurated endo-skeleton of the highest and newest vertebrals, is the most striking. We have already observed that many of the characters assumed by the embryos of existing fishes in the progress of their development were the permanent condition of the fossil fishes found in the oldest fish-bearing strata, and (as will be more fully explained in the article on Fossil Ichthyology, which follows) the researches of Agassiz have shown that as we ascend from the older to the newer deposits there is a progressive predominance of the endo-skeleton over the exo-skeleton, so that the Placoids of that author, or the Plagiostomous Chondropterygians are few in number in the present day compared to the osseous fishes, and the Ganoids with their heavy armour are much more sparingly represented still. During the chalk epoch both Ganoids and Placoids were in much greater numbers, and they are the only members of the class of fishes which have been found in the deposits below the chalk. Mr Owen has some most instructive sentences bearing on this point in his remarks on the *genesis of fins*. The development of fins, he observes, is at first restricted to the region of the head, as in most of the ancient Cephalaspid fishes—*Pterichthys* and *Pamphractus* for instance—in which the cephalic fins project from the opercular region before the nuchal plates, and there is no trace of true pectoral, ventral, or of vertical fins. In existing fishes the only thing analogous to these cephalic fins is the envelopment of the sides of the skull in the Rays by the fore corners of the pectorals, or in *Cephaloptera* and *Ceratoptera*, by what Müller calls "cephalic fins," but which he considers to be merely detachments of the pectorals, though connected with them only by integument, and not by a continuous succession of fin-rays. In others of the ancient fossil genera there are two closely approximated dorsals and two anal fins, and both are situated near the end of the tail, which runs into the upper lobe of an unsymmetrical caudal fin. Now, in the embryos of existing osseous fishes these vertical fins are developed from a single continuous fold of integument, which is extended round the point of the tail from the dorsal to the ventral surface; a condition which may be observed in the tadpoles of Batrachians, and which is persistent in the Eel and *Lepidosiren*. The growth of this fold is progressive at certain parts, and checked at others; and in places where development is active, the supporting dermal rays make their appearance, and the transformation into dorsal, caudal, and anal fins is thus effected. At first the caudal fin is unequally lobed, and the terminal vertebræ extend into the upper and longer lobe; the dorsals and anals are also at first closely approximated to each other and to the caudal fin. M. Agassiz has shown that all these embryonic characters were retained in many of the extinct fishes of the old red sandstone; and the caudal fin did not pass the heterocercal stage in any fish until after the jurassic or oolitic epoch. The heterocercal caudals are the predominating and almost exclusive form in the existing Sturgeons, Sharks, and Rays, and in most of these one, or both dorsals when there are two, are situated upon the tail, and not rarely near its extremity. The cutaneous seams without rays and other embryonic conditions are also common, as may be learnt by consulting the generic characters in the table.

Classification—Chondropterygians.

Cuvier observes that the parts of the skeleton of the *Selachians* (under which epithet he comprehends the Sharks and Rays) do not assume the fibrous structure of bone; their interior remaining always cartilaginous, and the induration of their exterior proceeding from the deposition of the earthy matter in a granular state, whence their characteristic dotted surface. It is on this account he infers that their *calvaria* are not divided by sutures, but are composed of a single shell, modelled, however, in other respects after the general plan of an ordinary fish-skull; so that we can distinguish the same regions, similar depressions and eminences, and the same holes. He gives an analysis of the vertebral cartilage of *Selache maximus*, which shows that water alone forms ninety per cent. of the mass, while nearly seven are oil and other animal matters, and little more than three of earthy salts.

Owen selects *Squatina* (the Monk-fish), an intermediate form between the Sharks and Rays, as a good typical example of the characters of the skull of a Plagiostome. The cranial end of the "chorda dorsalis" and its capsule are converted into firm granular cartilage, which, extending forwards from a prominent median basal-ridge, and also expanding laterally, constitutes the oblong flattened plate or base of the cranium. Two convex condyles are formed on the posterior margin of this "occipito-sphenoidal" plate for articulation with the end of the spine. Two notches on the side of the basal cartilage define a prominence representing the sphenoidal arch, which sends off a rudimental pterygoid; and further forward there is an expansion and groove forming the point of suspension of the palato-maxillary arch. Then the cartilage suddenly contracts, and is continued forwards to form the vomerine anterior base of the cranial cavity. The walls of this cavity are as firm and granular as the base, except at the antero-superior end which is closed by membrane only. The foramen magnum posteriorly gives passage to the spinal chord, and there are perforations for the exit of the cerebral nerves.

The cranial cavity is of larger size than the brain, and communicates only by nervous and vascular foramina with the acoustic labyrinth, which is buried in the side of the cartilage. In the *Chimæræ*, this insulation of the ear-capsules, denoting a high grade of development, is much less complete. The parts of the cranial cartilage, corresponding to the separate bones of the skull of an osseous fish, may be recognised by the foramina through which the several pairs of nerves pass; but the exterior of the skull

Classification—Chondropterygians.

is variously and singularly modified in the different Plagiostomous genera.

In the appended arches of the cranium there is a similar confluence of cartilage. A single strong suspensory pedicel articulated to the lateral posterior or mastoid process gives attachment to the hyoid arch by a close joint, and to the mandibular arches by two ligaments. The maxillary arch is suspended by a ligament passing from its ascending palatal process to a notch between the vomerine and the anterior supracranial cartilage. From this point the upper jaw is continued in one direction forwards and inwards, completing the arch by a ligamentous symphysis with its fellow; and in the opposite direction to coalesce with the outer side of the tympanic pedicel, and form the more immediate articulation for the lower jaw or mandibular arch. Each half of the mandible consists of a single cartilage, the two being united together at the symphyses by ligament. Two slender labial cartilages are developed on each side of the maxillary, and one on each side of the mandibular arch. (The parts described in this paragraph, with the teeth which they support, are the "Shark's jaws" usually brought home by seamen.)

Four or five short cartilaginous rays, in *Squatina*, diverge from the posterior margin of the tympanic pedicle, and support a membrane answering to the opercular flap of osseous fishes; these rays are the skeleton of the diverging appendage of the tympano-mandibular arch. The hyoid arch in the *Squatina*, as in most other Plagiostomes, consists of two strong lateral cerato-hyoids, and a median flattened basi-hyoid. Short cartilaginous rays extend from the back part of the cerato-hyoid to support the membranous wall of the branchial sac; these are the homologues of the branchiostegal rays of osseous fishes.

The *Cestracion* is not so far advanced in cranial development as the *Squatina*, and the cartilaginous basioccipital has a hollow conical articulation with the end of the spine; but the Skates and Rays have the skull moveably articulated by two condyles and an intervening space, as in *Squatina* and *Zygæna*. The skull of the Rays is flat and broad; the upper wall membranous to a greater or less extent, except in *Narcine*, where it is closed by cartilage. The anterior or vomerine part forms a long pyramidal rostrum, to which are articulated cartilages connecting its extremities with the radial or anterior angles of the pectoral fin, or largely expanded hand; in the space between the pectorals and skull the *Torpedidæ* carry their electric batteries. The tympanic pedicels are short and thick; the maxillary and mandibular arches long and wide, stretching across the under part of the head.

The capsules of the organs of sense are all cartilaginous; that of the ear is involved, as we have said above, in the lateral walls of the cranium; that of the eye is articulated by a cartilaginous pedicel with the orbit; and the olfactory sacs are covered by vaults of the nasal processes. The long lateral processes supporting the eye-balls of the "Hammer-headed Sharks" have already been alluded to. In *Myliobates* and *Rhinoptera* a cartilage is attached to the prolonged anterior angle of the pectoral fin, connecting it with the internasal cartilage, and supporting a number of branched and jointed cartilaginous rays. A like series of rays on the other side of the head meet these before the skull on the median line, and form what Müller terms, as we have said in a preceding page, "cranial fins;" but Owen considers them to be merely dismemberments of the pectoral fins, and thinks that the real cranial fins are the opercular and branchiostegal appendages of the tympanic and hyoidean arches.

In tracing the progressive rise of organization of the spinal column in the Cartilaginous fishes, Owen commences with the Myxinoid fishes, whose spine is a gelatinous chorda with fibrous investments. The separation of the upper layers of the fibro-membranous sheath forms a neural canal, and a hæmal canal is produced below in like manner. In the Sturgeon there is a continuous central gelatinous chorda, but the inner layer of the fibrous investment assumes the texture of tough hyaline cartilage, while distinct, firm, and opaque cartilages are developed in the outer layer. Above the coalesced centra these cartilages have a similar arrangement to the homologous parts of osseous fishes; a neural canal is formed by two cartilaginous neurapophyses, each in the young fish formed of two superimposed pieces, and the arch is crowned by a single short neural spine. There is a short thick parapophysis on each side, with their bases expanding below to form a hæmal canal in the tail, by their union beneath the centrum. They include a small interhæmal cartilage on each side, and towards the end of the tail, hæmal cartilaginous spines are developed. Short pleurapophyses or ribs are articulated to the ends of the parapophyses. A beautiful progression, in the development of the spinal column and of the proper vertebral structure, is traced out by Müller in his *Anatomie der Myxinoiden*, and referred to by Owen, from whom we quote. In the Basking Shark (*Selache*) the vertebral centra are formed of hollow cones, meeting at their apices in the interior, and having their cups filled with the remains of the gelatinous chorda. This semi-fluid, slightly compressible, and very elastic, gives flexibility to the spine, while it sustains the shocks of violent inflexions. Strength and lightness are imparted to the centra by concentric plates of bone, crossed by others radiating like the spokes of a wheel from the apices of the cones. The highest stage of vertebral development occurs among *Galei* and other *Nyctitantes* or Sharks, which have a nictitating eyelid. In them the external surfaces of the centra, and their internal cones, are covered by a smooth osseous crust. A few Sharks only, as *Carcharias*, *Heptanchus*, and *Alopias*, have the ribs connected to the centrum at the base of the parapophyses; in most they are attached, as in the Sturgeon, to the ends of these processes.

The gills of the *Plagiostomi* do not present the pectinated arrangement of slender tapering processes in a double row, like the osseous fishes, but consist of folds of membrane on plane surfaces. A pseudobranchia coexists with a hyoid uniserial gill in most Plagiostomes, and in those which have spout-holes it is developed on the anterior wall of these outlets from the branchial cavity. The Plagiostomes have two or more transverse rows of semilunar valves in the bulbus arteriosus, or beginning of the arterial system; *Galeus* has two rows of three valves; *Sphyrna*, *Mustelus*, *Acanthias*, *Alopias*, *Lamna*, *Rhinobates*, *Torpedo*, and *Accipenser* have three rows of valves; *Hexanthus*, *Heptanchus*, *Centrophorus*, and *Trygon* have four rows of valves; *Scymnus*, *Squatina*, *Myliobates*, and *Raia batis*, or the common Blue Skate, have five rows. *Cephaloptera* has a very large bulbus arteriosus, and presents internally three longitudinal angular ridges, at the sides of which are small valves disposed in pairs, and in four or five rows; besides these there are three larger valves at the beginning, and three at the end of the bulb. The optic nerves of the Plagiostomes are connected by a commissure, but do not decussate as in the osseous fishes. And in this order the plexus of arteries, termed a vasoganglion, which lies between the layers of the choroid coat of the eye of most osseous fishes, does not exist. Müller found that generally when a fish possessed pseudobranchiæ, it had also the optic vasoganglia; but the Plagiostomes, Sturgeon, and Lepidosiren are exceptions, having the pseudobranchiæ, but wanting the vasoganglia. *Mormyrus*, *Cobitis*, *Silurus*, *Pimelodus*, *Synodon*, *Muræna*, and some other genera of the serpentiform apodals, have neither the pseudobranchiæ nor the vasoganglia, but in most osseous fishes in which they have been sought for they have been found existing together.

The only other parts of structure of the Plagiostomes that

Classification—Sharks.

we think it necessary to mention in the summary that our restricted limits compel us to resort to, are the organs of reproduction. In these fishes the secreting organs, or melts, are of compact oval or oblong form, and their efferent tubes communicate with the ureters, and terminate upon a rudimental organ in the cloaca. The claspers are present in the *Chimæridæ* as well as *Plagiostomi*, as appendages to the posterior edges of the anal fins, and have a fissure towards their ends, leading to a blind subcutaneous sac, which is well lubricated with mucus. In the Rays a glandular body adds its secretions to this mucus. The ovaria are smaller than those of osseous fishes, and the ova comparatively few in number. Some of the genera are viviparous, others ovo-viviparous, and others again merely oviparous.

SHARKS.

The Scyllidæ or Dog-fishes, have the anal fin situated either before or beneath or behind the second dorsal, and are mostly spotted or coloured with lively tints. Their French names are *Rousette* or *Rocher*. The typical genus *Scyllium* has two representatives on the British coasts, *Sc. canicula* and *Sc. catulus*, both very common, and constantly taken by the fishers with bait at all the fishing stations round the coast, but more plentiful among the Orkney Islands than elsewhere. They are scarcely ever brought to market, but the fishermen do not disdain to eat them. Their flesh is remarkably white, but a little fibrous and dry. In the Orkneys they are skinned, split up, cleaned, aud then spread out on the rocks to dry for home consumption. The skins are used for smoothing down cabinet work. There is no reason why the fins of these and other Sharks, so extensively used in China for making gelatine soups, should not be applied to the same purpose in this country, or dried for exportation to the East. Both the British species exist in the Mediterranean also. Six different species frequent the seas that wash the Cape of Good Hope, and there are at least two on the coasts of Japan and China. The only described species of *Pristiurus* is a Mediterranean one, but individuals sometimes stray northwards to the British Channel; and one procured by Mr Couch, at Polperro in Cornwall, is figured by Mr Yarrell under the appellation of the "Black-mouthed Dog-fish." It is known at Madeira as the "Leitao de Mar," but is considered to be extremely rare. The handsome *Hemiscyllia* are Australian, and the *Chiloscyllia* belong to the Indian Archipelago and Polynesia. The curious bearded *Crossorhynus* frequents the seas of Japan as well as those of Australia, where it was first discovered, having thus a range extending over many parallels of latitude. *Ginglymostoma* has a representative in the Indian Ocean and Red Sea, and another on the coast of Cayenne, and *Stegostoma* belongs wholly to the Eastern seas. *Stegostoma fasciata* is one of the most beautiful of the order, and has been observed of the length of fourteen or fifteen feet, with a large and blunt head, and tapering body. A few years ago one of them followed for several hours a Liverpool East Indiaman off Madagascar. It was elegantly transversely banded with alternate whitish and dark brown or blackish fasciæ; and was further variegated by ocellated spots or rings on various parts of its body, which seemed to be about fourteen feet long. Its head appeared to be four and a half feet across, but the thickest part of its body did not seem more than two feet in diameter. It was accompanied by several Pilot-fish, which often swam before and returned towards it. Several attempts were made to catch it with large baits of fresh meat, but it never ventured to seize one of them. The lower jaw was distinctly visible whenever it opened its mouth, into which the accompanying fishes seemed to the spectators to enter and to leave at pleasure. The *Scylliidæ* generally have the parts about the nose and mouth more divided into cutaneous lobes and barbels, evidently as organs of touch, and in harmony with their habits as Ground Sharks. For they require some guide to keep them from grazing against the bottom in their rapid pursuit of their prey.

Classification—Sharks.

Under the appellation of true *Squali* (*Squales propremement dits*), Cuvier comprehended all the remaining Sharks except *Zygæna* and *Squatina*, which he characterized as distinct genera. His genus *Squalus*, therefore, included the *Carcharidæ*, *Galeidæ*, *Lamnidæ*, *Alopeciidæ*, *Rhinodontidæ*, and *Scymnidæ* of Muller. In Mr Owen's table, the *Spinacidæ*, *Lamnidæ*, *Alopeciidæ*, and *Scymnidæ* are separated from the *Squali* of Cuvier, and the remainder of that group are denominated, after Müller, *Nyctitantes*, which are chiefly, therefore, *Carcharidæ* and *Galeidæ*. The presence of a nictitating membrane to the eye is accompanied with a greater induration of the skeleton. This membrane, as it exists in *Galeus*, is superadded to a well developed circular palpebral fold of the skin. A superficial membrane or conjunctiva is reflected from the circular eyelid over the third eyelid, which is placed on the nasal side of the orbit. The third or nictitating eyelid is raised, and the upper part of the circular one depressed at the same time by muscular action when the fish wishes to close the eye. In our arrangement of the genera, we have generally followed the *Plagiostomen* of Müller and Henle, whose generic characters we have abridged, not having access at present to Müller's later works.

The Carcharidæ are armed with teeth which, by their arrangement in a linear series, make a sharp saw, each tooth in the majority of species being also serrated on the edge. The common form of the upper teeth is that of the tip of a lancet, frequently oblique, one shoulder of the lancet being more curved than the other. The teeth of the lower jaw are either similar to the upper ones, or have narrower cusps, according to the species. Each jaw supports several rows of teeth, the anterior row on the edge of the jaw being erected for use, and the posterior ones lying flat in the hollow of the cartilage, and coming forward in succession as they are required by the decay and loss of the front ones. No animal possesses a more perfect incisorial apparatus than these massive but powerfully active tyrants of the deep. They have been known to divide the body of a man in two at one bite, as if by the sweep of a sword, and we once had an opportunity of observing how clean a cut a Shark's jaws were capable of making. A piece of salt-beef weighing about 14 lbs. was hanging over a ship's stern, suspended by a strong cord in a net of sinnet. Sinnet is the sea term for a flat plait of rope yarns, more pliable but equally strong with rope containing the same quantity of material, and, from its looseness of texture, capable of stretching more, and less easily cut. In this instance, the sinnet forming the meshes of the net was of the wideness of two fingers' breadth. The beef just dipped below the surface of the water or rose above it, as the ship's stern rose and fell with the gentle swell of a tropical sea. Suddenly a Shark came up from the deep, and before the spectators could raise the beef on which a hungry party hoped to make a dinner, the monster turned his mouth gently upwards, and, without plunge or struggle, carried off the beef and half the net to the depths into which he immediately descended. The sinnet was cut evenly across as if with a razor. Had it been torn by the mere weight of the fish, the rope yarns would have hung out of unequal lengths, and the seamen considered that on exposure to a simple strain, the rope by which the net was suspended would have broken long before the net itself gave way. A Shark killed near Marseilles, is alleged to have had the entire body of a man and several fish in its stomach; and one captured off Santa Margaretta is said to have contained the carcass of a horse. Its weight was 1500 pounds. The cartilaginous jaws of Sharks shrink at least a third in drying, and cannot, as they lose their moisture, be kept at full stretch without tearing, yet specimens are not very rare in museums which

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may be slipt over a stout man easily. The widest jaws usually met with are those of *Carcharias, Oxyrhina, Selache,* and *Odontaspis.*

Of the GALEIDÆ, or *Topes* and *Hounds*, we have two British examples, one the *Galeus canis*, named by the fishermen of different localities "Penny-dog" and "Miller's Dog," but more generally the "Tope," an appellation which Artedi says is Cornish. *Galeocerdo arcticus* is a northern species that frequents the seas of Feroe, Iceland, and Norway; another species of the same genus inhabits the Indian Ocean. The *Mustelus lævis*, or *vulgaris* of Müller and Henle, is frequent enough on the British coast. Its flat pavement-like teeth indicate crustaceans as its chief food, which they are adapted for crushing. It gives less trouble to the fishermen than the other Ground Sharks, which are constantly taking his bait or driving away the fishes he is desirous of catching. Its rich diet improves the quality of its flesh, which is considered in the Orkneys to be more delicate than that of the Sea-dogs or *Scyllii.*

LAMNIDÆ. Of this family the *Lamna cornubica*, so well known on the southern coast of England, and the only member of its own genus, is an example. It is, from its size and its dentition, the most formidable of the Sharks of common occurrence in the English Channel. One caught in 1834, off the coast of Caithness, and now in the College Museum of Edinburgh, measured eight and a half feet in length and four feet eight inches in circumference. Its teeth are upwards of an inch in length, flatly compressed, thin-edged, but not serrated; in outline each tooth is triangular, and the older teeth have one toothlet sometimes at the base on each side. In the upper jaw, the tooth which follows the first two is smaller than them or than the one which succeeds it. In *Oxyrhina* the teeth near the symphysis are long and strong, like spike-nails, tapering to a point and slightly curved; anteriorly they are flat, and posteriorly convex. They are the most formidable-looking teeth that any of the existing Sharks possess, but are calculated rather for holding and tearing their victims than for sawing or cutting. *Selache maxima* is a northern species that frequents the Greenland and Spitzbergen seas, and descends in the summer to the coasts of New Jersey on the American side, and to the British Channel on the European side of the Atlantic. The teeth are comparatively small, and the habits of the fish, as far as known, are not remarkable for rapacity. In the numerous instances in which it has been captured on the coast of Scotland, nothing has ever been found in its stomach but fragments of sea-weed. It attains a large size, growing to thirty-six feet or more, but it is indolent and not very sensible to slight wounds. It is often seen lying on the surface of the water with its dorsal fin raised in the air, whence it has obtained the names of Sail-fish, Sun-fish, and Basking Shark. While thus reposing, it may be easily approached by a boat and harpooned. It enters the bays on the northern shores of Great Britain in the months of June and July, sometimes in numbers but more commonly in pairs, and retires on the approach of cold weather. It is a profitable capture, since eight barrels of fine oil have been procured from the liver of a full-grown fish. Sir Everard Home described much of the anatomy of this fish, with the help of Mr Clift who was the operator, but Sir Everard was mistaken when he referred the supposed Sea-snake, driven on shore in the Orkneys in 1808, to be this species. The enormous length of the Orkney animal, the smallness of its head and of the adjoining vertebræ, still preserved in the Museum of Edinburgh University, prove it to have been some great cartilaginous fish yet to be made properly known to naturalists. The parts that were saved were described by Dr Barclay in the *Transactions of the Wernerian Society.*

The *Alopecias vulpes* is distinguished from the rest of the sub-order by the extreme length of the upper lobe of its tail, exceeding that of the body. It is from the resemblance of this fin to the long brush of a fox, that Mr Yarrell ascribes the origin of its appellation of Sea-Fox, a name by which Aristotle makes mention of it, and which has been handed down to us by Ælian and Pliny. It generally receives the name of "Thresher" from seamen, on account of its attacking the whale, and striking it violent blows with its tail. Mr Yarrell (i., p. 144) gives a lively account of a combat of this kind, in which a party of Threshers, assisted by a Sword-fish, had nearly mastered a whale when the observer lost sight of them. The species attains the length of at least fifteen feet; but its jaws are not constructed for swallowing a prey equal in bulk to that which a *Carcharias* of equal length would ingulf.

CESTRACIONS. This family contains only two species, and perhaps only one, for the difference between the *Cestracion zebra* of Japan and the *Cestracion Phillipi* of the Australian seas, hitherto ascertained, are chiefly those of patterns of colour, which are certainly very dissimilar in fishes taken in the two localities. Müller and Henle considered them to be mere varieties of one species, and it is to be wished that some competent ichthyologist who has an opportunity of seeing recent specimens from both places, would strictly compare one with the other. The genus is one of much interest to geologists, as the fossil teeth of Cestracions are of older date than those of any other existing genus of fishes. The *Cestracion* received the name of the "Nurse" in Australia, and the Chinese call it "Cat-Shark" or "Kitten-Shark." Specimens of the young are often found in the Canton insect-boxes.

Hexanchus griseus, one of the *Notidanidæ*, inhabits the Mediterranean Sea, but occasionally strays to the English shores. The British Museum possesses one taken off the Isle of Wight.

The *Acanthias vulgaris*, the spined Dog-fish, is another of the Sharks that is confined to no one district of the ocean. It is found on both sides of the Atlantic, N. and S., in the Mediterranean, and in the South seas. It is very common in the British seas; and, according to Mr Couch, as quoted by Yarrell, sometimes occurs in almost incredible numbers, 20,000 having been taken in a sean, at one time, on the coast of Cornwall. It does much injury to the fishermen by cutting their lines and carrying off their hooks.

The Hammer-headed Sharks, *Zygænæ* or *Sphyrnæ*, are very plentiful in the Bight of Benin, and are considered to be more blindly voracious than others, and therefore more dangerous. They may be often seen ascending from the clear blue depths of the ocean like a great cloud. The extraordinarily elongated orbits are flexible in the early stage of the fish's development, and in the fœtus are doubled in upon themselves, so that the head occupies less than half the space it would otherwise do; neither does the head attain its final shape till the fish is grown to a considerable size. These fœtal specimens, from their convenient size, of a foot in length or so, are the most common in museums, and have given rise to some misapprehension respecting the true shape of the head of the adult fish; and as the transverse distance between the eyes becomes proportionally greater with the age of the fish, several nominal species have been introduced into our lists. M. Valenciennes (*Mem. du Mus.* ix.), in a dissertation on this genus, has given the forms of the heads of several; and in the Supplement to Mr Yarrell's *British Fishes*, an outline of the head of a young specimen of *Sphyrna Blochii*, copied from M. Valenciennes, and one of an older fish captured by Dr Cantor, are placed side by side, and show well the remarkable change of form which age produces, for *Sph. Blochii* and *laticeps* are the same species. A female *Sph. Zygæna*, measuring nearly eleven feet, examined by the active naturalist just named at Penang, contained thirty-seven living young. This species is almost cosmopolitan, having been taken in the

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English Channel, or both sides of the Atlantic, in the Mediterranean, Bay of Bengal, Indian Archipelago, and seas of Australia, China, and Japan. We have transferred the family of *Zygenidæ*, from its place after the *Carcharidæ* in Müller and Henle's *Plagiostomen*, to the neighbourhood of the *Squatinidæ*, where it stands in Owen's table.

Order XI.—PLAGIOSTOMI.

Endo-skeleton cartilaginous or partially ossified; exo-skeleton placoid. Gills with five or more apertures. No swim-bladder. Scapular arch detached from the head. Ventrals abdominal; intestine with spiral valve. *Copula gaudent.*

Sub-Order I.—SQUALI.

Plagiostomi, with lateral gill-openings. Free supplementary eyelids; incomplete scapular arch; and no naso-pectoral cartilage.

ANALYTICAL TABLE OF THE *SQUALI* (Dum.)

Pectorals not notched.
- Head short, obtuse; teeth tricuspid; gill-openings over pectorals ..... } Scyllium.
- Spout-holes none.
  - *Forehead abnormal, wide, eyes laterally stilted*....Zygæna.
  - *Forehead of the usual squaloid form.*
    - Gill-openings before the pectorals.....Lamna.
    - Gill-openings over the pectorals.....Carcharias.
- Spout-holes present.
  - *Teeth serrated, denticulated.*
    - Dorsals two.....Galeus.
    - Dorsal solitary.....Notidanus.
  - *Teeth not denticulated.*
    - Teeth flat.
      - *Anal distinct.*
        - Dorsal pointed .....Mustelus.
        - Dorsal rounded .....Cestracion.
      - *Anal wanting; dorsals with spines*.....Spinax.
    - Teeth not flat.
      - *Teeth trenchant.*
        - Dorsals with spines.....Centrina.
        - Dorsals without spines .....Scymnus.
      - *Teeth conical, pointed, very numerous*.....Selache.

Pectorals notched in front, affording space for the gill-openings..... } Squatina.

(A.) *Sharks, with an anal fin, and the dorsals far back; the first being behind the ventrals.*

Family I.—SCYLLIIDÆ.

Scyllia, Müll. and Henle. Spout-holes. No nictitating membrane. Five gill-openings, the last one over the base of the pectoral fin. A furrow at the corner of the mouth; an upper and under labial cartilage. Teeth with a pointed medial cusp, and four or five radical toothlets on either side. Caudal longitudinally extended, truncated or rounded at the end, with or without a trace of an under lobe, but having a notch on the under side near the end; no caudal pit; oviparous. Eggs resembling those of a Skate; intestinal valve spiral.

Genus I. Scyllium, Müll. and Henle. First dorsal between the ventrals and anal; the second between the anal and caudal. Spout-holes close behind the eyes. Gill-openings equidistant, the last pair over the pectoral. Snout short, blunt; nostril near the mouth, connected with it by a furrow, and having a valve. Dermal ossicles or scales tricuspid. Eleven species.

Genus II. Pristiurus, Bonap. *Scyllia*, but with an elongated snout. Upper edge of the caudal serrated by a row of flat spinelets; a trace of an under caudal lobe; second dorsal over the end of the anal. Eggs smooth as in *Scyllium*. One species.

Genus III. Hemiscyllium, Müll. and Henle. Nostrils reaching to within the mouth; nasal flaps distinct, outer one large, inner one with a barbel. Spout-holes large, longitudinal under the hinder half of the eyes. Gill-openings as in *Scyllium*. Both dorsals behind the ventrals and before the anal, which latter is close to the caudal; caudal notched, without an under lobe. Two species, *vide* fig. 11.

Genus IV. Chiloscyllium, Müll. and Henle. A broad cutaneous under lip, with a transverse furrow behind it; the elongated under fold at the corner of the mouth attached in the middle. Teeth pointed, with one or two radical toothlets on each side. Spout-holes longitudinal, close behind the eyes. Fourth and fifth gill-openings close together. Dorsals placed as in *Hemiscyllium*. Six species.

Genus V. Crossorhinus, Müll and Henle. Mouth large, nearer the end of the snout than in most Sharks. Head broad and flat; many cutaneous tags about the nasal flaps and sides of the head. Teeth trilobate. Spout-holes unusually long, beneath and somewhat behind the eyes. Gill-openings equidistant, decreasing in size from first to the last, which is over the pectoral. Dorsals between the ventrals and anal, the latter close to the caudal. One species.

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Genus VI. Ginglymostoma, Müll. and Henle. (*Nebrius*, Rüpp.) Snout blunt; a long barbel from the inner side of the nostrils; corner fold of the mouth divided by a deep transverse furrow, the under portion subdivided by a longitudinal furrow. Teeth very numerous, in ten successive rows, each having a simple rhomboidal base, a conical mesial point, and from two to four toothlets on each side. Fifth gill-opening almost concealed within the fourth. Spout-holes very small, directly behind the eyes. First dorsal over the ventrals; caudal very long, having a rudimentary under lobe; pectorals long. Two species.

Genus VII. Stegostoma, Müll. and Henle. Mouth small, quite transverse. Teeth small, tripartite. The skin between the nasal flaps wider than the flaps, and forming an outer upper lip. A stout barbel, formed by a prolongation of each nasal flap. Corner folds of the mouth short, with deep pits. Head depressed and rounded. Spout-holes perpendicular slits behind the eyes. Fifth gill-opening concealed within the fourth; the last three over the pectoral; caudal very long, almost of even height throughout, and notched as usual towards the end. One species.

(B.) *Sharks, with two dorsals and an anal; the first dorsal over the space between the pectorals and ventrals. A nictitating membrane. No spout-holes; the last two gill-openings over the pectoral.*

Family II.—CARCHARIDÆ.

Carchariæ, Müll. and Henle. Nostrils generally small, with a three-sided flap on their upper border. Pupil perpendicularly oval. Mouth boldly convex, with a small corner fold. Teeth compressed, triangular, with an entire or serrated cutting edge. Caudal always with a short under lobe, and a notch below near the end of the upper lobe. A pit above and below at the base of the tail. Intestinal valve rolled longitudinally, not spirally. Scales small. Skin smoothish.

Genus I. Carcharias, Müll. and Henle. Nostrils midway between the mouth and end of the depressed snout. Labial cartilages small or wanting. Yelk-bag connected with a kind of uterine placenta; oviduct smooth or villous.

Sub-Genus I. Scoliodon. A mesial tooth in the upper jaw, none in the lower one; cutting edges of the teeth entire, not serrated. Second dorsal over the anal or its hinder end. Tail-pits distinct. Upper and lower caudal lobes equal. Scales small, three-keeled. Oviduct villous. Three species.

Sub-Genus II. Physodon. Teeth like those of *Scoliodon*, but thicker and larger, and there are two small teeth on the mandible, opposed to the single mesial upper tooth. First back fin close before the ventrals, the second over the anal. One species.

Sub-Genus III. Aprion. Teeth not serrated; upper teeth straight or slightly inclined outwards; under ones straight, with a small point on a broader base. Three species.

Sub-Genus IV. Hypoprion. Base of the upper teeth strongly serrated or jagged on one or both sides; their cusps smooth; no serratures on the bases or points of the lower teeth. Two species.

Sub-Genus V. Prionodon. Teeth in one or both jaws finely serrated, oblique or straight, three-sided, or with a small cusp on a broad base; generally a solitary mesial under tooth. Oviduct smooth. Twenty species.

Genus II. Prionodon, Müll. and Henle. (*Leptocarias*, Smith.) Nasal flap broad or prolonged into a barbel. Orbits longitudinal. Corner folds of the mouth very small. Teeth of *Scyllia*, small and numerous, alike in both jaws. Second dorsal and anal opposite, or nearly so. Caudal as in *Carcharias*, or as in those *Scylliidæ*, in which the under lobe is scarcely perceptible. Scales from three to seven keeled. Two species.

(C.) *Sharks, with two dorsals and an anal; first dorsal between the pectorals and ventrals. A nictitating membrane. Spout-holes. The last two gill-openings over the pectoral.*

Family III.—GALEIDÆ.

Galei, Müll. and Henle. Nostrils, orbits, mouth, and its corner folds as in the *Carcharidæ*, but with small labial cartilages. Spout-

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holes small, elongated or round. Teeth alike in both jaws, compressed, with cutting edges, and a cusp pointing obliquely outwards; edges smooth, or serrated on the outside or on both sides. Upper caudal lobe with one or two notches near its end. Tail-pits absent or present. Intestinal valve spiral, or rolled lengthways. Scales small, three-keeled, with a medial cusp.

Genus I. Galeus, Cuv. Spout-holes longish, half the length of the orbits behind the eyes; pupil round above, angular below. Teeth smooth on the inner edge, serrated on the outer one; cusp smooth, upright; mesial teeth straight, jagged at the base on both sides, and as large as the others. No tail-pits. A notch on the upper caudal lobe. Intestinal valve spiral. Two species.

Genus II. Galeocerdo, Müll. and Henle. Spout-holes very small, half the length of the orbits behind the eyes; pupils as in *Galeus*. Corner-pits of the mouth and labial cartilages indistinct. Teeth denticulated on both edges; outer edge prolonged in form of a coarsely jagged base; a single mesial tooth on both jaws, with the point turned to a side. Upper caudal lobe long and pointed; two notches on the under caudal border, one of them at the end of the spine. A tail-pit above and below. Gut-valve rolled lengthways. Two species.

Genus III. Loxodon, Müll. and Henle. Pupil round. Teeth alike in both jaws, oblique-edged, not serrated, basal projection on the outside also entire; a mesial tooth in the upper jaw, none in the lower one. Spout-holes small, close behind the eyes. Tail-pits above and below. A single notch in the upper caudal lobe. One species.

Genus IV. Thalassorhinus, Valenc. Pupil perpendicularly oval. Nasal flap very short. Teeth triangular, without a serrated basal ledge. Spout-holes pretty large. Tail-fin as in *Carcharias*, with a single notch; tail-pits above and below conspicuous. Intestinal valve rolled lengthways. Two species.

Genus V. Triakis, Müll. and Henle. Head flat, blunt. Nasal flap broad, moderately long; large pits at the corners of the mouth. Labial cartilages. Spout-holes of medium size. Teeth and fins as in *Scyllia*. Under caudal lobe indistinct. Tail-pits wanting. Scales three-keeled and three-pronged. One species.

Genus VI. Mustelus, Artedi. Large spout-holes. Long orbits. Nictitating membrane puffed out from the under eyelid. Teeth pavement-like, flat, without cusp or cutting edge, resembling those of the *Rays*. Labial cartilages at the corners of the mouth, and also deep pits. Nostril bordered above by a three-sided cutaneous lobe with a rounded tip and a short blunt lobule on the outside. First dorsal nearly in the middle between the pectorals and ventrals; caudal short. Tail-pits indistinct. Intestinal valve spiral. One species.

(D.) *Sharks, with two dorsals and an anal; the first dorsal over the space between the pectorals and ventrals. Spout-holes, but no nictitating membrane.*

Family IV.—Lamnidæ.

Lamnæ, Müll. and Henle. Gill-openings large, all anterior to the pectorals. Second dorsal and anal roundish, of equal size, and opposite to one another. Tail-pits evident. Caudal crescentic. Tail keeled on the sides. Spout-holes very small. Intestinal valve spiral.

Genus I. Lamna, Cuv. Snout a pointed three-sided pyramid; nasal flap short, three-sided. Spout-holes very small, far behind the eyes. Teeth compressed, not serrated, triangular, with an acute basal toothlet on each side of the older ones; surface of the base that rests on the jaw deeply concave; in place of mesial teeth, a vacant space above and below. Skin smooth. Scales very small. One species.

Genus II. Oxyrhina, Agass. Snout, spout-holes, and fins of *Lamna*. Teeth very thick, narrow and long, nail-shaped, curved, without basal toothlets; each tooth flat before, convex behind, diminishing rapidly in size towards the corner of the mouth, and double rooted with a deep notch between the roots; a vacant medial space on both jaws, and the third tooth of the upper jaw smaller than its neighbours. Three species.

Genus III. Carcharodon, Müll. and Henle. Snout, position of fins and spout-holes, as in *Oxyrhina*. Teeth of *Carcharias*, but straight, equilateral, and without a basal ledge; no mesial tooth; the third upper tooth is a little smaller than the adjoining ones. One species.

Genus IV. Selache, Cuv. Snout short, blunt; spiracles small. Gill-openings very large, nearly meeting on the throat. Teeth very small and numerous, conical, without toothlets or lateral notches, curved backwards. Scales small, with radiating curved points, so that the skin feels rough to the finger drawn over it in any direction. One species. *S. maxima.*

Genus V. Odontaspis, Agass. (*Triglochis*, Müll. and Henle.) Gill-openings large, wholly before the pectorals. Spout-holes very small. Transverse folds on the throat; a stout triangular flap above the nostril; no upper corner fold to the mouth. Second dorsal and anal large; upper caudal lobe elongated as in *Carcharias*. Tail-pits indistinct or wanting. Fore teeth very long, conical, simple, or with one or more very sharp basal toothlets; towards the corners of the mouth the upper teeth are more incisorial and diminish rapidly in size; the under teeth are similar in form; roots of the tooth divided into two branches by a middle hollow. Second dorsal over the space between the ventrals and anal. Scales three-keeled, the keels ending in sharp points. Two species.

Family V.—Alopeciidæ, Müll. and Henle.

Snout short and conical; spout-holes very small; nostrils small with a short superior flap; no labial cartilages. Gill-openings small as in *Carcharias;* the last one over the pectoral. Teeth compressed, not serrated on their cutting edges, alike in both jaws; no tooth on the mesial line; a smooth crescentic fold of skin behind the upper teeth. Second dorsal opposite to the anal, very small; pectorals falcate; upper caudal lobe very long, with a pit at its root. Scales small, three-pronged. Intestinal valve spiral.

Genus I. Alopecias, Müll. and Henle. (*Alopias*, Rafin.) Teeth having the outline of a sharp isosceles triangle in both jaws. Upper lobe of the tail as long as the body. One species, *A. vulpes.*

Family VI.—Cestraciontidæ.

Cestraciontes, Müll. and Henle. Mouth at the fore end of the snout. Nostrils slit to within the mouth. Spout-holes distinctly visible, rather behind the eye. Gill-openings small, the last one above the pectorals; a spine forming the front of each dorsal. Tail short; its upper lobe notched underneath. Pavement-like teeth in rounded oblique scrolls, like the spines of some univalves.

Genus I. Cestracion, Cuv. Caudal wide, and strongly notched below. Two species, Pacific Ocean, from Japan to Australia.

Family VII.—Rhinodontidæ, Müll. and Henle.

Rhinodontes, Müll. and Henle. Head flat. Mouth and nostrils at its extremity; nasal flap triangular. Teeth extremely small, and very numerous, card-like, conical. Spout-holes very small. Gill-openings diminishing in size as they recede from the head; the last one above the pectoral. Caudal crescentic, its upper lobe not notched. Lateral keels on the keel and pits. Intestinal valve spiral.

Genus I. Rhinodon, Smith. One species.

(E.) *Sharks, with one anal and only one dorsal.*

Family VIII.—Notidanidæ, Müll. and Henle.

Galei, without a first dorsal. Upper corner-fold of the mouth very large, under one small; no nictitating membrane. Spout-holes vertical, small. Six or seven gill-openings decreasing gradually in size, all before the pectorals. A mesial upper tooth; towards the corners of the mouth the teeth are low and flat; the others are triangular above, serrated below, the foremost ones crowded and curved. A small inferior caudal lobe, obliquely truncated and notched at the end. No tail-pits. Intestinal valve spiral.

Genus I. Hexanchus, Rafin. Six gill-openings. One species.

Genus II. Heptanchus, Rafin. Seven gill-openings. Two species.

(F.) *Sharks, with spout-holes. Two dorsals; no anal; no nictitating membrane. Five gill-openings, all before the pectorals. Intestinal valve spiral.*

Family IX.—Spinacidæ, Müll. and Henle.

Each dorsal fronted by a spine.

Genus I. Acanthias, Bonap. Head flat. Large pits at the corner of the mouth. Two labial cartilages. Mouth very flatly arched. Spout-holes large, behind and rather above the eyes, with a thick border springing from their fore edges; orbits long. Teeth on both jaws incisorial, the edge almost horizontal, with the point directed laterally, and the base keeled interiorly. First dorsal over the space between the pectorals and ventrals; second dorsal between the ventrals and caudal; upper caudal lobe the bigger one. An upper tail-pit in some. Male claspers tipped by a moveable spine. Scales heart-shaped, with a middle cusp and one or more keels. Four species.

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GENUS II. SPINAX, Bonap. Head arched. Snout blunt; nostrils at the extremity of the snout. Folds at the corner of the mouth very large, naked; under one encircling the under lip and uniting with its fellow; a labial cartilage at the upper corner of the mouth. Under teeth as in *Acanthias*, but without keel and basal apophysis; upper teeth as in *Scyllium*, but with a longer, straight, conical, mesial cusp, and two pointed lateral toothlets on each side. No tail-pits. Claspers not furnished with a prickle. Curved hairs in place of scales. One species.

GENUS III. CENTRINA, Cuv. Snout short, thick, and flat, with the nostrils near its edge; nasal flap quadrilateral. Fold at the corner of the mouth naked, blending on the mesial line with the rest of the integument. Spout-holes very large, behind and somewhat above the eyes, vertical, and crescentic, with a single flap. Upper teeth slender, conical, straight, and feebly incisorial, connected with the integument of the front of the jaw, and notched in the middle of their base; under teeth very nearly straight, broader and flatter than the upper ones, keenly cutting, sub-equilateral and finely serrated, with their bases nearly quadrangular; mesial tooth single, perfectly equilateral. Dorsal spines enveloped in skin to their points; no under caudal lobe and no notch. Male claspers soft, spineless. Scales consisting of an upright cusp on a quadrangular base. One species.

GENUS IV. CENTROPHORUS, Müll. and Henle. Head flat. Nostrils near the end of the snout. Folds at the corner of the mouth naked, large, and deep, with a slit running backwards from them. Spout-holes behind and above the eyes, furnished with a flap. Fourth and fifth gill-openings near each other. Teeth of the under jaw as in *Acanthias*, and either serrated or entire; their roots a middle upright keel with a tranverse exterior lobe; upper teeth straight, equilateral with quadrangular bases traversed by two crossing keels, no denticulations, no accessary prongs or toothlets; no mesial tooth. No tail-pits. Male claspers with an exterior prickle near their tips. Two species.

GENUS V. CENTROSCYLLIUM, Müll. and Henle. Upper and under teeth similar, straight, pointed with one or two lateral cusps or toothlets, as in *Scyllium*. Distinguished from *Spinax* by the teeth being alike in both jaws. Scales pointed, with a stellate base. One species.

FAMILY X.—SCYMNIDÆ, Müll. and Henle.

Scymni, Müll. and Henle. Dorsal fins without spines. Upper teeth pointed; lower ones trenchant, not denticulated. No tail-pits.

GENUS I. SCYMNUS, Cuv. Head either flat, or compressed on the sides. Spout-holes far behind the eyes. Teeth of the upper jaw upright, curved; under teeth broader, with an upright or an inclined edge. Gill-openings small. No tail-pits.

Sub-Genus I. Scymnus, with lancet-shaped under teeth, convex anteriorly, sharp on the sides, rising from a high base; the mesial tooth below as large as the others, and a bilobed root longer than the cusp; upper teeth standing straight forwards, with their sides inclined outwards. Claspers without a prickle. Two species.

Sub-Genus II. Læmargus, Müll. and Henle. Upper teeth small, longer than wide, conical, feebly incisorial, without serratures; an upright anterior keel, and a notched base; under teeth broader and longer, with a recumbent edge as in *Acanthias*, no serratures; and a long flat root, concave lengthways, and keeled perpendicularly anteriorly. Male claspers with a prickle. Three species.

GENUS II. ECHINORHINUS, Blain. *Goniodus*, Agass. Head flat; corner-pits of the mouth widely apart. Teeth broad and low, with a nearly horizontal edge; on the lateral edge, from one to three small cusps or toothlets; a space at the symphysis of the under jaw, with a very small mesial tooth in its centre. First dorsal over the ventrals; no under caudal lobe. Gill-openings not wide, all before the pectorals. One species.

GENUS III. PRISTIOPHORUS, Müll. and Henle. Separated from *Pristis* by the want of a naso-pectoral cartilage, the posterior wall of the nose being in this genus formed by the skull itself. Snout greatly elongated, beset on both sides with spines, attached to the skin only. A long barbel from the under surface of the snout. Mouth transverse. Teeth pavement-like, with a short mesial cusp, as in the male rays. First dorsal over the space between the pectorals and ventrals. Side of the snout keeled. Fourth and fifth gill-openings approximating. Two species.

FAMILY XI.—SQUATINIDÆ.

Squatinæ, Müll. and Henle. Body flat above and below. Mouth at the extremity of the snout. Eyes on the dorsal aspect. Spout-holes large, behind the eyes. Pectorals large, their expanded roots interposing between the head and body, but divided from them by a furrow, in which are situated the closely approximated gill-openings.

GENUS I. *Squatina*, Dum. Both dorsals on the tail, which is keeled on the sides. Male claspers small and weak. Scales conical, with a terminal point. Teeth conical, irregular, with interspaces. Two species.

Classification—Sharks.

(G.) *Sharks, similar to those of division B, in having a nictitating membrane and no spout-holes, and in the position of the spineless dorsals; but with a lateral extension of the skull at the orbits, which is greatest in the adults.*

FAMILY XII.—ZYGÆNIDÆ.

Sharks, head flat, with the orbits largely extended latterly, and the snout truncated, or hammer-headed; a form of head not found in any other group of fishes.

GENUS I. ZYGÆNÆ, Cuv. (*Sphyrna*, Rafin.) *Sphyrnias* and *Sphyrna*, Rafin. Front of the head transverse to the ends of the lateral orbital extensions of the skull. Nostrils on the front border; nasal flap small, triangular on the inner edge of the nostril. Labial cartilages small. Teeth alike above and below, being a compressed pyramid, with an entire or serrated exterior basal ledge; a mesial tooth in both jaws. First dorsal near the pectorals; second one over the anal. Distinct tail-pits. Oviduct villous; yelk-bag connected to the sides of the ovisac. Four species.

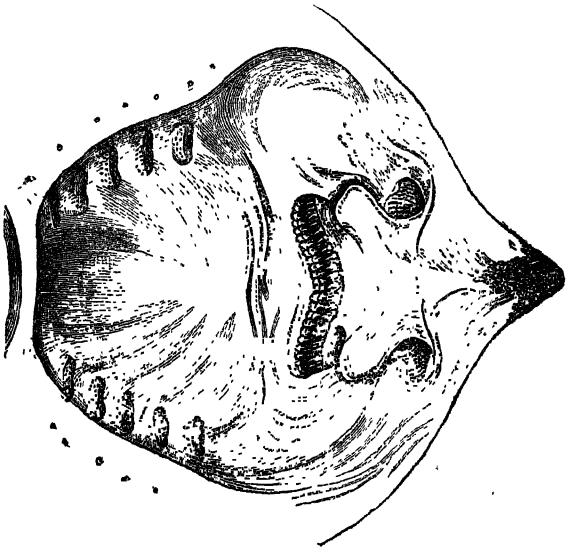


Fig. 136.
Head of *Raia Lemprieri*.

RAYS.

This sub-order, familiarly known by the name of Skates, has for the general character of its form the extreme depression of its body, and the lateral expansion of the pectoral

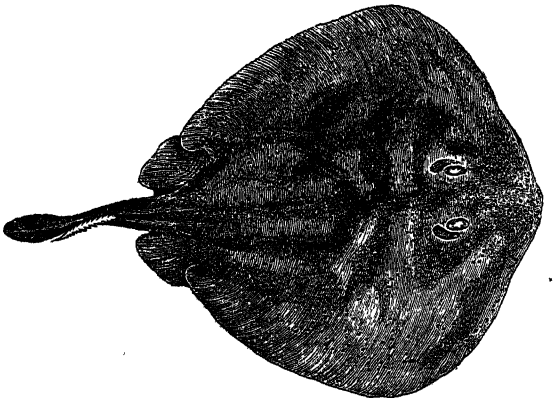


Fig. 137.
Urolophus ephippiatus, Australia.

Classification—Rays.

fins forming a discoid or subrhomboidal body, with an appended tail, which in the *Rhinobatidæ* is fleshy and tapering, and in the *Raiidæ*, *Trygonidæ*, and some other groups, is cartilaginous and slender, and sometimes elongated like the thong of a whip. In some a narrow lancet-shaped spine placed erect on the dorsal surface of this whip-like tail, with its cutting edges turned sideways, proves a dangerous offensive weapon, which the fish can use with great effect. The cartilaginous scapular arch is complete on the ventral surface, and running forwards at some distance, laterally from the skull in a crescentic tapering point, gives support to the long, jointed cartilaginous rays of the pectoral. In the space between the hinder horns of the scapulo-coracoid cartilages laterally, and the pelvic cartilages behind, lie the abdominal viscera; while the branchial apparatus and vascular centres occupy the posterior part of the spaces between the anterior cornua of the scapular arch and the narrow skull. On looking at the skeleton of a Skate, it will be seen that the skull is comparatively narrow; that the cartilages supporting the branchial apparatus stand out like wings behind, and those on which the eyes are placed also project laterally, exactly like the prominent orbits of the *Zygæna*, but that this lateral prominence is concealed in the entire Skate by being inclosed between the points of the pectorals. Anteriorly the skull is completed by a tapering cartilage whose tip supports the end of the snout. In the *Torpedinidæ*, a cellular galvanic battery fills up the wide spaces between the skull cartilages and the front horns of the pectorals. Recently a homologous apparatus, but much smaller and merely rudimentary, has been discovered in the ordinary Skates—an indication seemingly of a general plan of structure in the members of the group, irrespective of function, which it has pleased the Great Architect of the Universe to give.

Except in the genera *Anacanthus*, *Aëtobates*, and *Myliobates*, we are not aware of any species of Ray that is common to both the Atlantic and Pacific districts of the ocean, but several exist both in the Mediterranean and North seas. *Anacanthus africanus* has been taken both in the Red Sea and in the Gulf of Guinea. *Myliobates Nieuhofii* exists in the Mediterranean, and in the Indian and Australian seas, and *Aëtobates narinari* frequents the coasts of Brazil, as well as the Red Sea and the Indian Ocean. Of the range of species, however, we are not prepared to speak with confidence. What is at present known on the subject rests chiefly on specimens in the European museums, examined by Müller and Henle, whose work on the *Plagiostomi* is the only one professing to include all the known species. The great advances that ichthyology has made since the publication of that work, and the attention now paid to anatomical structure in the definitions of species, will enable future ichthyologists to enter on the inquiry of distribution of species with great advantages. The Rays found on the British coasts are *Torpedo marmorata*, and *T. nobiliana*, of only occasional occurrence, and much more abundant in the Mediterranean; *Raia radula*, *R. clavata*, *R. radiata*, *R. batis*, *R. marginata*, *R. fullonica*, *R. oxyrhyncha*, *R. microcellata*, *R. intermedia*, *R. lintea*, and *R. acus*; *Cephaloptera Giorna*, *Myliobatis aquila*, and *Trygon pastinaca*. Some of these are of daily occurrence in our markets, as the *R. batis*, Blue or Grey Skate, Tinker or True Skate. The *R. oxyrhincha* (L.), or *miraleta* (Yarr. Ed. 2da.), Homelyn, Spotted Ray, or Sand Ray, is stated by Mr Yarrell to be one of the two commonest Skates brought to the London market; the other being the *R. clavata*, Thornback, Young Maidens, or Maiden Skate. Unlike most fish, the Skate improves by keeping several days, being hard and tough when cooked soon after it is caught. It is one of the fish that the fishmongers are in the habit of crimping. Figure 7, p. 123, represents the *Raia Lemprieri*, an Australian Skate, which somewhat resembles the Homelyn of our own coasts in general form, and fig. 136 shows the under surface of its head.

Classification—Rays.

Some of the *Cephalopteridæ* attain an enormous size. One mentioned by Risso, taken off Messina, weighed 1250 lbs.; the male is usually the smallest. Of a pair spoken of by this author, the female was first taken, and the male remained hovering about the boat for three days, and was afterwards found floating dead on the surface. But the size here spoken of is greatly surpassed by other fishes of this order, which have been but imperfectly described, such as the *Raia Banksii* of Lacépède, referred with doubt to the genus *Ceratoptera* by Müller and Henle. A fish of this kind taken at Barbadoes required seven yoke of oxen to draw it. A sketch of another, which was said to be 20 feet long, was sent to Lacépède; and Levaillant, in his second voyage to Africa, speaks of one which swam round the vessel, and appeared to be about 25 feet long and 30 wide. Sonnini also mentions one which seemed to him to be longer and wider than the ship in which he was sailing.

The *Torpedinidæ* all possess electric organs, and it is the space occupied by these batteries that gives the round or truncated outline to the fore part of the fish. The batteries lie one on each side of the head, bounded behind by the scapular arch, and laterally by the anterior crescentic tips of the pectoral fins. They consist of a congeries of vertical prisms, whose ends are in contact with the integuments above and below; and each prism is subdivided by delicate transverse septa, forming cells which contain a fluid, and are lined within by an epithelium of nucleated corpuscles. Between this epithelium and the transverse plates and walls of the prism, there is a layer of tissue, on which the extreme twigs of the nerves and vessels ramify. Hunter counted 470 prisms in each battery of the *Torpedo galvani*, and demonstrated the enormous supply of nervous matter which they receive. Each organ receives one branch of the trigeminal nerve, and four branches of the vagal nerve, the former and the three anterior branches of the latter being each as thick as the spinal chord. The fish gives the electric shock voluntarily, when excited to do so in self-defence, or when roused to kill its prey; but to receive the shock the object must complete the galvanic circuit by communicating with the Torpedo at two distinct points, either directly or through the medium of some conducting body. The shock received on handling the fish is described as too strong to be willingly encountered a second time, and it is said that a painful sensation may be produced by a discharge conveyed through the medium of a stream of water.

Sub-Order II.—RALÆ.

Plagiostomi, with flat bodies, spout-holes. Five slit-like gill-openings on the ventral aspect before the ventrals and under the pectorals. Eyes and spout-holes on the dorsal aspect. A complete scapular arch. Naso-pectoral cartilages. No eyelid, or an adnate upper one only.

ANALYTICAL TABLE OF THE *RALÆ* (Dum.)

Tail long, and
- Very thick at the root.
  - *Snout prolonged.*
    - Set laterally with teeth.....PRISTIS.
    - With even, thin, smooth edges.....RHINOBATES.
  - *Snout rounded, smooth*.....RHINA.
- Slender
  - *Dorsals two, caudal; disk rhomboidal*.....RAJA.
  - *Dorsal single or wanting.*
    - Eyes on the dorsal aspect.
      - *Teeth small; tail spiniferous*.....TRYGON.
      - *Teeth broad, flat, grinders*.....MYLIOBATES.
    - Eyes lateral; head truncated, horned..CEPHALOPTERUS.

Tail short; body smooth; electric organs visible.....TORPEDO.

Classification—Rays.

Family I.—PRISTIDÆ.

Pristides, Müll. and Henle. Form of Sharks, with the gill-openings on the ventral surface as in the Rays; characterized by a long flat narrow snout, set on the sides with strong bony spines, or teeth forming a saw, with two edges; true jaw-teeth like those of *Mustelus*.

Genus I. Pristis. (*Pristibatis*, Blain.) Six species.

Family II.—RHINOBATIDÆ.

Rhinæ, Müll. and Henle. Of an intermediate form between the typical Rays and the Sharks. Fore part of the body forming a disk by the conjunction of the pectoral fins with the snout; pectoral fins quadrangular, divided from the proper head part of the disk by a furrow, and not reaching back to the ventrals. First dorsal over the ventrals; caudal bilobate; upper lobe a little larger; the keels of the sides continued along the caudal fin. Margins of the mouth undulated; three protuberances of the under jaw fitting corresponding incurvations of the upper one. Nostrils longitudinal near the mouth, with flaps.

Genus I. Rhina, Bloch, Schneid. Snout broad, rounded. Spout-holes close behind the eyes. Nasal flaps reaching to the inner corner of the nostril. Undulations of the jaws bold. Teeth almost round, not broader than long. One species.

Genus II. Rhynchobates, Müll. and Henle. Snout pointed, with a mesial tapering keel. Spout-holes close behind the eyes; nasal flaps not reaching to the inner corner of the nostril, but only halfway. Undulations of the jaws feeble. Teeth broader than long. A transverse curved row of pores on the ventral aspect of the scapular arch. One species.

Genus III. Rhinobatus, Bloch, Schneid. Pectorals blending imperceptibly with the sides of the snout; the space between them and the skull cutaneous. Both dorsals on the hinder part of the tail; ventrals longer than the head, rounded before, pointed behind; no under caudal lobe. Mouth transverse, straight, or gently curved. Teeth pavement-like, with a transverse ridge more or less acute. Spout-holes close behind the eyes. A row of pores on the scapular girdle. Two sub-genera, *Syrrhina* and *Rhinobatus*, varying in the extent of the nostril flaps. Eighteen species.

Genus IV. Trygonorhina, Müll. and Henle. *Rhinobati*, but the nasal flaps uniting with one another to form a single flap, which hangs over the mouth as in *Trygon*, leaving a round nasal aperture on each side. Upper eyelid adnate, crescentic; fore margin of the disk with a single incurvature. One species.

Genus V. Platyrhina, Müll. and Henle. Pectorals approaching one another at the point of the snout, and inclosing the front of the skull. Tail more slender than in the other *Rhinobatidæ*. All the fins rounded. Upper nasal flap triangular, extending above the inner angle of the nostril. Upper eyelid as in *Rhinobatus*. No raised edge at the spout-holes. Two species.

Family III.—TORPEDINIDÆ.

Les Torpilles, Cuv.; *Torpedines*, Müll. and Henle. Tail short, less thick and fleshy than in the *Rhinobatidæ*, depressed, towards the end cylindrical, keeled on the sides. Disk naked, rounded, without scales or prickles. Ventrals immediately behind the pectorals; dorsals none, or one or two on the tail; caudal sub-triangular. Upper eyelid adnate. A quadrilateral flap, with a free edge between the nostrils, furnishing folds which embrace all the nostril except its lateral corner; the flap is connected to the upper lip by a bridle. Teeth pointed or flat. A galvanic battery occupying the space bounded by the skull, gills, and pectorals. Teeth flat or cuspidate.

Genus I. Torpedo, Dum. (*Narcobatis*, Blain.) Two dorsals. Disk rounded, anteriorly truncated evenly or with a slight incurvature. Mouth crescentic. Teeth pointed, attached to a jaw cartilage, and not extending outwards beyond the margin of the lips; base of each tooth widest transversely. Spout-holes at a distance from the eyes, with a cuticular fringe round the orifice. First dorsal bigger than the second one, and situated over the hinder part of the ventrals; caudal triangular with a straight terminal edge. Four species.

Genus II. Narcine, Henle. Two dorsals. Disk roundish, elliptical or angular, rounded in front. Mouth small, surrounded by a fold of skin which passes on the mesial line above into the bridle of the nasal flap; this flap is transverse, straight, or with a medial convexity, so as to become faintly three-lobed on the edge; a labial cartilage above and below. Teeth in quincuncial order, with a middle cusp, forming in the aggregate an elliptical plate, not adhering to the jaw, but moving with the skin; a velum within the upper jaw. Tail longer than the disk. Edges of the spout-holes not fringed. Five species.

Genus III. Astrape, Müll. and Henle. One dorsal. Snout short, without a keel. Mouth as in *Narcine*. A cylindrical cartilage in the bridle of the nasal flap. Cusps of the teeth on a quadrangular base; dental plate overpassing the border of the mouth a little; velum within the mouth, above and below. Spout-holes near the eyes, with smooth borders. Three species.

Classification—Rays.

Genus IV. Temera, Gray. No dorsal. Mouth, *vela*, and nostrils as in *Astrape*. Tail proportionally short. Spout-holes close behind the eyes, with smooth borders. Teeth flat. One species.

Genus V. Discopyge, Heck. Disk orbicular. Mouth transverse, with thick lips at the corners; upper jaw having a dental lamina, turning outwards, covered with minute teeth, in quincuncial order. Teeth flat, rhomboidal, their hinder angle acute. Nasal valve truncated, with a notched process in the middle; beneath joined by a bridle to the circle of the mouth. Spiracles adjacent to the eye, with naked borders. Ventrals united under the tail; dorsals two, equal; caudals obliquely ovate.

Genus VI. Hemigaleus, Bleek. Temporal openings minute, triangular; pupil convex above, narrow beneath. Premaxillary teeth serrated on their outer edge, smooth internally; mandibular teeth slender, with a broad base not serrated. Conspicuous caudal furrows above and below. Valve of the great intestine rolled up longitudinally. Batavia. Two species.

Genus VII. Hypnos, Dum. Disk longish, somewhat notched in the middle of the front border. Spout-holes close to the eyes, surrounded by a wreath of long and numerous fringes. No labial cartilages. Mouth crescentic, not protractile. Pointed teeth on the edge of the jaws, whose whole length they occupy, but do not go beyond. Bridle of the nasal flap connected with the fore border of the upper lip. Tail extremely short.

Family IV.—RAIIDÆ.

Disk broad, rhomboidal, the two sides which meet to form the lateral angle belonging to the pectoral fins; these are attached posteriorly, as far back as the root of the ventrals, and flank the point of the snout anteriorly; dorsals near the tip of the tail. Tail depressed, with a cuticular keel on the sides. Caudal wanting, or existing as a mere cuticular seam. Upper eyelid adnate. Spout-holes separated from the orbits by a slender cutaneous bridge, smooth-edged. Nasal flap confluent with the upper lip, forming an even surface, with a free rounded lobe on each side, that folds over the nasal aperture. Mouth curved, with its convexity towards the tip of the snout; no labial cartilages. Teeth of the males with a central cusp in spawning time; an upper velum only. Skin smooth, or studded with prickles pointed backwards, among which, chiefly on the dorsal ridge, and on the sides of the tail, there are often larger spines. In the males, sharp prickles are developed on the borders of the pectorals in the spawning season. Oviparous.

Genus I. Raia, Cuv. (*Dasybatis*, Blain.) Snout keeled, with the interior limits of the pectorals parallel to the keel, but separated from it by a cuticular space. Ventrals deeply notched behind, hence bilobate; anterior or outer lobe more narrow. Terminal caudal seam low, and more conspicuous above than below, generally interrupted at the point. Thirty species.

Genus II. Sympterygia, Müll. and Henle. Pectoral fins uniting before the head and forming the point of the disk as in Trygon. Ventrals not notched, being merely undulated posteriorly; caudal as in *Raia*. One species.

Genus III. Uraptera, Müll. and Henle. Snout and ventrals of *Raia*; no caudal. One species.

Family V.—TRYGONIDÆ.

Trygones, Müll. and Henle. Point of the disk formed by the pectorals. Upper eye-lid adnate. United nostril flaps free and fringed, but bound to the upper lip by a slender mesial bridle; nostrils closely approximated under the flap. Skull higher than in the Rays. Spout-holes large and close behind the eyes. Teeth transversely elliptical, with a ridge which is blunt, sharp, or cuspidate. Ventrals not notched. Tail slender, often whip-like, without lateral keels; naked, or bearing one or more barbed spines. No caudal. Skin smooth or tuberculated, or prickly. No prickles are developed on the pectorals of the males, as in the Rays.

Genus I. Anacanthus, Ehrenb. No spine on the tail; which also wants a fin with rays, but is either naked or furnished with a cuticular seam merely. Two species.

Genus II. Trygon, Adan. (*Trygonobatus*, Blain.) Disk oval or rhomboidal. Tail equal in length to the body, or longer, bearing one or more spines without cuticular ridges, or with short ones merely, not reaching the point. Teeth cuspidate, or transversely ridged with cross furrows; upper velum deeply fringed with a second crescentic one behind; generally a papilla behind the under teeth. The species may be divided by the wholly finless condition of the tail, or the existence of a cuticular seam below, or of a seam above as well as below. Eighteen species.

Classification—Rays.

Genus III. Pteroplatea, Müll. and Henle. Disk nearly twice as broad as it is long. Tail for the most part shorter than the body, bearing one or more spines, with low cuticular seams, or quite naked. Mouth crescentic, with the dental plate reaching to its corners. Teeth having from one to three cusps; upper velum not fringed; no papillæ behind the under teeth. Skin smooth or tuberculated. Three species.

Genus IV. Teniura, Müll. and Henle. Disk roundish. Tail little longer than the body, depressed before the spine, which is near its middle, compressed posteriorly, with a high under-fin running from near the spine to the end, together with a shorter or longer cuticular hem above, also reaching the point. Nostrils approximating as in *Trygon*. Teeth with a transverse ridge or a cusp. Mouth straight or undulated. Upper velum straight. No papillæ below. Five species.

Genus V. Urolophus, Müll. and Henle. Disk roundish, egg-shaped or rhomboidal. Tail destitute of a dorsal, but with a caudal which has cartilaginous rays, and reaches further forwards below than above. Teeth and mouth as in *Trygon*; upper velum gently scalloped; under one with five warts. Four species.

Genus VI. Trygonoptera, Müll. and Henle. Tail short, broader at the end, with a small rayed dorsal immediately before the spine. Teeth rather acute. Disk as in *Trygon*. One species.

Genus VII. Aëtoplatea, Valenciennes. A *Pteroplatea*, except that it has a dorsal before the spine. One species.

Family VI.—Myliobatidæ.

Head more elevated than in *Raia*, projecting as far as the gills, beyond the pectoral disk, having no fin-rays on its sides, but a kind of head fin is developed before the skull, making the point of the disk. Nasal flaps forming the sides of a quadrangular flap which reaches to the mouth, and is fringed posteriorly; nostrils separated by a thin fillet merely, which comes from both angles of the mouth over the quadrangular flap, and is slightly pointed in the middle. Mouth transverse; dental plates reaching far back in the cavity of the mouth. Teeth large like mosaic pavement, even; upper velum very long, with a convex border fringed in the middle; under velum close to the teeth, with only one papilla behind. Eyes and spout-holes in the sides of the skull; a broad bridge between the spout-holes and eyes. No eyelids. Tail long, whip-like; a dorsal fin on its root, and a spine behind the dorsal.

Genus I. Myliobates, Cuv. (*Aëtobates*, Blain.) Union of the antecephalic rays of the pectoral forming a pointed snout; nasal flaps joined by a straight-edged membrane. Mouth transverse. Teeth arranged in a mosaic pavement of long hexagonal plates in the middle, and two or three rows of short quadrangular or hexagonal pieces on the sides; on the upper jaw the dental surface is convex both longitudinally and transversely. Five species.

Genus II. Aetobates, Müll. and Henle. Snout pointed, not notched; under edge of the coalescent nasal flaps deeply notched; the nasal bridle papillose. Upper jaw straight-edged; crowns of the teeth in rows; the dental plates not extending to the sides of the jaws. Two species.

Genus III. Rhinoptera, Kuhl. Snout deeply notched in the middle. The antecephalic fin in a lower plane to that of the pectoral, and joined to the inferior base of the latter. Nasal flap straight posteriorly; its lateral angles pointed. Jaws straight; teeth occupying the whole transverse breadth of the jaw, and forming from three to five rows of transversely long, antero-posterior narrow hexagonal plates, with smaller lateral ones as wide as they are long. Six species.

Family VII.—Cephalopteridæ.

Head straight transversely in front. The precephalic fins proceed from the under edge of the pectorals, and project like ears on the sides of the head, and curl upwards and inwards. Under edge of the coalescent nasal flap straight; nostrils near the precephalic fins, wide laterally. Teeth very small. Eyes on the sides of the skull immediately before the commencement of the pectorals. Spout-holes on the dorsal aspect, widely separated from the eyes. Tail as long, or longer than the body, bearing a dorsal fin, and behind it a spine.

Genus I. Cephalopterа, Dum. (*Dicerobatis*, Blain.) Mouth on the ventral aspect. Teeth of both jaws small, flat, pavement-like, of diverse forms. Pectoral fin prolonged forwards to a point beyond the truncated head, looking like a horn; the edge of the fin from this point to behind the eyes being convex. Four species.

Genus II. Ceratoptera, Müll. and Henle. Mouth at the end of the snout; upper jaw crescentic on the edge; under one convex; no teeth in the upper jaw; on the under jaw they are small and scale-like. Pectorals not passing the front of the head, a rayless space between the cephalic portion and the body of the fin; lateral edge of the fin incurved at the head, and spreading outwards at the third gill-opening. Three species.

Classification—Rays.

In our preceding compendious review of the class of fishes, we have, as already stated, taken as our almost exclusive authority, with regard to structure, Professor Richard Owen, late Curator of the Museum of the College of Surgeons of London, and now Zoological Superintendent of the British Museum. From his lectures delivered in 1844 and 1846 before the college our facts have been taken. The great *Histoire des Poissons* of Cuvier and Valenciennes, which closed with the 22d volume in 1849, has been our text-book for the characters of families and genera of most of the osseous fishes, as well as for the few remarks we have made on their species. Several families and groups of families not included in that work have been characterized by the labours of Dr Kaup of Darmstadt; and for our analysis of the *Plagiostomi*, we have taken for our sole text-book the treatise of Müller and Henle on that subject, published in 1838. Some other works of Johannes Müller that we wished much to consult, were not to be found in those public libraries to which we had access, and we have been unable therefore to give the latest views of that very distinguished physiologist. We could not within encyclopædic limits enter into the discussion of disputed points, or entertain questions respecting priority of names, and we therefore have with scarcely an exception adopted the generic names of the authorities we have mentioned, and also their family groups, occasionally, however, for the sake of uniformity changing the few terminations of the names of the latter into *idæ* where that had not been previously done, intending by such uniformity of termination to denote more readily the rank of the group in the system. The labour of clearing up the intricate synonyms that have crept into the science, is one of the greatest, and is certainly the most irksome, that the ichthyologist has to encounter, and one whose successful results are generally shown by the adoption of a single word, giving no indication to the uninitiated of the time, and research, and thought they have cost. It is, however, a labour that cannot be lightly passed by; for without a correct determination of the species the descriptions are useless or encumbering to science. Without such careful preliminary work no one can enter at all upon the subject of the geographical distribution of species. Yet that branch of ichthyology, no less than the habits of the species, is of vast importance to a maritime nation, desirous of extending her fisheries, and thereby increasing the supply of a most healthy and nourishing food for her teeming population, and raising new nurseries for seamen.

However desirous we may be of adding a few words on the geographical distribution of fish, the time has not yet arrived for enunciating many observed facts. There is as yet no general list of species comprising the whole class, and in local lists our conclusions are universally marred by the clashing of synonyms, and the superabundance of nominal species. A work, however, has been going on for some years, silently almost, and without attracting a tithe of the notice it deserves from scientific zoologists, but which, when completed, will supply exactly what is required. We mean the *Zoological Catalogues* of the British Museum, now in the course of publication in parts. The enlightened plan of this catalogue, as conceived by Dr John Gray, the keeper of the zoological department of the Museum, is to comprehend descriptions of all known species, of which specimens are to be found in any of the great European museums, with a comparison of the actual specimens in every instance in which that can be effected. In this way, not only are the species in the British Museum correctly named and pointed out, so as to relieve future inquirers of a load of labour; but the species not to be found in the Museum are also indicated. We know of no work on Natural History better planned, nor one that is likely to have

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more effect on the progress of Ichthyology. The Museum catalogues of the Serpentiform Apodals, the Lemniscate Apodals, the *Mormyridæ* and *Balistidæ*, contain descriptions of a great many species, previously unknown to the world, and present comprehensive views of these groups nowhere else to be found. The generic and higher groups they characterize are embodied in our table. We cannot enter further on the bibliography of Ichthyology, and must refer the student to the *Bibliographia Zoologica*, published by the Ray Society, where he will find all that he wants in this respect.

ON THE GEOGRAPHICAL DISTRIBUTION OF SPECIES.

This is a wide field for observation and discussion; but the way for entering upon it with much hope of success has not as yet been cleared. Systematic Ichthyology is but of recent date; our acquaintance with the species of fish is as yet limited; our knowledge of their habits and migrations very imperfect; and we should only lead to error, were we to attempt to deduce general laws from such scanty data. We can merely therefore glance at a few circumstances connected with this department of Ichthyology, which, little as it has hitherto been considered, will, when the science has advanced to the proper point, certainly meet with the attention it so fully merits. *Temperature* has an acknowledged influence, both directly and indirectly, on the distribution of organized beings over the globe. Vegetation ceases, or nearly so, when we reach the regions of perpetual frost, either by ascending lofty mountains, or sailing towards the poles; and even the *Protococcus nivalis*, that propagates and flourishes in the snow, must owe its growth to the action of the sun's rays, in liquefying a portion of the snow sufficient to furnish fluid for the extension of the simple cells of which it consists. The range of phytophagous animals depends, of course, on that of the plants which they can eat and assimilate; and their distribution again influences that of the predacious kinds which subsist solely or mostly on animalized matter. Migration, though not synonymous with distribution, yet inasmuch as it is an instinctive movement, having for its end proper supplies of food, must furnish many facts that bear on the dissemination of species. The extent and character of the migration varies with he species. Among Mammals it has been little noticed, except in the gregarious Ruminants and certain Rodents. The American bison roams over the prairies in quest of fresh grass. When the herbage has gone to seed in one locality, and the haulms are dried up, the vast herds travel onwards till they find a younger and greener vegetation in some district over which a fire has recently run. This movement, whatever may be the extent of the journey over these sea-like prairies, scarcely comes under the term migration. But the reindeer, pressed by some more recondite instinct, quits the interior where it has fed in winter, and in herds of greater or smaller size, but in numberless succession, and all actuated by a common impulse, hastens to the coasts and islands of Hudson's Bay, or of the Arctic Sea, passing rapidly over the intervening barren districts wherein pasture is scanty; but throughout the march regularly waited upon by bands of wolves. Birds, with their greatly superior locomotive powers, perform migrations much more remarkable for the length of way. Vast numbers of *Anatidæ*, natives of the extreme capes and islands of Arctic America, assemble in flocks on the approach of winter, and move southwards to pass that season on the table-lands of Mexico and of Central America, lingering on their way only in berry-producing or marshy districts and coasts, and passing over the others high in the air, and with great velocity. The annual migrations of the Swallows are no less extensive than those of the *Natatores*, and are as evidently designed to secure an appropriate succession of food. Every species has its proper range, that of some being of much greater extent both northwards and southwards than others. Of the Reptilian class, the algivorous Chelonians resort in numbers to certain solitary and sandy shores, for the purpose of depositing their eggs, but there is, as far as we know, no extensive migration of any member of that class in search of food. The *Pinnotheres*, a family of Crustaceans, also assemble annually in multitudes, descend from their usual places of abode in the interior, and travel in a straight line to the sea, to deposit their eggs in the sand of the shore. It is questionable whether any kind of fish makes long migrations either to seek for food or to deposit its eggs. Herrings have been said to do so, and to issue from their polar retreats to visit their proper spawning places on the coasts of Scotland; but as regards the length of their journey, this is probably a mistake, though there can be no doubt, that in common with many other fishes, they seek the shallow waters at spawning time; and it is true also, that the common Herring exists in the arctic seas, but it is precisely in the spawning months that it has been taken off the arctic shores of America, as well as in the British friths.

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In respect of the power of making long journeys, many fishes are as favourably endowed as the swiftest bird,—their muscular powers are as great or greater, and the medium in which they move is more nearly equal to their bodies in gravity. Whoever has seen the Dolphin (*Coryphæna*) accompanying for days together a fast-sailing vessel running at speed before a fresh trade-wind, and occasionally shooting ahead, or playing round her as if she were at anchor, can have no doubts about the velocity with which a fish can travel. It has been calculated, indeed, that the Salmon can travel 20 miles an hour against the stream, and that the Tunny or *Coryphæna* would encircle the globe in a few weeks. This shows us, that unless the diffusion of a species be limited by other causes, mere distance is no obstacle to very many fishes. A bird in its migratory flight can soar high, and take advantage of the upper or lower currents of the air that may be favourable for its course, while at the same time it carries along with it the temperature of the colder regions it has left; the tenuity of the atmosphere being in fact the limit to its ascent. In the same way a northern fish might find at a distance from the surface the mean temperature of the sea (39°·5 Fahr.); its descent into the bosom of the ocean being limited by the pressure it can bear. This line of mean temperature varies in its depth with the latitude. Sir James C. Ross found it to be, in S. Lat. 45 degrees, 3600 feet below the surface; and in the equatorial and tropical regions 13,000 feet, the surface heat being in the latter districts 78°. In 70 degrees of south latitude, the surface heat is 30° Fahr., and the mean heat of 39°·5 has descended 4200 feet.

The obstacles that are likely to arise to a long journey by any fish, and also to the spread of the species, will vary with its habits. Ground fish, organized for swimming near the bottom only, and feeding there, will be stopped by great depths of the ocean as effectually as a land animal would be by a high mountain range rising far into the snowy regions,—they would neither be able to endure the pressure they would have to encounter at great depths, nor the privation of food to which they would be exposed in following the bottom to a depth to which they were not accustomed. James Forbes, whose early death has deprived Natural History of one of its most able and successful cultivators, has shown that marine life diminishes with the depth, and at length ceases, not perhaps at the limit he was inclined to assign to it, but still in a manner analogous to the ascent of a mountain. To favour the spread of ground-fish, then, a chain of sand banks, submerged to the proper

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depth, would be necessary. While the Scomberoids and other fishes that habitually swim near the surface would be more directly influenced by temperature, both as regulating the supplies of food, and as acting immediately on their own constitutions.

There can be no doubt that species have been framed to endure certain degrees of temperature only; that some which thrive in water, just above the point of congelation, would perish in the tepid ponds of intertropical regions, and *vice versa*. Dr Davy has shown that a continued heat of 80° will addle the egg, and destroy the embryo of the common Salmon; the fact of that species being limited to the countries lying northwards of the 41st parallel of latitude being most probably dependent on the small power the species has of resisting heat. On the other hand, the experiments of Broussonnet show that by using much caution, and elevating the temperature gradually, fish of temperate regions may be brought to endure a heat of 97° Fahr. The *Ambassis thermalis* is reported in the *Histoire des Poissons*, on the authority of M. Renaud, as capable of inhabiting the hot springs of Cannea, near Trincomalee, in a temperature of 115°·25 Fahr.; but there is reason to suspect some inaccuracy of observation here. Dr Davy visited these springs in 1817, when of seven wells, then existing, the hottest and principal one, and the one which he thought supplied the others, had a temperature of 105·75° Fahr.; but the heat was said to vary, and he was told that it occasionally rose to 110°. The coolest of the seven wells had a heat only of 86° Fahr.; and in one only, whose temperature was 91°, did he see any fishes. Many small fishes, such as the *Antennarii*, and others of the less active swimmers, dwell in the floating islands of Sargasso, and most probably spawn among its stems. Though they find shelter in its mimic groves from the predacious birds and fishes, yet they must be exposed to a pretty high temperature under the direct rays of a tropical sun, against which, however, nature has furnished them with a protection, in the copious secretion of mucus which envelops their skins. The *Anabas*, again, ascends the palm trees of Bengal, and endures the heat of an atmosphere rising to 97° in the shade; while the *Callichthys* of tropical America must be exposed to at least an equal heat in its overland journeys. Fish constituted to brave such heats would speedily perish, there is every reason to believe, in colder regions; and a review of the whole class leads irresistibly to the conclusion that many species have been created solely to meet the conditions of existence which certain limited localities afford, such as the *Amblyopsis* of the Mammoth Cave of Kentucky, and the Siluroids of the mud volcanoes of the Andes.

The creation of a single pair of each species in certain spots, and the diffusion of their progeny from thence, has been of late a favourite subject of speculation; but this implies the subsequent calling into existence of the more predacious kinds, when the others had multiplied, so as to need a check; and the simpler supposition, and the one that is most consistent with the facts that are known, is that when the ocean was in a condition to support ichthyic life it was peopled by the Great Creator, each species being placed in sufficient numbers in the district best suited to its structure and habits, and the purpose it was designed to serve, while at the same time the balance between reproduction and supplies of food was provided for by a sufficient number of the rapacious kinds. And, moreover, that new species were created when a change in the condition of the ocean and its boundaries led to the extinction of the older races, and rendered such an exercise of creative power necessary.

Our limits will not permit us to stray into further speculation, and we shall conclude this article by hastily glancing at a few general facts. The northern seas, which are for the most part comparatively shallow, nourish many of the *Sclerogenidæ*, which feed at the bottom and frequent shelving, sandy shores or sandbanks. The majority of these have barbels or portions of the pectoral fins detached or otherwise organized as fingers or organs of touch. An allied group, the *Uranoscopidæ* or *Trachinidæ*, have often the tips of the anal rays similarly constituted. The *Gadidæ*, also, which have barbels under the chin, are ground feeders; and these, with the *Cotti* and *Scorpænæ* among the Sclerogenids, and the fresh-water *Truttæ*, and anadromous *Salmones*, are the most characteristic groups of fishes in the northern seas. The same generic forms of sea-fish, but not the same species, reappear in corresponding southern latitudes; the *Cotti*, *Scorpænæ*, and *Gadidæ* being also conspicuous among the South Australian fishes. The Sclerogenids are not unknown in the middle tropical districts of the ocean, but they are different generically; the *Cotti* and *Scorpænæ* being replaced by *Pelors*, *Synanceia*, and others of a different aspect. There is a general resemblance between the fishes of the northern and southern extra-tropical seas, so that emigrants to Australia have very generally bestowed familiar European names on the sea-fish they found in the country of their adoption. In like manner there is a similarity of general aspect, but an almost total difference of species between the fish of Behring's Sea and the Sea of Ochotsk, and those of the German Ocean—though there are some facts which lead us to infer that in a higher parallel still there is a zone in which the same species form a circumpolar ichthyic *fauna*. This is different, both generically and specifically, from the fragments of the antarctic circumpolar groups of fish, which have reached us through Sir James Ross, the only navigator who has made collections in the high southern latitudes. Some genera, of few species, are the more remarkable from their occurrence both in the northern and southern seas, though in form of distinct yet closely resembling species. *Macrourus* has two representatives in the seas of Greenland and Norway; two in the Mediterranean; and two in the Australian seas. *Lophius* has one species in the European seas and another in the sea of China, so much alike that very close comparison is required to distinguish them. *Zeus*, also, and the allied genus of *Capros*, have each a species in the Mediterranean and temperate parts of the North Atlantic, as well as in the seas of Australia. The Greenland and Iceland *Notacanthus*, also, or *Campilodon* of Fabricius, reappears in the seas of South Australia with exactly the same generic aspect, but some subordinate difference of details, showing the species to be distinct, and without having been detected in the intervening districts of the ocean. No example of the genus, M. Valenciennes remarks, has ever reached the Paris Museum from the Indian Ocean. The true *Salmonidæ* or *Truttæ* of some authors are confined, as we have already more than once remarked, to the northern hemisphere. They do not pass the great Himalayan range. We have seen none from Africa, nor a figure of any species among the drawings made at Canton of all the fish brought to that market, though the *Salmonidæ* are both various and plentiful in the Kamtschadale seas. The *Characinidæ*, once included in the Salmon family, because they possess the characteristic Linnæan mark, an adipose fin, are chiefly South American; while the *Scopelinidæ*, another family having also an adipose fin, are oceanic, being found in all seas from the German Ocean to the Chinese, Australian, and Polynesian waters, the only large district from which specimens have not hitherto been brought being the North Pacific and Behring's Sea. They are small fish, mostly nocturnal in their habits, and though many of them carry phosphorescent lamps, they have until lately escaped the observation of mariners; but when the practice of keeping a trawl overboard becomes more frequent, it is likely that they

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will be discovered to be inhabitants of the North Pacific also. *Chirus* has been found only in the North Pacific, but as low down as California, and more abundantly in Behring's Sea.

One large portion of the ocean, including the Sandwich Islands and the more southern Chinese seas, the Indian Ocean, Red Sea, and Polynesia, down to the northern and eastern coasts of Australia, forms an almost uniform ichthyic district, from the general diffusion throughout it of a great majority of the species that exist within its limits—though there are many local littoral species within its bounds. The Scomberoid skimmers of the surface are nearly the same in all parts of this wide sea. As we approach its confines, N. and S., there is a gradual intermingling of the forms belonging to the higher latitudes on each side; and on removing still farther from the equator, we find the seas of Kerguelen's Land, South Shetland, and Cape Horn showing as much identity of species as those of Norway, Spitzbergen, and Greenland; the *Notothenieæ*, however, and other predominant forms in the Antarctic seas being dissimilar to the Arctic ones. In fact, there is a greater generic dissimilarity between the extreme Arctic and Antarctic fish than we observe between the fish of the British Channel and the antipodal species. A *Notothenia*, we may add, is one of the most southern fish, having been found to the amount of 28 lbs. in the stomach of a seal, in S. Lat. 66., on Sir James C. Ross's voyage; and an *Ophidium* was found by the same distinguished navigator to the N. of Spitzbergen. Both seek shelter from the seals in crevices of the ice.

With respect to fresh-water fish, the common Salmon, as we have more than once mentioned, is identical on both sides of the North Atlantic down to the 41st parallel, but does not occur in Behring's Sea; and we are not aware of any other species of *Salmo* or *Trutta* being common to the Old and New Worlds, although the family is even more abundant both in individual numbers and in variety of specific forms than in Europe or Asia. Sturgeons, another family of fresh-water fishes, containing anadromous members, have a less high northern range than the Salmon, not being found in rivers that fall into the Icy or Arctic American seas, but existing abundantly in most of the great rivers of Siberia and North America that flow southwards, or laterally, into the Black Sea, North Atlantic, or Northern Pacific. The genus exists in China, but we have seen none from the southern hemisphere. This leads us to observe, that no living Ganoid fish has as yet been detected in the southern hemisphere. The *Pharyngobranchii* are confined as natives to India and the Cape of Good Hope, though one or two species have been transported to Cayenne, and thrive there. Some of the remarkable genera that occur in the Nile exist also in the Gambia and Niger, though, as far as we know, not the same species; and there is a similar likeness between the marine fish of Western Africa and those of the Red Sea, extending in one or two instances even to species. The Siluroids have their headquarters in India and the southern seas, the species being comparatively few in Europe and North America. There are many in South America; and the Goniodonts are exclusively natives of that country.

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There are other facts connected with this subject, some of which we shall simply mention without dwelling on, such as the influence of the Gulf Stream and other oceanic currents, in bringing fish that are natives of the warmer districts of the ocean into the higher latitudes. A drift tree or a spar is seldom met with at sea without its attendant fish, especially if it has been long enough afloat to be covered with fuci and barnacles. It would appear as if these fish stuck by it in all its wanderings, from their unwillingness to quit it, even when approached by a boat. And all mariners are familiar with the fact of certain fish following a ship for weeks together, until it has entered the colder latitudes. The beautiful *Naucrates*, or Pilot-fish, has in this way been brought to the Cornish shores, and we have known the *Echeneis* to attach itself in considerable numbers to a ship's bottom in the Bight of Benin, and to continue there until the Azores were passed on the homeward voyage. (J. R—N.*)

* The accomplished naturalist and excellent man, James Wilson, by whom the first edition of this article was penned in 1835, was preparing to revise his work when death put an end to all his labours, and the task which he would have accomplished so well was entrusted to another. During the last twenty years Ichthyology has gained so many new facts that it became necessary to write the whole over again; but such passages of the original treatise as were suitable have been interpolated in the text.

NOTE.—At page 236 we have mentioned the *Meletta venenosa* as being occasionally a poisonous fish; and at page 312 the Tetraodons are noticed as having generally a bad reputation on the same account. Not without reason, indeed, since the small liver of a single Tetraodon was the cause of two deaths at the Cape of Good Hope. The subject is one of much interest both to seafaring men and to physiologists; and we gladly avail ourselves of a little spare room on this page to insert a few of the details given by Dr Julius Hellmuth, surgeon of the Dutch brig of war, and Mr Hugh Jameson, surgeon of the royal navy, who witnessed the fatal occurrence.

"J. Kleinhaus, boatswain's mate, thirty-two years of age, and J. Hausen, purser's steward, forty-three years of age, had partaken at dinner-time (noon), in addition to the usual ship's fare, of the liver of a fish. Within ten minutes I was called to render assistance to both, and observed the following symptoms:—J. Kleinhaus could not raise himself without the greatest exertion, his face was somewhat flushed, his eyes glistening, and pupils rather contracted; the mouth was open, the muscles of the pharynx spasmodically contracted; the lips tumid and somewhat blue; the forehead covered with perspiration, and the pulse quick, small, and intermittent. The patient was in great distress but still conscious. He complained, but with great difficulty, of pain from constriction of the fauces and gullet, together with great uneasiness in the region of the stomach, and had an inclination to vomit. An emetic was administered, but he could scarcely swallow it, and he almost immediately became paralytic; his eyes were fixed in one direction, his lips became livid, and his pulse failing, he expired scarcely seventeen minutes after eating of the liver of the fish. There was no full vomiting during the rapid action of the poison, the emetic having produced no effect. The other patient vomited thrice, the first time before taking an emetic which was given to him, followed by abundance of warm water, which caused a repetition of the vomiting, after which he said that he was easier, but in a few moments a single convulsive movement in the arms ensued, the livid tongue was protruded from the mouth, and he expired about one minute later than his messmate. Mr Jameson did not reach the Dutch vessel till forty-five minutes after twelve, before which time both men had expired. He found their faces collapsed, pallid, and covered with cold moisture, the lips livid, pupils of the eyes moderately dilated, the joints still flexible, and the limbs relaxed. On examining the bodies next day the stomachs were observed to be moderately distended with pultaceous food, nearly wholly reduced to the state of chyme, some of which had passed the pylorus. None of the poisonous fish could be distinguished among this comminuted mass. The inside of the stomach round the cardiac orifice was of a deep purple colour, and minute ramifications of the vessels extended along the smaller arch, and to the eminence at the beginning of the greater arch. The vascularity was not perhaps greater than it would have been in a healthy stomach during the first process of digestion, but it was rendered more conspicuous by the dark colour of the blood. In the right ventricle of the heart there was a fibrinous clot and a small quantity of fluid blood; the left ventricle was moderately distended with dark fluid blood; the muscular tissue of the heart was natural, and the muscles of the body generally were florid and healthy in appearance. The spotted Tetraodon measured from 6 to 8 inches, and it was the liver only, not exceeding 4 drams in weight, that was eaten by the men."

FOSSIL ICHTHYOLOGY.

Of all the vertebrated animal creation fishes are by far the most numerous species, and are the most widely distributed in the strata composing the crust of our earth. Some are found in formations as old as the *Silurian*, and become very numerous in all the more recent formations, even to the *Tertiaries* containing the remains of mammals. Fossil fishes, therefore, possess a high geological interest; and aid us greatly in determining the successive changes which have affected the surface of our planet.

Our knowledge of Fossil Fishes was, until very lately, exceedingly imperfect. Indeed, with the exception of the *Ittilithologia Veronese*, published in 1796, we had scarcely a tolerable attempt at the determination of fossil species, before the appearance of the magnificent and truly scientific *Recherches sur les Poissons Fossiles* of M. Agassiz (1833-43). In the first-mentioned work, however, fossil species are often confounded with fishes now existing; although not a single species of the immense accumulation in Monte Bolca, though evidently belonging to a comparatively recent geological epoch, is identical with any fish now existing. Good descriptions, it is true, of some fossil fishes were scattered through various works; but they were connected by no general classification to unite them into allied groups, or to exhibit their relations to the various geological series of formations that compose the crust of our earth. But the work of Agassiz was a gigantic undertaking; and the success which has crowned his labours is most creditable to the unwearied industry and great talents of this distinguished naturalist. He has presented his readers with full descriptions or notices of about 1000 species of fossil fishes, illustrated by accurate and exquisite designs, and supplied us with a method of determining the species that may be hereafter discovered, with a certainty and precision that has no parallel in this branch of natural history. This is the result of the examination of more than 20,000 specimens of fossil fishes preserved in the public and private museums of Europe; and now that he has taken up his abode in North America, we know that he pursues this subject with his accustomed energy, and will no doubt add greatly to our knowledge of this subject, one of the most interesting branches of geological palæontology.

In his work on the *Fresh Water Fishes of Europe*, M. Agassiz had pointed out the important character to be obtained from observing the form and structure of the scales of fishes; and this character he successfully employs as the distinction of the four orders into which he divides the class of fossil fishes. He had before pointed out the constancy of the structure of the scales in each kind of fish; a character which had been too much overlooked by preceding naturalists, although this integument is a principal medium by which external influences reach the internal organization of the animal. He considers it as a sort of external skeleton, differing widely and invariably in its structure, in each of the great divisions of this class of animals. The scales have, too, a peculiar value in fossil ichthyology, from the perfect manner in which their durable nature has preserved their minutest features in their stony repositories. Thus, the examination of a few scales determines the order to which the specimen should be referred, and often points out their affinities to existing species.

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The orders are divided into *Families*, chiefly from the structure and position of the fins, from the form of the bones of the head, especially of the teeth, and the structure of the *opercula* or gill covers; and a most important character is obtained, especially in the *Placoid* order, from the spinous rays of the several fins, which often are the formidable defensive weapons of the fish.

In these researches, M. Agassiz has freely acknowledged the assistance he has received from contemporary naturalists, and speaks in high terms of the valuable labours of Blainville, Eichwald, Buckland, Sedgwick, Murchison, Miller, Hibbert, and especially of Richard Owen, whose most valuable *Odontography* has thrown so much light on zoological subjects.

In the following sketch of this new and interesting subject we shall endeavour to present, as far as the necessary limits of the work will permit, a general view of the system of Agassiz.

M. Agassiz divides fossil fishes, as he had previously done their living representatives, into four great orders—the Ganoïd, Placoïd, Ctenoïd, and Cycloïd—founded on the form of their scales. This arrangement would comprehend the immense variety of existing fishes, except two genera, *Myxine* and *Petromyzon*, which are totally destitute of scales.

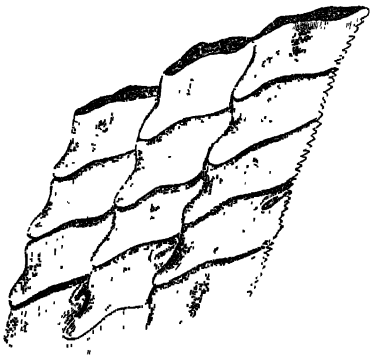


Fig. 1.

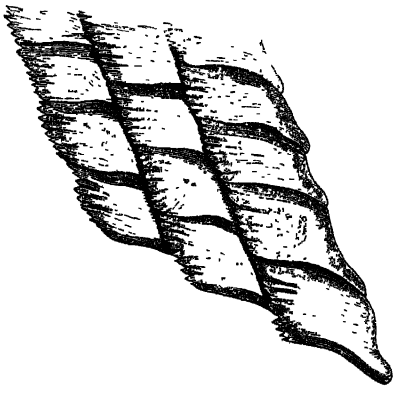


Fig. 2.

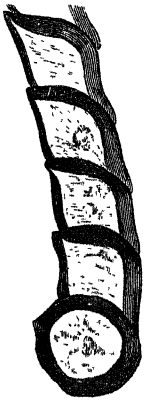


Fig. 3.

I.—Ganoïd fishes (figs. 1, 2, 3), (so designated from γάνος, splendour) have shining scales, covered with a firm enamel, generally of a rhomboidal form, and *imbricated*, or applied to each other as the slates on a roof.

II.—PLACOÏDS (figs. 4, 5), (from πλὰξ, a table) have scales not imbricated, but approximate on the skin: they are often elevated in the middle, and sometimes have a strong projecting point or spine from their centre. The *Placoïds* embrace the genera referrible to the families of the shark and ray of Linnæus.



Fig. 4.

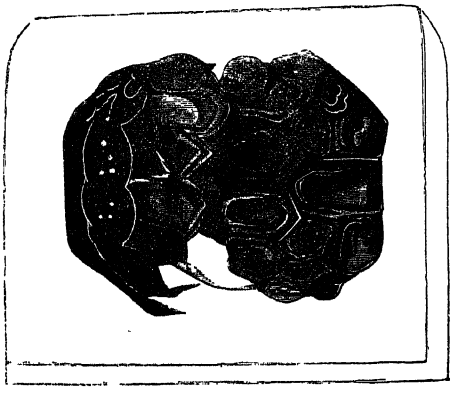


Fig. 5.

III.—CTENOÏDS (figs. 6, 7, 8), (from κτεὶς, a comb) have

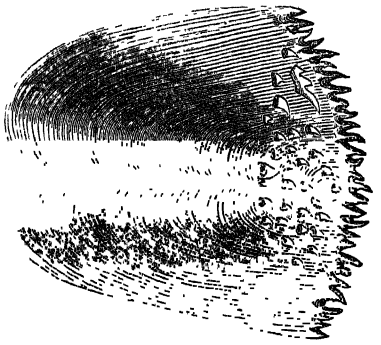


Fig. 6.

imbricated scales, generally of a rounded or ovoid form,

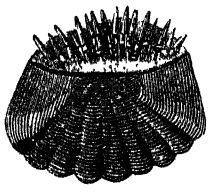


Fig. 7.

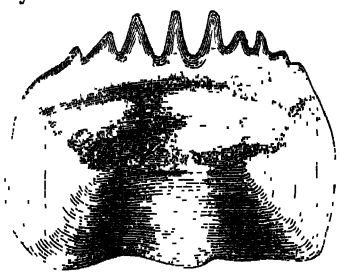


Fig 8.

with several teeth or sharp projections on their posterior margin.

IV.—CYCLOÏDS (figs. 9, 10, 11, 12), (from κύκλος, a circle) have circular imbricated scales, without dentations on their margins, but with concentric markings. Three-fourths of all known fossil fishes belong to the two last orders, and occur in all formations from the chalk upwards. The fishes found in the older rocks are the least numerous, and belong chiefly to the first order; the *Placoïds* extend through all the fossiliferous rock-formations, but are chiefly found in the coal, Jurassic, chalk, and tertiary formations; while not one species of *Ctenoïd* or *Cycloïd* fish occurs in formations older than the chalk. Fishes belonging to the older formations differ most from existing species in form and structure; and Agassiz states that the fishes of the older geological formations have smaller pectoral fins (the representatives of the fore extremities of the higher classes of animals), and that they are invariably placed before the ventral fins; so that they belong to the Linnæan order of *Abdominales*. In the formations above the chalk, the ventral fins approach nearer to the head; while in those below the chalk, the ventral fins are always behind the pectorals.

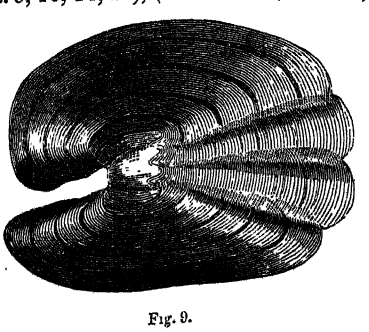


Fig. 9.

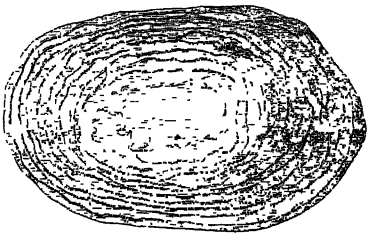


Fig. 10.

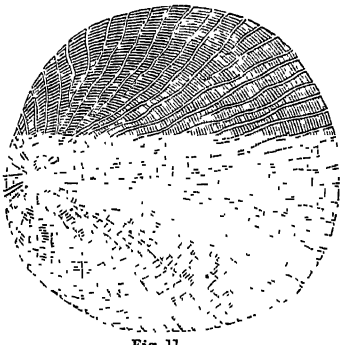


Fig. 11.

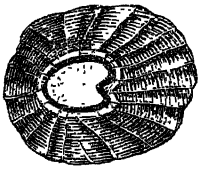


Fig. 12.

M. Agassiz divides the orders of fossil fishes into *families*, *genera*, and *species*, the characters of which are chiefly derived from the structure of the bones of their spine, head, opercula, teeth, and the form of their bodies and position of their fins. It may suffice to state that the fins placed perpendicular to the plane of the body are, according to position, denominated the *Dorsal*, the *Ventral*, the *Anal*, and the *Caudal* or fin of the tail. The *Pectorals* are always a pair of fins, one of which is on each side of the thorax of the fish; and according as the ventral fin is situated behind, under, or before the pectoral the fish said to be *abdominal*, *thoracic*, or *jugular*. When the ventral is wanting, they are said to be *apodal*. The bones, the scales, and the fins being those parts generally best preserved in fossil fishes, they are chiefly relied on by M. Agassiz, whose intimate knowledge of living species has enabled him, like another Cuvier, often from a few fragments, to determine the genus, or even the species, to which the scattered reliques have belonged.

ORDER I.—GANOÏDEI.

Scales angular, rhomboidal or polygonal, formed of osseous plates, covered by enamel.

FAMILY I.—LEPIDOSTEI.

Teeth *scopular* or brush-like, disposed in several rows, or consisting of a single row of small obtuse teeth. Scales flat, rhomboidal, parallel to the body, which they wholly cover. All the genera of this family that have the bones of the back produced into the upper lobe of the tail, or are what Agassiz terms *heterocerques*, occur in strata earlier than the Jurassic. Those with the regular tail, or the *homocerques*, belong to later formations. This family has no representatives among existing fishes.

We shall shortly indicate the rock formations in which each fish occurs in the tables at the end of this article.

Ganoïdei. Lepidostei.

A. *Body fusiform.*

Genus I. Acanthodes. Teeth scopular. Scales extremely small; dorsal fin opposite to anal; no ventral; pectorals large; first ray of dorsal, anal, and pectorals thick, strong, and rough; the succeeding rays, as well as those of the caudal, very slender, and scarcely distinct. Lower jaw longer than the upper; mouth very wide. The known species are—

1. A. Bronnii. 2. A. sulcatus. 3. A. pusillus.

Genus II. Catopterus, *v.* Dipterus. This is *Dipterus* of Sedgwick and Murchison. Dorsal long, opposite to anal, and both extending nearly to caudal; dorsal seemingly consists of two portions; ventral uncertain; pectorals small. Scales of middle size.

1. C. macrolepidotus. 2. C. gracilis. 3. C. parvulus. 4. C. anguilliformis.

Genus III. Amblypterus. All the fins very large, composed of numerous rays, especially the pectorals; dorsal opposite to the space between the ventral and anal; no small rays at the margin of the fins, except in the upper lobe of the caudal. Scales of middle size.

1. A. macropterus. 2. A. eupterygius. 3. A. lateralis. 4. A. latus. 5. A. nemopterus. 6. A. punctatus. 7. A. striatus. 8. A. Agassizii. 9. A. Elforsii.

Genus IV. Palæoniscus. All the fins of middle size, with small rays at their margins: dorsal opposite to space between ventral and anal. Scales of middle size—there is always a large scale before the first ray of the dorsal and anal fins.

1. P. fultus. 2. P. Duvernoy. 3. P. minutus. 4. P. angustus. 5. P. Blainvillei. 6. P. Voltzii. 7. P. macropomus. 8. P. Freieslebeni. 9. P. magnus. 10. P. elegans. 11. P. Vratislavensis. 12. P. lepidurus. 13. P. Robisoni. 14. P. striolatus. 15. P. ornatissimus. 16. P. comptus. 17. P. glaphyrus. 18. P. microphthalmus. 19. P. longissimus. 20. P. carinatus. 21. P. Agassizii. 22. P. macropterus. 23. P. Egertoni. 24. P. Monensis.

Genus V. Osteolepis. Two dorsal fins, the first in the middle of the back, the second in the middle of the space between the first and the tail, while the two anals alternate with the two dorsals, and the second anal extends behind the second dorsal; the pectorals are large and rounded; the ventral small, and opposite to the anterior edge of the first dorsal. Scales larger than in palæoniscus. Mouth large, armed with small teeth.

1. O. macrolepidotus. 2. O. microlepidotus. 3. O. arenatus. 4. O. major.

Genus VI. Cheiracanthus. Body covered with small scales. Pectorals, dorsal, ventral, and anal fins, with a strong spinous ray; dorsal in the middle of the back, opposite to the space between the ventral and anal. Jaws armed with several rows of very small pointed teeth.

1. Ch. Murchisoni. 2. Ch. microlepidotus. 3. Ch. minor.

Genus VII. Cheirolepis. Body covered with very minute scales. Fins without the bony ray, but its place supplied by slender rays laid on each other in an imbricated manner. Mouth large; teeth small. Dorsal placed posteriorly to the anal.

1. Ch. Traillii. 2. Ch. uragus. 3. Ch. Cummingiæ.

Genus VIII. Diplacanthus. Body cylindric; tail short and heterocerque. Scales very minute. Two dorsal fins; the first near the head, a little before the pectorals; the second opposite to the anal: pectorals placed on a strong thoracic belt, on which are some spines; the anal has a strong osseous ray, and similar rays are in the other fins, except the caudal.

1. D. striatus. 2. D. striatulus. 3. D. crassispinus. 4. D. longispinus.

Genus IX. Coccolepis. Body small, covered by uniform minute scales, which are finely granular. Dorsal fin proportionally very large, and truncated behind, so as to form an equilateral triangle; ventrals small, and approximated to the anal, which is larger than the ventrals. The only genus known is— Ganoïdei. Lepidostei.

1. C. Bucklandi.

Genus X. Plectrolepis. Not described by Agassiz The scales are somewhat rounded and pointed, giving a rough appearance to the skin of the fish.

1. P. rugosus.

B. *Body Flattened.*

Genus XI. Platysomus. Body very broad, or much elevated, almost trapezoidal, and nearly as high as long, covered with large scales. Mouth small, with scopular teeth. Dorsal and anal opposite to each other, and extending from the middle of the body to the root of the tail, with their anterior rays the longest.

1. P. gibbosus. 2. P. rhombus. 3. P. striatus. 4. P. macrurus. 5. P. parvus.

Genus XII. Gyrolepis. Chiefly distinguished by the scales, which have striæ or ridges running concentric or parallel with the edges of the scale; sometimes they are oblique, or irregularly ramified.

1. G. maximus. 2. G. tenuistriatus. 3. G. Rankinei. 4. G. Alberti.

Genus XIII. Eurynotus. Dorsal large, occupying the length of the back, with the anterior rays much elongated; anal opposite to the posterior part of the dorsal, with its anterior ray longer than the rest; ventral large, placed in the middle of the abdomen; pectorals still larger, with their tips reaching to the insertion of the ventrals; caudal less developed than the other fins. Head large; mouth with very small obtuse teeth.

1. Eu. crenatus. 2. Eu. fimbriatus. 3. Eu. tenuiceps.

Genus XIV. Dapedius. Body broad, and rapidly decreasing to the root of the tail, which is thick. Head rounded. Teeth sloping on their cutting edges. Fins of middle size; the caudal is the largest; the dorsal extends from the middle of the back to the root of the tail.

1. D. politus. 2. D. granulatus. 3. D. punctatus. 4. D. Colei. 5. D. orbis. 6. D. micans. 7. D. altivelis. 8. D. arenatus.

Genus XV. Tetragonolepis. Resembles the last in most respects, but has pointed teeth, instead of the sloping teeth of Dapedius.

1. T. semicinctus. 2. T. confluens. 3. T. speciosus. 4. T. radiatus. 5. T. pustulatus. 6. T. leiosomos. 7. T. Leachii. 8. T. heteroderma. 9. T. pholidotus. 10. T. ovalis. 11. T. Bouei. 12. T. dorsalis. 13. T. monilifer. 14. T. angulifer. 15. T. Magneville. 16. T. mastodonteus. 17. T. striolatus.

Genus XVI. Amblyurus. Body broad, flattened. A long dorsal commencing opposite to the ventral; a small, straight anal; and a wide, truncated caudal. Mouth wide; jaw narrow, armed with small pointed teeth.

1. A. macrostomus.

C. *Body Elongated.*

Genus XVII. Semionotus. Body generally of large size. Head elongated; jaws narrow, with scopular teeth more or less minute. Dorsal long, commencing opposite the ventrals, and ending over the anal; pectorals of mean size; ventrals wide; anal narrow, with its first ray longer than the rest; caudal forked, with the upper lobe a little longer than the lower, though the vertebræ do not really extend into the upper one, as hasty inspection might suppose.

1. S. leptocephalus. 2. S. Bergeri. 3. S. latus. 4. S. minutus. 5. S. Nilssoni. 6. S. Pentlandi. 7. S. striatus. 8. S. rhombifer. 9. S. pustulifer.

Genus XVIII. Lepidotus. Body the form of a large Carp. Greatest thickness of the body just behind the thoracic belt; scales large, rhomboidal. Fins of middle size; dorsal over the space between the ventral and anal; caudal almost square; anal shaped like the dorsal; and

Ganoïdei. Lepidostei.

both the latter have a thick anterior ray; ventrals and pectorals small.

1. L. gigas. 2. L. semiserratus. 3. L. undatus. 4. L. rugosus. 5. L. fimbriatus. 6. L. ornatus. 7. L. serratulus. 8. L. unguiculatus. 9. L. lævis. 10. L. palliatus. 11. L. radiatus. 12. L. notopterus. 13. L. tuberculatus. 14. L. oblongus. 15. L. minor. 16. L. Mantellii. 17. L. Fittoni. 18. L. speciosus. 19. L. parvulus. 20. L. striatus. 21. L. Maximiliani. 22. L. latimanus. 23. L. pectinatus. 24. L. Cottæ. 25. L. punctulatus. 26. L. temnurus. 27. L Virleti. 28. L. frondosus.

Genus XIX. Pholidophorus. Resembles the Herring, but with enamelled rhomboidal scales. Fins as in Lepidotus; caudal deeply cleft, with equal lobes. Jaws with small scopular teeth.

1. Ph. Bechei. 2. Ph. onychius. 3. Ph. macrocephalus. 4. Ph. microps. 5. Ph. tenuiserratus. 6. Ph. longiserratus. 7. Ph. striolaris. 8. Ph. latus. 9. Ph. micronyx. 10. Ph. intermedius. 11. Ph. latimanus. 12. Ph. ornatus. 13. Ph. Flesherii. 14. Ph. limbatus. 15. Ph. Stricklandi. 16. Ph. Hastingsiæ. 17. Ph. angustus. 18. Ph. gracilis. 19. Ph. minor. 20. Ph. furcatus. 21. Ph. dorsalis. 22. Ph. latiusculus. 23. Ph. pusillus. 24. Ph. Taxis. 25. Ph. radians. 26. Ph. uræoides. 27. Ph. radiopunctatus. 28. Ph. maximus. 29. Ph. pachysomus. 30. Ph. crenulatus. 31. Ph. Hartmanni. 32. Ph. fusiformis. 33. Ph. leptocephalus.

Genus XX. Notiosomus. Scales broader than long. Dorsal fins very long. Size small. Like the last genus, except in having two dorsal fins.

1. N. octostychius. 2. N. lævissimus.

Genus XXI. Ophiopsis. Elongated body, covered with equal scales. Superior lobe of the tail extends a little obliquely, and the fin forked slightly; pectoral very large and long; dorsal very long, but not deep; with the ventral opposite to its middle. Head small; but opercula broad and strong.

1. O. procerus. 2. O. penicillatus. 3. O. dorsalis. 4. O. Munsteri.

Genus XXII. Notagogus. Resembles Pholidophorus, but is of small size, and with two dorsal fins.

1. N. Zeitenii. 2. N. Pentlandi. 3. N. latior. 4. N. denticulatus.

Genus XXIII. Propterus. Size small. Two dorsals, with the anterior rays of the first elongated beyond the rays of the second. Vertebræ are thick and short, with the interapophysal bonelets stout. Scales rhomboidal, and finely notched on their posterior margin; anal a little behind the second dorsal; and the ventrals opposite to the extremity of the first; caudal slender.

1. P. microstomus. 2. P. serratus.

Family II.—SAURÖIDEI.

Pointed conical teeth, alternating with small scopular teeth. Skeleton osseous. Scales flat, rhomboidal, and completely investing the body.

In some of the genera, the vertebral column is continued into the upper lobe of the tail, a structure which Agassiz designates *heterocerque;* other genera have the tail in the regular form, which he distinguishes as *homocerque.* The heterocerques have all lived prior to the deposition of the Jurassic formation; the homocerques have existed at later geological periods. This family has no living representatives, except in the genera Lepidosteus and Polypterus.

A. *Heterocerques.*

Genus I. Pygopterus. Fins extremely developed; dorsal opposite to the space between ventrals and anal; anal much elongated; small rays placed on the anterior fin-rays.

1. P. Humboldtii. 2. P. mandibularis. 3. P. Bucklandi. 4. P. Jamesonii. 5. P. Bonnardi. 6. P. Greenockii. 7. P. lucius. 8. P. sculptus.

Genus II. Acrolepis. This genus resembles the last; but the anal is short and in the centre of the space between the ventrals and the caudal fin; and the dorsal less extended than in Pygopterus; ventrals nearer to the anal than to the pectorals; caudal lobes unequal. Head thick and short; muzzle pointed; jaws armed with strong, conical, closely-set teeth. Each scale surmounted by one or more keels.

Ganoïdei. Sauroïdei.

1. A. acutirostris. 2. A. asper. 3. A. Sedgwickii.

Genus III. Saurichthys. This genus only known by fragments of its jaws and teeth. Teeth, short, conical, slightly compressed at the sides, with the bone supporting the enamelled point finely longitudinally striated, the point smooth. They have much resemblance to the teeth of land lizards. The fishes seem to have been of small size

1. S. apicalis. 2. S. Mangeoti. 3. S. acuminatus. 4. S. longidens. 5 S. semicostatus. 6. S. tenuirostris. 7. S. angustus. 8. S. costatus.

Genus IV. Diplopterus. Size large; body elongated, and tapering gradually to the tail. Head large, broad, and flat; muzzle rounded; eyes large, close together, and surrounded with strong scales; jaws strong, with a single row of closely-set teeth. Two dorsals opposite to two nearly similar anal fins; two large rounded pectorals placed on the sides of the throat. Tail heterocerque, with most of the rays inserted under the elongation of the vertebral column; caudal fin truncated almost vertically. The branchiostegous rays are represented by plates below the neck. Scales on the body rhomboidal and granular.

1. D. macrolepidotus. 2. D. affinis. 3. D. borealis or Agassizii. 4. D. carbonarius. 5. D. Robertsoni.

Genus V. Megalichthys. Size large. Scales rhomboidal, and finely granular; as are the opercula and plates on the head. The teeth have a furrowed root, and smooth point; and several large appear among many smaller teeth.

1. M. Hibberti. 2. M. maxillaris. 3. M. priscus.

Genus VI. Graptolepis. Imperfectly known. The scales are finely sculptured. Jaws supposed to be elongated from the fragments found.

1. G. ornatus.

Genus VII. Orognathus. Known only by fragments of the jaws which seem to have been straight.

1. O. conoideus.

Genus VIII. Pododus. Known only by the form of its teeth. The only known species was found in the coal measures at Carluke, in Lanarkshire.

1. P. capitatus.

B. *Homocerques.*

Genus IX. Ptycholepis. Scales with deep furrows, distinguished with difficulty from the divisions of the scales, which give them an irregular figure, and make the body appear rough. Head short, with large conical teeth. Tail slender, and the caudal rays small, which distinguish this genus from *Eugnathus.*

1. P. Bollensis.

Genus X. Sauropsis. Vertebræ very short, with the slender apophyses almost in contact, with small interapophysal bones, and slender ribs, which are longer and less curved than the apophyses. Scales minute, rhomboidal. Pectorals large, so as almost to touch the ventrals; caudal equilobed, dilated, and deeply forked. Head short and thick; jaws with sharp, conical, rather distant teeth.

1. S. latus. 2. S. longimanus. 3. S. mordax.

Genus XI. Pachycormus. Body inflated, covered by very small scales. Caudal fin very broad, with many undivided rays, which, gradually lengthening towards the middle, give it a rounded form; dorsal in the middle of the back, opposite to the space between the ventral and anal; pectorals very large. Vertebræ very short. Branchiostegous rays numerous, and close-set.

1. P. macropterus. 2. P. curtus. 3. P. macrurus. 4. P. he-

Ganoïdei. Sauroïdei.

terurus. 5. P. latirostris. 6. P. gracilis. 7. P. latipennis. 8. P. latus. 9. P. macropomus. 10. P. acutirostris. 11. P. leptosteus.

Genus XII. Thrissops. Resembles *Sauropsis*, but has larger vertebræ. Pectorals large, straight, composed of a few large rays; ventrals small; anal very large, often extending to the root of the tail, and often equalling one-half the length of the body; lobes of the caudal unequal; all the fin-rays jointed and dichotomous. Head short and thick; jaws slender, with small sharp teeth.

1. T. formosus. 2. T. cephalus. 3. T. micropodius. 4. T. intermedius. 5. T. salmoneus. 6. T. subovatus. 7. T. mesogaster.

Genus XIII. Caturus. A large dorsal opposite to the ventrals; pectorals large; caudal forked. Head large; jaws very large, with large conical teeth interspersed among scopular teeth. Spinous apophyses of the caudal vertebræ strong, inclined, with their bodies approximate.

1. C. furcatus. 2. C. latus. 3. C. similis. 4. C. pachyurus. 5. C. macrurus. 6. C. maximus. 7. C. angustus. 8. C. microcheirus. 9. C. branchiostegus. 10. C. elongatus. 11. C. macrodus. 12 C. Meyeri. 13. C. pleiodus. 14. C. Bucklandi.

Genus XIV. Leptolepis. Scales very thin. Dorsal opposite to ventral; caudal forked. Mouth wide; teeth scopular in front of the jaw, and larger behind.

1. L. sprattiformis. 2. L. Voithii. 3. L. crassus. 4. L. macrolepidotus. 5. L. polyspondylus. 6. L. Bronnii. 7. L. caudalis. 8. L. Jægeri. 9. L. longus. 10. L. Knorrii. 11. L. dubius. 12. L. contractus. 13. L. filipennis. 14. L. paucispondylus. 15. L. pusillus. 16. L. tenellus. 17. L. macrophthalmus. 18. L. latus.

Genus XV. Megalurus. Caudal fin rounded, very large, with slender, long rays; dorsal opposite to the space between the ventral and anal. Head large; jaws with large conical teeth, intermingled with smaller teeth.

1. M. lepidotus. 2. M. brevicostatus. 3. M. elongatus. 4. M. parvus.

Genus XVI. Eugnathus. Fins generally large; dorsal deep and long, with strong rays, opposite to the space between ventrals and anal; anal smaller; all have their principal rays furnished with fulcra to their extremities: caudal has its upper lobe larger than the lower. Scales rhomboidal, large, but smaller on the belly, with grooves and dentations on their posterior margin, which fit into the contiguous margin of the next scale. Teeth unequal; very large, conical teeth being mingled with smaller, especially in the middle of the jaw.

1. Eu. orthostomus. 2. Eu. speciosus. 3. Eu. Philpotiæ. 4. Eu. chirotes. 5. Eu. minor. 6. Eu. polyodon. 7. Eu. opercularis. 8. Eu. microlepidotus. 9. Eu. giganteus. 10. Eu. tenuidens. 11. Eu. jaculatus. 12. Eu. ornatus. 13. Eu. scabriusculus. 14. Eu. lepidotus. 15. Eu. mandibularis.

Genus XVII. Conodus. Differs from *Eugnathus* only in its dentation; as its teeth are all conical, and much more equal in size.

1. C. ferox.

Genus XVIII. Amblysemius. Resembles *Caturus*, but its form is more slender, and its vertebræ less massive; the spinous processes more slender, and the end of the vertebral column is much elevated. Caudal forked; dorsal the largest fin.

1. A. gracilis.

Genus XIX. Thrissonotus. A genus intermediate between *Thrissops* and *Sauropsis*, with a general resemblance to *Pachycormus;* but its dorsal fin is in the middle of the back, with its anal elongated like *Thrissops*.

1. T. Colei.

Genus XX. Macrosemius. Size small. Dorsal extends along the whole back, with very large rays; caudal rounded, its upper lobe is less powerful than the lower; ventrals and anal small. Head thick; mouth small, but teeth strong and conical.

1. M. rostratus. 2. M. brevirostris.

Genus XXI. Saurostomus. Lower jaw elongated, and has a long row of large triangular teeth, compressed, with cutting edges. Muzzle elongated; size large.

Ganoidei. Calicanthi.

1. S. esocinus.

Genus XXII. Aspidorhynchus. Body much elongated, upper jaw prolonged into a beak, extending beyond the lower, and with teeth in this projection; the upper jaw receives the teeth of the lower jaw in a groove. Dorsal fin placed far back, opposite the anal; pectorals and ventral rounded; caudal forked. Scales large, higher than long, especially on the middle of the body.

1. A. acutirostris. 2. A. speciosus. 3. A. ornatissimus. 4. A. mandibularis. 5. A. lepturus. 6. A. Anglicus. 7. A. euodus. 8. A. Walchneri. 9. A. Comptoni.

Genus XXIII. Belonostomus. Differs from *Aspidorhynchus*, which it much resembles, in having the jaws of equal length, or nearly so, and in having no groove in the upper jaw, while the body is more slender. Mouth deeply cut, with sharp, unequal teeth. Eye large. Skeleton robust.

1. B. sphyrænoides. 2. B. Munsteri. 3. B. acutus. 4. B. cinctus. 5. B. Anningiæ. 6. B. tenuirostris. 7. B. subulatus. 8. B. Kochii. 9. B. ventralis. 10. B. leptosteus. 11. B. brachysomus.

Family III.—Cœlacanthi.

One of the most remarkable characters of this family is, that all the rays of the fins, and their bones, are hollow,—a trait which occurs not in any other ganoid fishes. Another peculiarity is, that the rays are all stiff, articulated only at their bases, and are supported on the interapophysal bonelets, which takes place in other fishes only with the rays of the caudal and anal fins.

Genus I. Cœlacanthus. There are two dorsals; the first is opposite to the extremity of the pectorals, the second to the space between the ventrals and the anal, which last approximates to the caudal; and the caudal comprehends the cluster of jointed rays that garnish the end of the vertebral column, and equals the one-third of the length of the fish. The scales large, elongated, with their posterior margin rounded. Teeth sharp and conical.

1. C. granulosus. 2. C. Phillipsii. 3. C. minor. 4. C. gracilis. 5. C. lepturus. 6. C. Munsteri.

Genus II. Undina. Approximates the last in the fins; but the teeth resemble a pavement, as in some *pycnodonts*.

1. U. Kohleri. 2. U. striolaris.

Genus III. Holoptychius. Size large; scales large and rugose. Bones of the cranium sculptured like those of the crocodile. The conical teeth exceed those of the largest saurians.

1. H. Hibberti. 2. H. sauroides. 3. H. falcatus. 4. H. Portlockii. 5. H. Garneri. 6. H. granulatus. 7. H. striatus. 8. H. minor. 9. H. giganteus. 10. H. Flemingii. 11. H. nobilissimus. 12. H. Andersoni. 13. H. Murchisoni. 14. H. Omaliusii.

Genus IV. Hoplopygus. Size small. Tail rather trilobate than forked, the terminal and principal lobe being between two other lobes, which last might be mistaken for a dorsal and an anal fin, were these not distinctly visible a little before these side lobes, which have another peculiarity in possessing a large spinous ray before their slender rays. Head very broad. The scales large.

1. H. Binneyi.

Genus V. Glyptosteus, v. Bothriolepis. The scales sculptured with grooves of various contorted forms, sometimes presenting isolated hollows, separated by rounded ridges, somewhat resembling the ripple marks on the seashore.

1. G. favosus. 2. G. reticulatus. 3. G. ornatus.

Genus VI. Glyptolepis. Body of middle size, as broad as deep. Scales thin, rounded, much imbricated, covered by a thin, smooth enamel, with fine radiating striæ on their interior. Fins large; two dorsals opposite to two anals, approximate to the caudal, ventrals have thin rays supported on a series of plates extending along the belly, as in

Ganoïdei. Pycnodontei.

Megalichthys; second anal and second dorsal larger than the fins before them. Branches of the lower jaw strong, and garnished with a single row of small conical teeth.

1. G. leptopterus. 2. G. elegans. 3. G. microlepidotus.

Genus VII. Phyllolepis. Scales exceedingly thin, but of large size: only the scales, or rather plates, known, some of which are six inches in diameter, of a square form, with rounded corners, and with concentric wrinkles.

1. Ph. concentricus. 2. Ph. tenuissimus.

Genus VIII. Platygnathus. Body and tail elongated. Scales sculptured. Incisive teeth large, isolated, and placed in compartments apart from the jaw. Fins supported on soft, flexible rays.

1. P. Jamesonii. 2. P. paucidens.

Genus IX. Dendrodus. This genus was established by Professor Owen. Teeth full, conical, isolated. Sections of the teeth show the medullary interstices branching, and laterally terminating in basins covered with enamel. The teeth are conical, with fine external striæ.

1. D. strigatus. 2. D. latus. 3. D. sigmoides. 4. D. minor. 5. D. tenuistratus.

Genus X. Lamnodus. Teeth full, laterally compressed, with the medullary interstices terminating in lateral branches; point capped with enamel.

1. L. bifurcatus. 2. L. hastatus. 3. L. Panderi.

Genus XI. Cricodus. A single medullary cavity. Teeth curved back, with a rounded summit, and thick plicæ at the root.

1. C. incurvus.

Genus XII. Asterolepis, v. Chelonichthys. Osseous plates ornamented with granulations, which have perforated summits, and a star-formed base. The fish seems to have been of large size from its hyoid bones which have been discovered. One of the most perfect of these hitherto found is in the Museum of Stromness, Orkney. The original is six inches long, its head 2·38 inches.



Fig. 13.

1. A. Asmusii. 2. A. ornata. 3. A. speciosa. 4. A. miliaris. 5. A. granulata. 6. A. minor. 7. A. Höninghausii. 8. A. Malcolmsoni. 9. A. apicalis.

Genus XIII. Psammolepis, v. Psammosteus. Scales with fine granulations like shagreen, and marked by many contorted medullary canals, that form a somewhat elegant net-work, among which is a hard homogeneous mass, more like *dentine* than true bone.

1. Ps. paradoxus. 2. Ps. meandrinus. 3. Ps. arenatus. 4. Ps. undulatus.

Genus XIV. Uronemus. A long dorsal fin, extending from near the nape uninterruptedly to the tail, to which also the anal reaches. Size small.

1. U. lobatus.

Genus XV. Ctenolepis. The scales are distinguished by a few projecting teeth; in other respects it resembles the genus *Cœlacanthus.*

Genus XVI. Gyrosteus. Imperfectly known from fragments, which belong to a very large fish.

1. G. mirabilis. Probably this is the largest of fossil fishes.

Genus XVII. Macropoma. In its heavy form, and disposition of its fins, as well as its large scales, this genus much resembles *Cœlacanthus;* but the structure of the rays are different, as their edges are bristled with spines, no doubt as a defence. Skeleton robust. Head thick, and equal to one-third of the body.

1. M. Mantelli. 2. M. Egertoni.

Family IV.—PYCNODONTEI.

Teeth flattened or rounded, arranged in several rows. Scales flat, rhomboidal, in rows parallel to the body, which they entirely cover. Body flat and broad. Skeleton osseous.

Genus I. Placodus. Teeth of two kinds, viz., grinders, with flat crowns paving the interior of the mouth; the largest occupy the middle of the dental-plate, with sometimes lateral rows; the incisors, or prehensiles are most massive teeth, and are less pointed than in other genera; and those of the upper jaw are implanted in a sort of beak. The anterior prehensile teeth are arranged in two rows, with six in each row. Ganoïdei. Pycnodontei.

1. P. gigas. 2. P. Andriani. 3. P. Munsteri. 4. P. rostratus. 5. P. impressus.

Genus II. Sphærodus. The teeth are only parts known, and are always rounded, often hemispheric, from the size of a pin's head to that of a lentil; the crown smooth, and covering the root.

1. Sp. gigas. 2. Sp. annularis. 3. Sp. cinctus. 4. Sp. conicus. 5. Sp. crassus. 6. Sp. depressus. 7. Sp. discus. 8. Sp. lens. 9. Sp. irregularis. 10. Sp. microdon. 11. Sp. parvus. 12. Sp. mitrula. 13. Sp. Neocomensis. 14. Sp. oculus-serpentis. 15. Sp. truncatus. 16. Sp. minor. 17. Sp. minimus.

Genus III. Pycnodus. Body anteriorly truncated and puffed out, posteriorly elongated. Tail slightly sloping. Vertebræ massive, short; most species have remarkable bony pieces behind the nape that obliquely cross the spinous apophyses. Teeth smooth, with crown slightly expanded, surfaces more or less convex; middle or principal row of oval teeth transverse, bounded on each side by a double alternate row of smaller circular teeth.

1. P. platessus. 2. P. rhombus. 3. P. orbicularis. 4. P. gigas. 5. P. Nicoleti. 6. P. Bucklandi. 7. P. didymus. 8. P. rugulosus. 9. P. umbonatus. 10. P. ovalis. 11. P. Hugii. 12. P. toliapicus. 13. P. Mantelli. 14. P. Munsteri. 15. P. complanatus. 16. P. subclavatus. 17. P. cretaceus. 18. P. latirostris. 19. P. obtusus. 20. P. parvus. 21. P. biserialis. 22. P. discoides. 23. P. angustus. 24. P. elongatus. 25. P. latior. 26. P. depressus. 27. P. marginalis. 28. P. trigonus. 29. P. latidens. 30. P. priscus. 31. P. gracilis. 32. P. minutus. 33. P. minor. 34. P. tristychius.

Genus IV. Gyrodus. Teeth elliptical or circular, with the summit provided with an umbilicated centre, surrounded by a circular furrow that divides it into two distinct parts. The superior jaw, the maxillaries, and intermaxillaries, have a single row of teeth; the vomer has five longitudinal rows, diminishing in size from behind forward; the lower jaw has four rows on each side.

1. G. macrophthalmus. 2. G. frontatus. 3. G. rugosus. 4. G. umbilicus. 5. G. Jurassicus. 6. G. Cuvieri. 7. G. punctatus. 8. G. trigonus. 9. G. radiatus. 10. G. lævior. 11. G. cretaceus. 12. G. Mantellii. 13. G. minor. 14. G. angustus. 15. G. rugulosus. 16. G. Munsteri. 17. G. runcinatus. 18. G. analis. 19. G. circularis. 20. G. platurus. 21. G. punctatissimus. 22. G. rhomboidalis. 23. G. macropterus. 24. G. mammillaris. 25. G. gibbosus. 26. G. perlatus. 27. G. gracilis.

Genus V. Microdon. The form of the body is nearly that of *Pycnodus.* Dorsal and anal very long, opposite to each other, and prolonged to the caudal, which is much sloped and forked; pectorals small, with fine rays. The best character is taken from the teeth, which are smaller than in *Pycnodus;* they are in five rows on the vomer, and one row on each of the superior maxillaries; in the lower jaw there are four rows on each side of nearly equal size; they have a flattened angular form.

1. M. elegans. 2. M. hexagonus. 3. M. analis. 4. M. radiatus. 5. M. platurus. 6. M. abdominalis.

Genus VI. Globulodus. Teeth small, and pediculated at the summit, which distinguishes them from all the *Pycnodonts.*

1. G. elegans.

Genus VII. Colobodus. The teeth, disposed in irregular pavements, have their layers very serried, of a size between that of *Microdon* and *Sphærodon,* have a rounded or cylindric base, with their crown bent in the form of a club, having in its centre a little truncated papilla; all the surface of the teeth finely vertically striated.

1. C. Hogardi.

Ganoïdei. Schlerodermi.

Genus VIII. Scrobodus. Body fusiform, which is peculiar to this genus of all the *Pycnodonts*. The teeth marked with a distinct furrow.

1. S. jubovatus.

Genus IX. Pisodus. Distinguished by Professor Owen. Crown of the very dense teeth fusiform or hemispherical, and scattered over the whole surface of the dental plate.

1. P. Oweni.

Genus X. Gyronchus. Only yet known by its upper jaw, which resembles that of *Pycnodus;* but the middle row of teeth on the vomer is arranged longitudinally, instead of transversely. Size probably small.

1. G. oblongus.

Genus XI. Acrotemnus. The molar teeth, instead of the regular rounding of the crown, have a salient ridge like a crest.

1. A. faba.

Genus XII. Periodus. Teeth, instead of the general form of the *Pycnodonts*, have a deep grove near the crown, so as to present, in a transverse section, the form of a hat, with its wide brim turned up.

1. P. Kœnigii.

Genus XIII. Phyllodus. Dental plates present a form like that of a leaf, the posterior part being contracted, as if for the attachment of a petiole; the middle row are the largest. A tooth consists of a mass of united plates, more or less flattened, in number from four to ten, which are not more than a quarter of a line in thickness each. Only known from the teeth.

1. Ph. toliapicus. 2. Ph. planus. 3. Ph. polyodus. 4. Ph. marginalis. 5 Ph. medius. 6. Ph. irregularis.

Family V.—SCHLERODERMI.

Palatine arch immoveable; muzzle salient, armed with a few distinct teeth. Scales flat, in the form of large rhomboidal, or polygonal plates, placed obliquely on the body, which they wholly cover. Ossification of the skeleton, as if retarded, fibrous.

Genus I. Ostracion. This genus has several living representatives, but only one fossil species yet known. Body covered with an osseous case, consisting of plates firmly united, forming an inflexible covering, so that the fins and tail are alone moveable. Mouth with small lips, covering the sockets of the teeth.

1. O. micrurus.

Genus II. Acanthoderma. Approaches the genus *Balistes* among living fishes. The scales or plates appear from their impressions in the rock to have possessed small points rising from their surface. Skeleton robust; vertebræ thick, and short; the spinous apophyses long and strong. First dorsal fin has a long spinous ray; the second dorsal and the anal have only very slender soft rays; caudal slender, composed of articulated dichotomous rays.

1. A. ovale. 2. A. spinosum.

Genus III. Acanthopleurus. Allied to the *Balistes;* with a dorsal spine, but with a more slender form. Dorsal spine strong; two strong spines also to the ventrals. Skin covered with asperities that leave fine granular impressions in the rock.

1. A. serratus. 2. A. brevis.

Genus IV. Glyptocephalus. This large genus discovered by König. Head covered with symmetrical rows of tubercles, which send out rays passing from their centre to the circumference of each plate.

1. G. radiatus.

Genus V. Blochius. Body very long, like an eel; head the thickest part of the fish, with a very long beak. Teeth scopular. Vertebræ very long and slender. Enamelled scales rhomboidal, with their angles in the longitudinal and transverse direction of the fish.

1. B. longirostris.

Genus VI. Dercetis. Body and head elongated; beak narrow; upper jaw longer than the lower; both armed with teeth, which are long and conical, and alternating with smaller teeth. Vertebræ robust, longer than high, expanded at the articulating surfaces, but more slender in the middle. Pectorals very large; ventrals very near pectorals, short, with few rays; dorsal extends over almost all the back, reaching from before the ventrals to the tail; anal half the length of the dorsal. Sides covered with three rows of osseous shields, like those of the sturgeon, in form like the ace of hearts, with a granular surface.

Ganoïdei. Acipenseridei.

1. D. elongatus. 2. D. scutatus.

Genus VII. Rhinellus. Small elongated body, with a slender beak. Two distinct dorsals, one near the head, the other near the tail; caudal large and forked. Sides covered with three rows of shields, like the last genus, from which it differs in having two dorsals.

1. Rh. furcatus. 2. Rh. nasalis.

Family—VI. ACIPENSERIDEI.

The existence of fossil fishes resembling the sturgeon, in the Jurassic and tertiary formations, has been proved by the discovery of their large dermoid plates; but their bones, which were chiefly cartilaginous, have disappeared. These plates have a thin coat of enamel.

Genus I. Acipenser. This genus has much resemblance to the living *Acipenser ruthenus.*

1. A. toliapicus.

Genus II. Chondrosteus. This has no living representative, but the form of the plates show that it belongs to this family.

1. Ch. acipenseroides.

Family VII.—GYMNODONTEI.

The palatine arch is immoveable; jaws covered with a case of ivory, formed of united teeth. Scales salient, with sharp spines placed obliquely to the body, which they wholly cover. Skeleton fibrous, with imperfect ossification.

Genus I. Diodon. Orbicular body, sometimes elongated, with numerous sharp spines. Head thick, and obtuse. The bony plate of the jaws divided into two by a fissure, so as to represent two teeth in each jaw, as in living *Diodons.*

1. D. tenuispinus. 2. D. erinaceus. 3. D. Scillæ.

Family VIII.—LOPHOBRANCHIATI.

Branchiæ united into little rounded tufts. Body elongated, angular, covered with angular scales. Skeleton osseous. Muzzle tubular, terminated with small free jaws.

Genus I. Calostomena. Snout tubular, resembling the living *Hippocampus;* but there is a rounded fin at the end of the tail. Sides have three principal rows of oblong scales, which are higher than broad, and become smaller towards the tail; on the belly is a fourth row of small size.

1. C. breviusculum.

Genus II. Syngnathus. One anal, one caudal, and one dorsal fin; which last is far back.

1. S. opisthopterus, v. typhle.

Family IX.—CEPHALASPIDEI.

Whole body and head covered by a few large shields or plates, which are not imbricated. Tail, which is heterocerque, covered with imbricated scales, without a true caudal fin. Instead of pectorals, this family have two long, bony stilettes. The place of vertebræ is supplied by a *dorsal cord*, like that of embryo fishes and the sturgeons.

Genus I. Pterichthys. No separation between head and trunk. The lateral anterior plates of the trunk touch the mesial line. The bony processes representing the

Ganoïdei. Cephalaspidei.

pectorals are long. It was at first supposed to be an insect, but determined to be a fish by M. Agassiz. The species known are—

1. P. Milleri. 2. P. productus. 3. P. latus. 4. P. cornutus. 5. P. testudinarius. 6. P. oblongus. 7. P. cancriformis. 8. P. major.

Genus II. Pamphractus. Head and trunk distinct. Anterior lateral plates of the trunk separated by a mesial shield of enormous size, which forms a large portion of the surface of the carapace, and its anterior margin touches the head, the plates of which are separated from the carapace by a transverse line. Pectoral appendages like those of the last genus. It was at first mistaken for a *Pterichthys*.

1. P. hydrophilus.

Genus III. Polyphractus. The only known specimen of this genus, consisting of plates of the head, was communicated by Professor Traill to M. Agassiz, and is figured by him in his *Poissons Fossiles du Vieux Grès-Rouge*, Tab. 27, fig. 1. The head-plates are numerous, and finely sculptured with concentric lines, presenting the appearance of a mosaic. (See fig. 5.)

1. P. platycephalus.

Genus IV. Coccosteus. This genus wants the spinous processes which distinguish the *Pterichthys*, and therefore has no pectoral appendages; it has one anal, and one dorsal. The anterior of the trunk is covered by a single large shield. Mouth furnished with small, equal, conical teeth.

1. C. decipiens. 2. C. cuspidatus. 3. C. oblongus. 4. C. maximus.

Genus V. Cephalaspis. Head covered by one large shield-shaped plate, with lateral prolongations extending some way along the sides of the animal, which seem to be spines united to the suborbitar bones, as in the *Gurnard*. Body narrower than the head, and covered by vertical rows of scales. No ventral nor pectoral fins; two dorsals, the first rising just behind the head and reaching nearly to the middle of the back; the second ends near the root of the tail; the anterior of the anal is opposite to the middle of the second dorsal; the first rays of all the fins only are osseous.

1. C. Lyellii. 2. C. rostratus. 3. C. Lewisii. 4. C. Lloydii.

Order II.—Placoïdei.

The order, named from the tabular form of their dermoid covering, consists of portions of the genera *Squalus* and *Raja*, of the Linnæan system, and is one of the most difficult branches of fossil ichthyology, because in most instances all that remain to us are the spinous appendages of the animal, the teeth, or a few scales. The spines, however, have a character which demonstrates them to have belonged to cartilaginous fishes. The spines consist of a single piece, the base of which has a distinct *talus*, that has been inserted in the flesh, and not articulated to any part of the skeleton, as is the case with the defensive spines of all osseous fishes. They have besides a groove in their posterior and inferior surface, more or less deep, which is often carried far into the interior of the spine, and even to its extremity. Their skeletons having been cartilaginous have been easily broken up, and have disappeared in the geological changes of the strata, in which their remains are imbedded; and it is only by a careful comparison of the fragments that remain with analogous parts in living species, that they can be referred to genera and species. Their skeletons are very rarely preserved; their moveable teeth are generally detached from the jaws; their fins, little connected with their skeleton, render it difficult to recognise their position on the animal. The scales of Placoïds have great diversity of form and structure. Sometimes they consist of little scaly plates variously truncated at their posterior margin, as in the *shagreen* of the skin of the shark; another sort consists of large rounded plates, with a loop in the centre, which sometimes terminates in a sharp prickle or spine rising out of a circular hollow, as in the skate. If this animal be taken as a type of the structure of such parts in this order, the circular base is formed of cartilaginous fibrous tissue, on which the calciferous tubes radiate from the spine to the margins of the scale, just as if it were a tooth implanted in a jaw. This structure cannot be traced in the minute granulations on the skin of the shark; but probably the structure is similar in all the scales of Placoïds.

Placoïdei. Ichthyodorulithes.

In the magnificent work of M. Agassiz, the spines of Placoïds, which were described by Dr Buckland and Mr De la Bèche as *Ichthyodorulites*, were at first mistaken for the defences of osseous fishes, as the *Silurus* and *Balistes*; but were proved by M. Agassiz to belong to the rays of the fins of cartilaginous species; a conclusion to which it appears that Buckland and De la Bèche had also arrived by their own researches. The term has been retained by Agassiz, to include certain genera which we only know by these osseous rays.

The form of Placoïd scales will be understood from figs. 4 and 5.

Division I.—Ichthyodorulithes.

They are characterized as the conspicuous osseous fin-rays which rise from a broad base, forming a talus to the spine, without the least appearance of the two apophyses that mark the basal joint of the spinous rays of osseous fishes.

Genus I. Onchus. The spinous rays are of medium size, the surfaces longitudinally grooved, with rounded ribs between their channels, more or less broad. Most of the species have these growing on all their surfaces; but one species has the posterior surface smooth.

1. O. Murchisonii. 2. O. tenuirostris. 3. O. arenatus. 4. O. sulcatus. 5. O. hamatus. 6. O. semistriatus.

Genus II. Ctenacanthus. Immense semi-compressed rays, broad at the base, the posterior cavity rather small, with a few small spines on the posterior surface, and pectinated longitudinal striæ.

1. Ct. major. 2. Ct. tenuistratus. 3. Ct. brevis. 4. Ct. ornatus.

Genus III. Orcanthus. Rays thick, and very broad at base, with asteroid delineations on the portion above the flesh; no posterior spines, which distinguishes them from *Asteracanthus*, which occurs, not like this genus in the coal, but in the oolite formation.

1. O. Milleri. 2. O. pustulosus. 3. O. minor.

Genus IV. Gyracanthus. Rays have deep grooves and intervening ridges extending obliquely on the surface, from the middle of the anterior to the posterior part of the ray, and abutting those on the mesial line.

1. G. formosus. 2. G. tuberculatus. 3. G. Alnaricensis.

Genus V. Tristychius. Rays with strongly marked longitudinal grooves on all the surfaces above the flesh, with often coalescing striæ, while the base is simply finely striated. On the anterior surface there are three keels, the central the most prominent; the two lateral keels divaricate as they descend; striæ between the keels.

1. T. arenatus.

Genus VI. Ptychacanthus. Rays have the form of a slightly bent sickle, insensibly growing thinner towards the point, and laterally compressed, with the anterior edge presenting an obtuse keel; its posterior edge carries teeth; the surface ornamented with fine thick-set plicæ.

1. Pt. sublævis. 2. Pt. Faujasii. 3. Pt. dubius.

Genus VII. Sphenacanthus. Rays with well marked grooves and ridges, from top to bottom; anterior surface rounded; posterior flattened, smooth, with crenelled, but not toothed edges.

1. S. serrulatus.

Ichthyodorulithes.

Genus VIII. Nemacanthus. Rays laterally compressed and flattened; anterior edge has a keel surmounted by a rounded fillet, and divided from the rest of the ray by a slight channel; on the exterior edge are several rounded knobs, and along the channel minute tooth-like projections; except where the knobs exist, the surface is longitudinally finely striated. The internal cavity is small, extending only to half the thickness of the ray at the base, and becoming a mere line where the knobs commence.

1. N. monilifer. 2. N. filifer.

Genus IX. Leptacanthus. Dorsal fins beset with small, flat, ensiform spines, the posterior part of which is armed with short teeth, and the anterior edge sharp; the rays marked by numerous fine longitudinal striæ.

1. L. tenuispinus. 2. L. semistriatus. 3. L. serratus. 4. L. longispinus.

Genus X. Asteracanthus. Rays generally large, slightly arched, rounded anteriorly, and armed with a double row of close-set teeth on their posterior edge, while their surface is covered with starry tubercles; base smooth, with a wide open groove on its posterior part.

1. A. ornatissimus. 2. A. acutus. 3. A. minor. 4. A. semisulcatus.

Genus XI. Pristacanthus. Rays very long, and much compressed, so that their posterior cavity rather resembles a delicate fissure than an organic cavity; anterior edge as sharp as a knife, and so is the posterior, which is provided with sharp, flat, triangular teeth, like those of a saw.

1. P. securis.

Genus XII. Myriacanthus. Rays rounded, but with something of a quadrilateral form, from the arrangement of two series of spines on its posterior side, which are compressed and sharp, with their points towards the apex of the ray. The surface between these ranges of spines is finely longitudinally striated; the anterior face has a row of larger spines of the same form down its centre.

1. M. paradoxus. 2. M. retrosus. 3. M. granulatus.

Genus XIII. Leiacanthus. Rays slightly curved, one-third part buried in the flesh, finely striated, with an aperture posteriorly, which leads into a pulpar cavity, reaching nearly to the sharp point of the ray; the surface of the exposed part is marked by longitudinal ridges of a rounded form, separated by furrows as deep. No teeth on the posterior side of the ray.

1. L. falcatus.

Genus XIV. Spinax. Of this genus there are living species; and the rays of the fossil resemble those of the existing species, but are much larger, proportionally thicker, straighter, and more rounded.

1. S. major.

Genus XV. Chimera. Dorsal ray like that of *Spinax*, but differs in being more flat, and having dentations on its posterior edge, and also by a projecting anterior border. The jaws of four species have been found in the chalk by Dr Buckland.

1. Ch. Mantelli. 2. Ch. Egertoni. 3. Ch. Agassizii. 4. Ch. Tessori. 5. Ch. Bucklandi. 6. Ch. Townsendii. 7. Ch. Johnsonii. 8. Ch. brevirostris. 9. Ch. Helvetica. 10. Ch. Dutertrii. 11. Ch. emarginata. 12. Ch. Dufrenoyi. 13. Ch. Beaumontii. 14. Ch. Colei. 15. Ch. Owenii. 16. Ch. regulosa. 17. Ch. neglecta. 18. Ch. curvidens. 19. Ch. Sedgwickii. 20. Ch. falcata. 21. Ch. psittacina.

Genus XVI. Pleuracanthus. All the surfaces of the rays rounded, depressed, and armed on each edge towards the base by a row of arenated teeth; along the posterior surface is a deep, wide, round groove.

1. P. lævissimus.

The remaining genera of Placoïds are chiefly determined by their teeth, though the two first genera are also well characterized by the spinous rays of their fins. The labours of Agassiz on these fishes have been ably assisted by the researches of the Prince of Musignano, of Muller and Henle, and above all, by the admirable investigations of Owen in his *Odontography*, a work that has thrown much light on the whole zoological Division of the Vertebrata.

Plagiostomi. Cestraciodontei.

DIVISION II.—PLAGIOSTOMI.

Family I.—CESTRACIODONTEI.

The living representative of this family is *Cestracion Philipsii* of Australia. The form of the teeth is better adapted for crushing or grinding to shreds, than for cutting.

Genus I. Hybodus. Besides the teeth of this genus, we possess some of the osseous rays, and even of their fins. They possess two dorsals, the osseous rays of which are of considerable size, with roots equal to one-third of their whole length concealed in the flesh. The surfaces of these rays present longitudinal furrows, divided by rounded ridges; they have a gentle curvature, with a flattened posterior surface, which is armed with two rows of large, sharp serratures, gradually approximating, and finally coalescing into one row. The teeth are peculiar, and are rather thin than massive; the central projection of each tooth is a lengthened cone, subulate or pointed; and on the same base arise smaller flanking cones, decreasing in size as they recede from the central cone. These compound teeth sometimes amount to four in each side of the jaw. The enamel of the teeth consists of vertical folds, which in some species can be seen at even the apex of the central cone. The first twenty-two species are chiefly characterized by their osseous rays, the succeeding species by their teeth.

1. H. dorsalis. 2. H. apicalis. 3. H. marginalis. 4. H. striatulus. 5. H. sulcatus. 6. H. leptodus. 7. H. acutus. 8. H. pleiodus. 9. H. striatus. 10. H. subcarinatus. 11. H. lævisculus. 12. H. crassus. 13. H. crassispinus. 14. H. minor. 15. H. curtus. 16. H. reticulatus. 17. H. formosus. 18. H. ensatus. 19. H. carinatus. 20. H. major. 21. H. dimidiatus. 22. H. tenuis. 23. H. pyramidalis. 24. H. medius. 25. H. grossiconus. 26. H. polyprion. 27. H. obtusus. 28. H. inflatus. 29. H. raricostatus. 30. H. dubius. 31. H. undulatus. 32. H. plicatilis. 33. H. Mougeoti. 34. H. angustus. 35. H. longiconus. 36. H. obliquus. 37. H. polycyphus. 38. H. cuspidatus. 39. H. sublævis.

Genus II. Ptychodus. Teeth quadrangular, root and crown divided by a wide shallow groove; root coarse and porous, flat below, and gradually enlarging towards the crown, which suddenly expands beyond the root; interiorly the tooth consists of medullary and calcigerous tubes arranged as in Cestraciæ, but smaller in size. Dorsal ray very thick, and differs from that of the rest of the genera in not consisting of one piece, but seemingly formed of several layers, intimately soldered together, but perceptible in the longitudinal furrows; the anterior of the ray has bosses formed by the intersections of transverse ribs seen on its sides.

1. Pt. spectabilis. 2. Pt. gibberulus. 3. Pt. arenatus. 4. Pt. articulatus. 5. Pt. altior. 6. Pt. sulcatus. 7. Pt. concentricus. 8. Pt. decurrens. 9. Pt. acutus. 10. Pt. Knorrii. 11. Pt. latissimus. 12. Pt. mammillaris. 13. Pt. Mortoni. 14. Pt. polygrus.

Genus III. Ctenoptychius. Teeth somewhat like those of *Orodus*, but more compressed, with the elevated central ridge dentate.

1. Ct. apicalis. 2. Ct. pectinatus. 3. Ct. denticulatus.

Genus IV. Orodus. Teeth elongated, with the central part forming a transverse, obtuse cone, of which the longitudinal diameter is much the greatest.

1. O. cinctus. 2. O. ramosus.

Genus V. Psammodus. Crown of teeth found formed of minute vertical tubes, which give the surface the appearance of being *sanded*; they appear to have been in several ranges in the jaw.

1. Ps. rugosus. 2. Ps. porosus.

Genus VI. Helodus. Formation of teeth like the last, with which it was by Agassiz at first confounded, as were

Plagiostomi. Squali, or Sharks.

the three following genera also; but in this genus the crown of the tooth is perfectly smooth, with a conical elevation in the centre, and sometimes it has several such, but the central is most elevated.

1. H. simplex. 2. H. lævissimus. 3. H. subteres. 4. H. gibberulus. 5. H. turgidus.

Genus VII. Chomatodus. Teeth like those of *Psammodus*, but the base of each is surrounded with a series of concentric plicæ, more or less salient; they are generally elongated, with the crown either flat or slightly salient, and occasionally the edge is sharp.

1. Ch. cinctus. 2. Ch. linearis. 3. Ch. acuminatus.

Genus VIII. Cochliodus. The crown of the teeth convoluted like a shell, instead of having them disposed in several rows.

1. C. contortus.

Genus IX. Strophodus. Teeth elongated, narrow, truncated at each end, with more or less torsion in the longitudinal diameter; occasionally they are nearly straight, or only slightly bent; the crown without projection or ridge.

1. S. longidens. 2. S. reticulatus. 3. S. subreticulatus. 4. S. magnus. 5. S. tenuis. 6. S. irregularis. 7. S. radiopunctatus. 8. S. angustissimus. 9. S. elytra. 10. S. asper. 11. S. punctatus.

Genus X. Ceratodus. Structure of teeth like *Psammodus*, but they have only been placed in a single row; one of their sides is straight, the opposite has several strong projections.

1. C. altus. 2. C. latissimus. 3. C. curvus. 4. C. Kaupii. 5. C. planus. 6. C. parvus. 7. C. emarginatus. 8. C. gibbus. 9. C. Dædaleus. 10. C. obtusus. 11. C. disauris. 12. C. Phillipsii. 13. C. serratus. 14. C. heteromorphus.

Genus XI. Ctenodus. These singular teeth look very like the valve of an *echinated cockle;* but how fixed in the jaw is unknown.

1. Ct. alatus. 2. Ct. cristatus. 3. Ct. Robertsoni.

Genus XII. Acrodus. A fragment of a jaw was found showing teeth like the living *Cestracion* of Australia. The enamel covers a granular bony structure. The teeth has transverse ridges radiating from a longitudinal central one, not unlike in appearance to a contracted leech, for the petrifaction of which the tooth has often passed: in some species the central ridge is high, especially in the middle.

1. A. nobilis. 2. A. latus. 3. A. gibberculus. 4. A. undulatus. 5. A. leiopleurus. 6. A. minimus. 7. A. acutus. 8. A. Gaillardoti. 9. A. lateralis. 10. A. larva. 11. A. Braunii. 12. A. hirudo. 13. A. rugosus.

Family II.—SQUALI, OR SHARKS.

An elongated body; strong muscular tail; mouth below the muzzle; breathe through several open spiracles on the sides of the neck; generally sharp cutting teeth, which are moveable. Skeleton cartilaginous. From this last circumstance, we seldom find more of them fossilized than the teeth, and spines of the fins.

Genus I. Notidanus. Single dorsal, opposite to the space between the ventral and anal fins. Teeth composed of a series of toothlets, the first of which is crenulated on its anterior margin; the toothlets become smaller and smaller, and the last represent a fine serrature on the posterior margin of the tooth; the root broad and flat.

1. N. primigenus. 2. N. recurvus. 3. N. microdon. 4. N. pectinatus. 5. N. Munsteri. 6. N. serratissmus.

Genus II. Corax. Teeth solid, and resemble those of the living *Galeus*, except in the regularity of the serratures on the edges of the teeth.

1. C. pristidontus. 2. C. Kaupii. 3. C. falcatus. 4. C. appendiculatus. 5. C. affinis. 6. C. Egertoni. 7. C. planus.

Genus III. Galeocerdo. Teeth chiefly differ from those of *Galeus* by serratures on both edges, and from *Corax* by the greater size of those at the base. They are flat exteriorly, and convex on the inside. Two of this genus are its living representatives, and five are fossil.

Plagiostomi. Raja.

1. G. aduncus. 2. G. latidens. 3. G. minor. 4. G. gibberulus. 5. G. denticulatus.

Genus IV. Sphyrna, v. *Zygæna*. Unfortunately the determination of the fossil species is very difficult; for, in this genus, the teeth in both jaws differ much from each other; and we even find, in the same jaw of the living species, teeth with serratures on the edges, and some without them. The general form of the teeth resembles those of the sharks termed *Prinodon;* but these are more slender. The species referred by Agassiz to this genus are,—

1. S. prisca. 2. S. lata. 3. S. denticulata.

Genus V. Hemipristis. Teeth have smooth points, but are distinctly serrated towards their base; they are pyramidal, broad at the base, and sharp pointed, with smooth enamel.

1. H. serra. 2. H. paucidens.

Genus VI. Carcharias. Teeth triangular, in several rows, serrated on both margins; enamel perfect; dentine presents a hollow cone.

1. C. tenuis. 2. C. acutus.

Genus VII. Glyphis. This genus separated from the last, because of the lancet form of the teeth, which at the point resemble a sculptor's chisel, the root and base of the crown being a little enlarged.

1. G. hastalis.

Genus VIII. Carcharodon. Teeth chiefly differ from those of *Carcharias* by being solid within, and by their vast size. The living type is the *Lamna* of the Prince of Canino.

1. C. megalodon. 2. C. rectidens. 3. C. subauriculatus. 4. C. productus. 5. C. polygyrus. 6. C. sulcidens. 7. C. auriculatus. 8. C. angustidens. 9. C. turgidus. 10. C. semiserratus. 11. C. lanceolatus. 12. C. toliapicus. 13. C. heterodon. 14. C. megalotis. 15. C. leptodon. 16. C. disauris. 17. C. subserratus. 18. C. Escheri.

Genus IX. Otodus. Only known as a fossil. Teeth differ from *Carcharodon* by the total want of serratures on the edges, and being smaller, while they have a conspicuous collar on each side of the tooth; their form is wide, and their root large.

1. O. obliquus. 2. O. lanceolatus. 3. O. appendiculatus. 4. O. latus. 5. O. crassus. 6. O. semiplicatus. 7. O. serratus. 8. O. macrodus. 9. O. tricuspis. 10. O. subplicatus. 11. O. trigonatus. 12. O. recticonus.

Genus X. Oxyrhina. Teeth with the lateral collar of *Otodus*, in which they differ also from *Lamna*. Muzzle sharp.

1. Ox. hastalis. 2. Ox. xiphodon. 3. Ox. trigonodon. 4. Ox. plicatilis. 5. Ox. Mantellii. 6. Ox. retroflexa. 7. Ox. quadrans. 8. Ox. leptodon. 9. Ox. Desorii. 10. Ox. crassa. 11. Ox. subinflata. 12. Zippei. 13. Ox. minuta. 14. Ox. meristodon, v. paradoxa.

Genus XI. Lamna. Teeth have the lateral collar, but it is much less conspicuous than in *Otodus;* are flat and lamelliform, but less broad than in the last mentioned; and they have small lateral cones.

1. L. elegans. 2. L. cuspidata. 3. L. compressa. 4. L. denticulata. 5. L. acuminata. 6. L. crassidens. 7. L. Hopei. 8. L. ventralis. 9. L. acutissima. 10. L. contorta. 11. L. dubia. 12. L. gracilis. 13. L. subulata. 14. L. raphidon. 15. L. Bronnii. 16. L. duplex. 17. L. longidens. 18. L. plana.

Family III.—RAJA.

Distinguished by their horizontally flattened bodies, with the mouth placed below their disk, and the enormous development of their pectoral fins.

Genus I. Myliobates. Known by the extraordinary size of the transverse dental plates, that supply the place of teeth in both jaws, but are longer and more flat in the lower than the upper jaw. The central teeth are elongated, and are supported on each side by much smaller lateral teeth, of an irregular hexagonal figure, in three rows. These

Plagiostomi. Chimæra.

teeth or plates are closely applied, and seem to pave the mouth. The living species are few, but they seem to have been very numerous in a former geological epoch.

1. M. micropleurus. 2. M. Stokesii. 3. M. geniopleurus. 4. M. Dixoni. 5. M. Regley. 6. M. striatus. 7. M. toliapicus. 8. M. punctatus. 9. M. suturalis. 10. M. gyratus. 11. M. heteropleurus. 12. M. jugalis. 13. M. Brongniartii. 14. M. nitidus. 15. M. angustus. 16. M. Colei. 17. M. Owenii. 18. M. Sternbergii. 19. M. Woodwardii. 20. M. canaliculatus. 21. M. lateralis. 22. M. marginalis. 23. M. acutus.

Genus II. Ætobates. Differs from *Myliobates* by the projection of the lower jaw, and the square truncation of the upper. Teeth all parallel to each other, and the lateral teeth are wanting.

1. Æ. sulcatus. 2. Æ. irregularis. 3. Æ. arenatus. 4. Æ. subarenatus.

Genus III. Zygobates. The dental plates disposed in several rows, diminishing gradually in size from the central to the lateral rows. The living species are found on the coast of Brazil; the fossil species in the crag formation.

1. Z. Studeri. 2. Z. Woodwardii.

Family IV.—CHIMÆRA.

The fossil species were discovered by Dr Buckland, who recognised the jaws and teeth. The latter are undivided plates. The family more numerous in former epochs than now.

Genus I. Chimæra, *v.* Ischyodon. The living species have but one branchial opening, the upper jaw represented only by the vomer; and this and also the lower jaw are furnished with hard undivided plates instead of teeth.

1. Ch. Egertoni. 2. Ch. Agassizii. 3. Ch. Tessoni. 4. Ch. Bucklandi. 5. Ch. Townsendii. 6. Ch. Johnsonii. 7. Ch. brevirostris. 8. Ch. Helvetica. 9. Ch. Dutertrii. 10. Ch. emarginata. 11. Ch. Dufrenoyi. 12. Ch. Beaumontii. 13. Ch. Colei. 14. Ch. Owenii. 15. Ch. rugulosa. 16. Ch. neglecta. 17. Ch. curvidens. 18. Ch. Mantellii. 19. Ch. Sedgwickii. 20. Ch. falcata. 21. Ch. psittacina.

Genus II. Elasmodus. Differs from *Chimæra* by the extreme shortness of the lower jaw, as was first pointed out by Sir Philip Egerton. The symphysis of the jaw flat, with dental plate truncated, and sloping backward.

1. E. Greenoughii. 2. E. Hunteri.

Genus III. Edaphrodon. Characterized by Buckland as having on the superior maxillaries three tubercles of dentine projecting from the bone; on the interior maxillary are two smaller tubercles, placed obliquely on the dentaledge.

1. E. Bucklandi. 2. E. leptognathus. 3. E. eurygnathus.

There are some other Placoids which are imperfectly known from small fragments, described chiefly by the German naturalists, Count Münster, MM. Müller, Henle, and Wagner, which we can here only slightly notice.

Genus I. Janassa. This has much of the character of the genus of the *Myliobates*, with teeth somewhat like those of *Zygobates;* they have a tubular structure, and are smallest towards the point, placed in three principal ranges, with small lateral teeth.

1. J. angula. 2. J. Humboldtii. 3. J. bituminosa.

Genus II. Dictea. A nearly complete impression shows this to have a flattened form, with large rounded pectorals prolonged on the sides of the head.

1. D. striata.

Genus III. Aëllopos. From a specimen in the museum at Munich, it has vertebræ like a *Galeus*, as long as high, with a smooth surface. The second dorsal fin is large, of a pyramidal form; the caudal much elongated; the shagreen of the skin finely and uniformly granular.

1. Æ. Wagneri. 2. Æ. elongatus.

Genus IV. Scylliodus. This is contained in the collections of Lord Enniskillen and Sir Philip Egerton. It is a *Squalus* of mean size, found in the Kentish chalk. The teeth are small, tricuspid, the middle point only cutting; the base large, which keeps the lateral points distant from the cutting one. Jaws dilated at the sides, narrowing towards the symphysis. Plagiostomi. Chimæra.

1. S. antiquus.

Genus V. Thyellina. Discovered by Count Münster in the chalk of Baumberge. Both dorsals are behind the insertion of the ventrals; the second dorsal is opposite to the anal, which it exceeds in size. Form that of a true *Scyllium*. The inferior angle of all these fins is rounded.

1. Th. angusta. 2. Th. prisca; this last, found in the lias of Lyme Regis.

Genus VI. Arthropterus. Observed by Agassiz in the lias of Bristol; only known by its fins, which are five inches long, composed of articulated, cylindrical rays; dilated at their ends, and sending off parallel branches to very distant articulations; unequal in different parts of the same ray.

1. A. Rileyi.

Genus VII. Squalo-raja, *v.* Spinacorhinus. From the lias of Lyme Regis. The prolongation of the head is owing to a projection analogous to the *saw* of a *Pristis*, composed of two parallel pieces, of which the larger and lower receives the other. Around this beak are spines, like those on the skate. Jaws transverse, and placed before and below the orbits, with very small pointed teeth.

1. Sq. polyspondyla.

Genus VIII. Asterodermus. The collection of the Geological Society of London possesses a small fish like a *ray*, from Solenhofen; but the vertebræ have more the form of a shark than a ray. All the surface is covered with star-like spinous scales, the largest of which are in the middle of the back. It has eight pairs of ribs on the sides of the pelvic vertebræ, which are long and slender, unlike the skeleton of a *ray*. Fins with flat, simple, transversely articulated rays.

1. A. platypterus.

Genus IX. Cyclarthrus. In the Bristol museum, a fish which cannot be referred to any known species of *ray*, though like them. The rays are cylindrical. Thick and short towards the base of the fins. The shagreen very fine.

1. C. micropterus.

Genus X. Euryarthra. Count Münster has a fin from Solenhofen, of large size, with flat, broad rays, composed of a few large articulations. The animal seems to have been very large.

1. Eu. Munsterii.

Genus XI. Pristis. The *saw* of this species, found in Sheppy, is in the British Museum; and a similar one of the same genus in Sir P. Egerton's collection. They belong to a species no longer existing. They have on the superior surface two grooves. The two osseous plates composing this beak are supported by vertical pillars, that lie side by side.

1. P. bisulcatus. 2. P. Hastingsiæ.

Genus XII. Trygon. This genus belongs to the Rays, and the two known species are found at Monte Bolca. The genus is distinguished by the double dentate spine or sting, with which the tail is armed. Both species occur at Monte Bolca.

1. T. Gazzolæ. 2. T. oblongus.

Genus XIII. Torpedo. A large fish, with the appearance of the existing *Torpedo*, occurs at Monte Bolca. The disk of the body is nearly circular; the tail short and robust.

1. T. gigantea.

Genus XIV. Narcopterus. In the museum of Padua is a fish which Agassiz mentions under this name, from

Ctenoïdei. Percoidei.

Monte Bolca. It appears to have considerable resemblance to the last genus, having a very broad muzzle.
1. N. Bolcanus.

Order III.—CTENOÏDEI.

This order, unlike the two last, has many living representatives in all its families. The character is, "scales circular, more or less elongated, formed of osseous plates, toothed or dentate on their posterior margins." The fossil families are nine, and many of the species are found in excellent preservation.

Family I.—PERCOÏDEI.

Body oblong; scales rough; opercula strongly dentate or spinous. Teeth on the intermaxillaries, the forepart of the vomer, the lower jaw, and frequently on the palate. Strong anterior spinous rays on the anterior part of the back, forming a fin, quite distinct from the soft rays, or uniting with them in a common membrane. Ventral fins often *thoracic, i.e.*, anterior to the pectorals.

Genus I. Sphenocephalus. One dorsal, with some spinous rays only at its anterior margin; this fin is of small extent, and scarcely surpasses the size of the anal. Head wedge-shaped.
1. Sph. fissicaudus.

Genus II. Hoplopteryx. Spinous portion of the dorsal formed of very thick rays, and as large as the soft part; this fin extends as far as the end of the anal. Bones of the head dentate.
1. H. antiquus.

Genus III. Beryx. A single dorsal, with a few spinous rays only in its anterior. Head thick, and very obtuse.
1. B. ornatus. 2. B. radians. 3. B. microcephalus. 4. B. Zippei. 5. B. Germanus.

Genus IV. Acanus. Spinous portion of the only dorsal very large, formed of thick rays longer than the soft rays. Several strong rays before the anal.
1. A. ovalis. 2. A. Regeley. 3. A. oblongus. 4. A. minor. 5. A. arcuatus.

Genus V. Podocys. Lower jaw projecting. Ventrals much developed, with long rays. Dorsal extending to the nape.
1. P. minutus.

Genus VI. Acrogaster. Abdominal region large, and salient. A few spines before the dorsal, which extends not below the middle of the back; anal as long as the dorsal.
1. A. parvus.

Genus VII. Myripristis. Præoperculum bristled with two parallel rows of dentations, but without a spine at its angle. All the opercula and the bones of the face and cranium are equally dentate. Two nearly equal dorsals.
1. M. homopterygius. 2. M. leptacanthus.

Genus VIII. Holocentrum. Operculum and præoperculum equally armed with spines, and the latter has besides, at its angle, a strong one directed backwards; cranial bone and the suborbitar bones are also dentate. Two dorsals; the first of which is formed of large sharp spines, and is larger than the second.
1. H. pygæum. 2. H. pygmæum.

Genus IX. Pristigenys. Suborbiculars strongly dentate. Spinous rays of the dorsal longer than the soft, and occupying it to a greater extent.
1. P. macrophthalmus.

Genus X. Enoplosus. Broad compressed body. Anterior dorsal very high. Ventrals very large.
1. E. pygopterus.

Genus XI. Smerdis. First suborbitar bone strong, dentate; præoperculum equally so, but without a spine at its angle; operculum terminates behind by a rounded projection. Two very narrow dorsals; caudal forked. Ctenoïdei. Sparoïdei.
1. S. micracanthus. 2. S. pygmæus. 3. S. minutus. 4. S. macrurus. 5. S. ventralis. 6. S. latior.

Genus XII. Perca. Two approximate dorsals. A strong spine at the angle of the operculum; præoperculum dentate, especially below; interoperculum, at its inferior margin, as well as the subopercula, less dentate. There are dentations also at the scapularies and angles of the humerus.
1. P. lepidota. 2. P. Beaumontii. 3. P. angusta.

Genus XIII. Labrax. Operculum with a double point; suborbitars, interopercula, and subopercula smooth; præoperculum dentate, rounded at its angle, with large teeth at its inferior margin; opercular pieces scaly.
I. L. lepidotus. 2. L. schizurus. 3. L. major.

Genus XIV. Apogon. Two very distinct dorsals. Præoperculum with a double dentate margin. Body short. Scales large.
1. A. spinosus.

Genus XV. Lates. Præoperculum dentate, with a strong spine at its angle, directed backwards; humeral angle dentate. Two dorsals. Tail rounded.
1. L. gracilis. 2. L. gibbus. 3. L. notæus. 4. L. macrurus.

Genus XVI. Cyclopoma. Operculum terminated by a thick point, very strong and sharp; præoperculum strongly dentate, and the strongest dentations on this bone are at its inferior margin, and directed forward; humeral angle rounded. Two dorsals slightly united at their base; caudal rounded.
1. C. gigas. 2. C. spinosum.

Genus XVII. Dules. Jaws furnished with finely *scopular*, or velvet-formed teeth. Opercula spinous; præoperculum dentate. Six branchiostegous rays. Dorsals united.
1. D. temnopterus. 2. D. medius.

Genus XVIII. Pelates. Operculum terminated by a strong spine; præoperculum dentate. Teeth scopular. Dorsal has numerous spinous rays, and this part is scarcely distinguishable from the soft part of the fin.
1. P. quinquedecimalis.

Genus XIX. Serranus. Spinous and soft portions of the dorsal united. Jaws with canine teeth, mingled with scopular teeth. Operculum terminated by two or three flat spines; præoperculum finely dentate. Seven branchiostegous rays. Cranium and opercular pieces scaly.
1. S. microstomus. 2. S. occipitalis. 3. S. ventralis.

Family II.—SPAROÏDEI.

The living fishes of this family were involved in much confusion, until remodelled by Valenciennes. Its fossil fishes are not numerous. The most ancient occur at Monte Bolca, and among these there is one extinct genus, *Sparodus*; all the other *genera* have living representatives, though the *species* which occur as fossils no longer exist.

The *Sparoïds* are characterized by a mouth not porrectile, by the absence of palatal teeth, and of spines or dentations on the opercular bones; no bulging of the cranial bone, and no scales on their vertical fins.

Genus I. Dentex. Deep and compressed body. Head large; conical teeth in one row on the edges of the intermaxillaries and inferior maxillaries; the anterior teeth extend in a hooked form beyond the other teeth. Cheeks scaly.
1. D. leptacanthus. 2. D. microdon. 3. D. crassispinus. 4. D. breviceps. 5. D. ventralis. 6. D. Faujasii.

Genus II. Pagellus. Two rows of small molar teeth on the intermaxillaries and maxillaries, in the form of pavements, with small conical slender teeth in the front of the jaws.
1. P. microdon. 2. P. leptesteus.

Genus III. Sparnodus. A single row of large, conical,

Ctenoïdei. Scienoidei.

short, and obtuse teeth on the edge of the intermaxillaries and inferior maxillaries. On the back and behind the anal fin are grooves, in which the anal and dorsal fins may lie.

1. S. macrophthalmus. 2. S. ovalis. 3. S. altivelis. 4. S. micracanthus. 5. S. elongatus.

Genus IV. Sargus. Body small, elongated, much compressed, and deep, especially in the middle. Cutting incisors in the interior part of the intermaxillaries and inferior maxillaries.

1. S. Cuvieri.

Family III.—SCIENOÏDEI.

This family presents most of the characters of the *Percoïds*, except that they have no teeth on vomer and palate, which are always smooth. The head, and especially the muzzle, is rounded, so that the outline presents an ogee Gothic arch. There are but two fossil genera.

Genus I. Pristipoma. The spinous rays of the dorsal are united to the soft rays; seven branchiostegous rays. Muzzle much rounded; mouth small. Operculum obtuse.

1. P. furcatum.

Genus II. Odonteus. Spinous part of dorsal very high, and separated from the soft rays by a slope. One row of thick conical teeth, which are short, on the intermaxillaries and maxillaries; præoperculum finely dentate. Cavernous bone round the orbits. Six branchiostegous rays.

1. O. sparoïdes.

Family IV.—COTTOÏDEI.

Head large, depressed, cuirassed, furnished with spines or tubercles. Two dorsals.

Genus I. Cottus. Head and body at its anterior thick and broad, tapering to the tail. Head tuberculated or spinous. Dorsals distinct; the first narrow; inferior rays of pectorals simple; ventrals with few rays. Branchiostegous rays six.

1. C. brevis. 2. C. aries. 3. C. papyraceus.

Genus II. Pterygocephalus. Spinous dorsal rays very long, separate, and reaching to the head, while the soft part of this fin occupies all the back. Caudal large, rounded. Scales carinated.

1. Pt. paradoxus.

Genus III. Callipteryx. Body large, elongated. Few spinous rays in the anterior of the dorsal. which extends along the whole back; anal also very extended. No scales have yet been found. The last caudal vertebra dilated into a plate, and caudal fin ample.

1. C. speciosus. 2. C. recticaudus.

Family V.—GOBIOÏDEI.

Ventral-thoracic fins united by their inner margins so as to form a sort of funnel more or less open. Dorsal has simple slender rays, which sometimes mingle with the soft rays, or form sometimes a distinct fin. Six branchiostegous rays.

Genus I. Gobius. Two distinct dorsal fins. Ventrals united. Teeth finely scopular.

1. G. macrurus. 2. G. microcephalus.

Family VI.—TEUTHYS.

An oval compressed body; a small mouth, not porrectile, with a single row of teeth in each jaw; none on the palatines nor tongue. Dorsal single; caudal nearly square. Head sloping very rapidly.

Genus I. Acanthurus. Teeth cutting, and dentate on the edges. A strong, cutting, and mobile spine on each side of the tail.

1. A. tenuis. 2. A. ovalis.

Genus II. Naseus. Front more or less prominent. Teeth conical. Four branchiostegous rays. Ventral has three soft rays. Tail with fixed spines. Ctenoïdei. Chætodonta.

1. N. nuchalis. 2. N. rectifrons.

Family VII.—AULOSTOMATA.

This family contains several genera which have little resemblance with each other, except in having the mouth tubular, or like a flute. Body elongated, but some are *thoracic* and others *abdominal* fishes. The soft dorsal and anal fins are placed far back. Scales pectinated, as in *Chætodons*.

Genus I. Amphisyle. Back cuirassed with large scaly plates, with the anterior of which the first spinous ray of the dorsal is articulated.

1. A. longirostris.

Genus II. Aulostoma. Ventrals abdominal; the soft dorsal opposite to the anal, and far back; a few free spines are before the dorsal. Mouth-tube long and compressed; jaws without teeth.

1. A. Bolcense.

Genus III. Fistularia. Mouth-tube very long, and depressed; small teeth on the intermaxillaries and inferior maxillaries. A single dorsal opposite to the anal; middle ray of the caudal filamentous.

1. F. tenuirostris. 2. F. Kœnigii.

Genus IV. Rhamphosus. An immense spinous ray, dentate on its posterior surface, is inserted in the nape; a soft dorsal opposite to the anal fin; caudal squared. Muzzle projecting as a nose above the jaws.

1. Rh. aculeatus.

Genus V Urosphen. Body elongated, cylindrical, terminated by a large cuneiform fin. Mouth-tube elongated, as in *Fistularia*.

1. U. fistularis.

Family VIII.—CHÆTODONTA, *v.* SQUAMIPENNÆ.

Body compressed, appearing more or less deep according to the proportion of the vertical fins, the soft parts of which have scales on them, so as to render it difficult to see the beginning of those fins. Some of them have very fine scopular teeth.

Genus I. Semiophorus. Dorsal very high anteriorly, and all soft, except the fins, ray, and a few small spines; it extends along the whole back; anal much less; ventrals very long. Profile very perpendicular.

1. S. velifer. 2. S. velicans.

Genus II. Ephippus. Anterior of dorsal formed of very large spinous rays, which are not covered with scales. A deep groove exists in all the rays of both spinous and soft.

1. E. longipennis. 2. E. oblongus.

Genus III. Scatophagus. Two dorsals, of which the anterior is formed of thick spines, the first the longest; the anal has four spines. Scales very small.

1. S. frontalis.

Genus. IV. Zanclus. Few spinous rays in the dorsal; but elongating rapidly, where collected at the very high anterior of the dorsal. Muzzle very prominent.

1. Z. brevirostris.

Genus V. Macrostoma. Mouth very large. Dorsal and anal low, but very long.

1. M. altum.

Genus VI. Holacanthus. At the angle of the præoperculum is a large needle-formed spine, directed backwards, the surface of which is usually dentate. Spinous dorsal rays strong, but less high than in *Pomacanthus*.

1. H. microcephalus.

Genus VII. Pomacanthus. Resembles the last, but with much longer dorsal spines.

1. P. subarcuatus.

Genus VIII. Platax. Body much compressed, being scarce distinguishable from the vertical fins, which are very

Ctenoïdei. Pleuronectes.

high and scaly. Short spinous rays are concealed in the anterior of the dorsal; ventrals very long.

1. P. altissimus. 2. P. macropterygius. 3. P. papilio. 4. P. Woodwardii.

Genus IX. Pygæus. Dorsals united, the anterior spinous part formed of thick rays, the soft part rounded and acuminated by rays a little longer in the middle portion; anal conformed to the dorsal, but not so long.

1. P. gigas. 2. P. nobilis. 3. P. oblongus. 4. P. dorsalis. 5. P. nuchalis. 6. P. Coleanus. 7. P. Egertoni. 8. P. gibbus.

Genus X. Toxotes. Dorsal very far back, scaly on its soft portion, which is lost in the spinous part; anal resembles the dorsal, to which it is opposite. Lower jaw projecting. The living type is the *T. jaculator* of Bengal, which the fossil species much resembles.

1. T. antiquus.

Family XI.—PLEURONECTES.

Characterized by want of symmetry between both sides of the body, the irregularity of the head, the eyes on one side of the body. Fins of back and abdomen invest also the head. Scales with rough points at their extremities.

Genus I. Rhombus. Body very broad. Dorsal advancing to the border of the lower jaw, and prolonged, as is the anal to the caudal.

1. Rh. minimus.

Family XII.—MUGILLOÏDEI.

Body nearly cylindrical. Scales large, advancing to the top of the head. Two distant dorsals, the first consisting of a few strong spines; ventrals abdominal. Teeth minute.

Genus I. Mugil. Body short, covered with large scales. First dorsal consists of four spines.

1. M. princeps.

Order IV.—CYCLOÏDEI.

They have been defined osseous fishes, with elliptical or circular scales, formed of horny laminæ, without dentations on their posterior margins. From the varying size of the laminæ composing them, they appear marked with concentrical circular rings. This order does not correspond with any of Cuvier's divisions, but the structure of the scales is an excellent character for distinguishing either recent or fossil fishes. Agassiz subdivides this order into two great divisions.

DIVISION I.—CYCLOÏDEI ACANTHOPTERYGEI.

Family I.—SCOMBEROÏDEI.

Body more or less elongated, generally fusiform, rarely squat. Ventrals either *thoracic* or *jugular;* ventrals without scales; dorsals either separate or contiguous, with or without finlets behind the second dorsal or anal fins; opercula without spines or dentations. Jaws with strong conical teeth, or with loose scopular teeth. Scales very small. Of all the *Cycloïds*, the *Scomberoïds* have the greatest number of living representatives.

Genus I. Gasteronemus. Body compressed; abdomen very dilated. Thoracic ventrals supported by an immense pelvic bone, and composed of a long simple ray preceded by a small bonelet. Dorsal continuous. Head small. Teeth very small.

1. G. rhombeus. 2. G. oblongus.

Genus II. Acanthonemus. Body squat. Dorsal continuous; spinous rays of the dorsal and anal exceedingly developed. Muzzle porrectile. Teeth scopular.

1. A. filamentosus. 2. A. Bertrandi.

Genus III. Vomer. Body squat, compressed, wholly covered with very small scales. Head large, its profile much inclined. Ventrals thoracic; dorsals separate; fin-rays short and slender; vertebral apophyses stout; those of the abdomen curving forwards.

Cycloïdei Acanthopterygei. Scomberoïdei.

1. V. longispinus. 2. V. priscus. 3. V. parvulus.

Genus IV. Zeus. Body squat, compressed. Head large; muzzle porrectile. Spinous dorsal composed of very long rays; two anals; one spinous, the other soft; the soft dorsal and soft anal are flanked by large osseous and spinous shields; margin of the ventral has similar shields. Vertebræ short; ribs very slender, and partly attached to very strong inferior apophyses.

1. Z. priscus.

Genus V. Lichia. Body elongated, compressed. First dorsal composed of free, moveable spines, and of a fixed one directed forwards; two free spines before the anal. Teeth scopular.

1. L. prisca.

Genus VI. Trachinotus. Body short, elevated. Profile much inclined. First dorsal composed of free spines. Teeth scopular.

1. T. tenuiceps.

Genus VII. Carangus. Body elongated, compressed. First dorsal consists of free spines, rather long, without the spine projecting forwards; no free anal spines; second dorsal opposite to the anal; no finlets. Teeth scopular.

1. C. latior. 2. C. dorsalis. 3. C. analis. 4. C. maximus.

Genus VIII. Amphistium. Body broad and squat, probably flat. Dorsal continuous, occupying more than the half of the ridge of the back. Anal very large.

1. A. paradoxum.

Genus IX. Palimphyes. Body squat. Dorsals separate; pectorals very large. Pedicle of tail broad. Vertebræ short and numerous.

1. P. longus. 2. P. brevis. 3. P. latus.

Genus X. Archæus. Body more or less elongated. Vertebræ long and few; interapophysal bonelets very slender.

1. Ar. Glarisianus. 2. Ar. brevis.

Genus XI. Isurus. Body squat. Head large. Pedicle of tail very narrow. Skeleton robust.

1. I. macrurus.

Genus XII. Pleionemus. Allied to *Isurus*, but body more lengthened.

1. P. macrospondylus.

Genus XIII. Ductor. Body elongated and cylindrical. Pedicle of tail broad. Vertebræ long and few.

1. D. leptosomus.

Genus XIV. Thynnus. Body elongated. Dorsals contiguous; false pinnules or finlets behind the dorsal and anal fins. A corslet of unequal scales around the thorax.

1. Th. propterygius. 2. Th. Bolcensis.

Genus XV. Orcynus. Body elongated. Dorsals contiguous; finlets behind the dorsal and anal fins; pectorals very long, which distinguish it from *Thynnus*.

1. O. lanceolatus. 2. O. latior.

Genus XVI. Cybium. Body elongated. Dorsals contiguous; finlets as in the last. Teeth large in both jaws.

1. C. speciosum. 2. C. macropomum.

Genus XVII. Goniognathus. Habit of the *Coryphæne;* but differs in the angular form of the jaws.

1. G. coryphænoides. 2. G. maxillaris.

Genus XVIII. Enchodus. Teeth strongly developed, bulging on their interior, and flat on their anterior surface, occupying the whole circumference of the jaws; but there are also scopular teeth on the margins of the jaws.

1. E. halcyon. 2. E. Faujasii.

Genus XIX. Anenchelum. Body much elongated, or eel-shaped. Head obtuse; jaws armed with strong teeth. Dorsals continuous; ventrals consist of some long rays. Vertebræ long and slender; apophysary bonelets are fastened to the apophyses.

1. A. Glarisianum. 2. A. isopleurum. 3. A. dorsale. 4. A. heteropleurum. 5. A. latum. 6. A. longipenne.

Cycloïdei Acanthopterygei. Xiphoïdei.

Genus XX. Nemopteryx. Body elongated. Caudal fin rounded; pectorals very large. Strong teeth in the jaws. Vertebræ robust.
1. N. crassus. 2. N. elongatus.

Genus XXI. Xiphopterus. Body very long. Tail deeply forked. Ventrals thoracic; anal extends to nearly two-thirds of the length of the fish. Head small. Ribs long, and interlaced with the sternal appendages, as in *Clupea*.
1. X. falcatus.

Genus XXII. Palæorhynchum. Body much elongated, or anguilliform. Head small. Jaws equal, and drawn out into a very long slender beak, without teeth. Dorsal and anal much developed; caudal fin little forked. Apophysal bonelets disposed in pairs.
1. P. longirostre. 2. P. Egertoni. 3. P. Glarisianum. 4. P. latum. 5. P. medium. 6. P. Colei. 7. P. microspondylum.

Genus XXIII. Hemirhynchus. Body elongated. Upper jaw drawn out into a slender beak, without teeth. Scales large. Skeleton feeble; spinous apophyses slender; interapophysal bonelets disposed in pairs.
1. H. Des Hayes.

Family II.—XIPHOÏDEI.

This remarkable family has but few fossil representatives. Body elongated; scales small; upper jaw lengthened into a thin beak. Ventrals *thoracic*. Teeth scopular. Vertebræ long, surmounted by apophyses in the form of vertical plates. Articular apophyses large.

Genus I. Tetrapterus. Body elongated. Beak very prominent. Teeth scopular. Scales long and thin. Dorsal commences at the nape. Ventrals *thoracic*. Vertebræ very narrow in the middle.
1. T. priscus. 2. T. minor.

Genus II. Cœlorhynchus. Beak extremely slender and straight, diminishing very gradually, and having a cavity extending to its point.
1. C. rectus. 2. C. sinuatus.

Family III.—SPHYRÆNOÏDEI.

Body elongated. Scales large. Jaws with long cutting teeth. Dorsals separated. Ventrals abdominal. Vertebræ few.

Genus I. Sphyræna. Body slender. Head lengthened. Intermaxillary, palatal, and lower-jaw teeth strong and cutting. Spinous dorsal separated from the soft fin. Scales of middle size. Vertebræ few and long.
1. S. Bolcensis. 2. S. gracilis. 3. S. Amici. 4. S. maxima.

Genus II. Sphyrænodus. Jaws with very strong but uniform teeth, conic, and slightly compressed.
1. S. priscus.

Genus III. Hypsodon. Seems to have been very large. Jaw very thick, and teeth formidable; those of the upper jaw placed in several rows.
1. H. Lewisiensis. 2. H. toliapicus. 3. H. oblongus.

Genus IV. Saurocephalus. Teeth straight, very compressed, and furnished with vertical plicæ.
1. S. lanceolatus. 2. S. striatus.

Genus V. Saurodon. Teeth narrower than in the last genus, compressed, oblique on their summit, and striated at their base.
1. S. Leanus.

Genus VI. Cladocyclus. Tube on the scales of the lateral line branched.
1. C. Lewesensis. 2. C. Gardneri.

Genus VII. Rhamphognathus. Body elongated. Ventrals *abdominal*. Jaws very slender, with the upper overlapping the lower.
1. Rh. paralepoïdes.

Genus VIII. Mesogaster. Body elongated. Head short, obtuse. Jaws equal. Ventrals *abdominal*.
1. M. sphyrænoïdes.

Family IV.—BLENOÏDEI.

Cycloïdei Malacopterygei. Cyprinoïdei.

Body squat; size generally small. Scales small. Ventrals *jugular*; one very long dorsal fin, partly consisting of spinous and soft rays. Teeth more or less conspicuous.

Genus I. Spinacanthus. First dorsal consists of enormous spines, equalling in length the body of the fish; and the anterior spines are dentate at their base; second dorsal slender.
1. S. blennioïdes.

Family V.—LOPHIOÏDEI.

Pectorals supported on a prolongation of the carpal bones, which form as it were an arm. Ventrals *thoracic*. Scales entirely wanting or replaced by osseous tubercles, or short spines. Head very large; jaws armed with numerous sharp teeth, in suborbitar bones.

Genus I. Lophius. Head enormous, depressed; mouth immense. Two dorsals, the first of which extends to the head.
1. L. brachysomus.

Family VI.—LABROÏDEI.

Form oblong; body scaly. A single dorsal sustained anteriorly by spinous rays. Jaws covered by fleshy lips. No palatal teeth; but they are found on the three pharyngeal bones, either as plates or pointed teeth.

Genus I. Labrus. Form squat. Skeleton massive. Opercular pieces without spines or dentations.
1. L. Valenciennesii. 2. L. Ibbetsoni.

DIVISION II.—CYCLOÏDEI MALACOPTERYGEI.

Family VII.—CYPRINOÏDEI.

Body oblong. Ventrals *abdominal*. Inferior pharyngeal bone armed with several rows of strong teeth, sometimes conical, sometimes compressed, or crooked; no jaw teeth; mouth small, with fleshy lips, often carrying beards. Vertebræ strong and few; three branchiostegous rays. The family are chiefly fresh-water fishes.

Genus I. Acanthopsis. Form very long, and compressed. Caudal fin truncated and rounded; dorsal placed a little before the ventrals. Beards short. First suborbitar bone mobile, bifurcated, and terminating in sharp points. Scales scarcely perceptible.
1. A. angustus.

Genus II. Cobitis. Form elongated, cylindrical. Cheeks smooth. Orbiculars immoveable, concealed under the skin. Scales small. Pharyngeal teeth slender, bevelled.
1. C. centrochir. 2. C. cephalotes. 3. C. longiceps.

Genus III. Gobio. Form cylindrical. Dorsals opposite to two ventrals, with a large simple ray. Scales of medium size, and very thin.
1. G. analis.

Genus IV. Tinca. Form squat. Fins thick. Scales small. A single row of pharyngeal teeth, claviform. Large rounded fins, with very thick rays.
1. T. furcata. 2. T. leptosoma. 3. T. micropygoptera.

Genus V. Leuciscus. Body fusiform, covered with large scales. Pharyngeal teeth in two rows. Skeleton robust.
1. L. Oningensis. 2. L. latiusculus. 3. L. pusillus. 4. L. heterurus. 5. L. leptus. 6. L. macrurus. 7. L. papyraceus. 8. L. cephalon. 9. L. gracilis. 10. L. Hartmanni. 11. L. brevis.

Genus VI. Apsius. Body elongated, compressed, covered with large scales, salient at their posterior margin. Mouth oblique; inferior jaw reaching beyond the upper; pharyngeal teeth long, in two rows. Dorsal behind the ventrals; caudal much forked. Skeleton slender.
1. A. gracilis. 2. A. Brongniarti.

Cycloïdei Malacopterygei. Cyprinodontei.

Genus VII. Rhodeus. Form squat, compressed, covered with large, thin scales. No beards. Pharyngeal teeth bevelled. Dorsal opposite to anal; caudal forked; all the fins small. Fishes all very small.
1. Rh. elongatus. 2. Rh. latior.

Genus VIII. Cyclurus. Dorsal and anal large; caudal rounded. Vertebral column recurved at its extremity. Vertebræ thick and short. Scales thick and long.
1. C. Valenciennesii. 2. C. minor.

Family VIII.—CYPRINODONTEI.

Form very regularly oblong. Scales large, though the fishes are small. Ventrals *abdominal.* Teeth in both jaws. More than three branchiostegous rays.

Genus I. Lesbias. Body rather elongated. Jaws horizontally flattened, and furnished with serrated teeth. Opercula large. Many branchiostegous rays. Dorsal opposite to the anal.
1. L. cephalotes. 2. L. perpusillus. 3. L. gobio. 4. L. Meyeri. 5. L. crassicaudatus.

Family IX.—ESOCIDEI.

Body slender, with large scales. Superior maxillaries without teeth, and placed in a line with the intermaxillaries. Teeth generally very strong, and conical in the lower jaw, palatines, and vomer.

Genus I. Esox. Form long, cylindrical. Head large; muzzle long, obtuse, depressed; mouth very wide. Palatine teeth very strong and conical, as are those on the anterior part of the vomer, and on the lower jaw; small teeth on the intermaxillaries; none on the maxillaries. Numerous branchiostegous rays. Dorsal and anal approximate to the caudal, which last is a little sloped. Scales large. Skeleton not robust.
1. E. Otto. 2. E. lepidotus.

Genus II. Holosteus. Form very elongated. Skeleton slender; ribs very thin; muscular apophyses numerous and very large.
1 H. Esocinus.

Genus III. Sphenolepis. Form elongated. Dorsal opposite to ventrals; caudal scarcely forked. Scales large.
1. Sph. squamosus. 2. Sph. Cuvieri.

Genus IV. Istius. Body elongated. Dorsal stretching along almost the whole back; anal very far back. Scales large. Vertebræ very short; spinous apophyses very close together, and more numerous than the apophysal bonelets. Small teeth in the jaws.
1. I. grandis. 2. I. macrocephalus. 3. I. microcephalus. 4. I gracilis.

Family X.—HALECOÏDEI.

This family includes the *Clupeæ* and *Salmones.* The fish are very symmetrical, and covered with well-defined scales. Ventrals *abdominal.* Superior maxillaries forming partially the margin of the jaw, often carry teeth, which are conical, and more or less conspicuous. Skeleton slender, with or without sternal ribs. Size from small to medium.

Genus I. Mallotus. Body elongated. Skeleton slender. Dorsal in the middle of the back; anal very large. Teeth scopular.
1. M. villosus.

Genus II. Osmerus. Body elongated. Dorsal opposite to ventrals. Teeth strong and conical, in the palatines and maxillaries.
1. O. Cordieri. 2. O. Glarisianus.

Genus III. Osmeroides. Dorsal far forwards. Head flat; mouth rather small. No sternal ribs.
1. O. Monasteri. 2. O. microcephalus. 3. O. Lewesiensis. 4. O. granulatus.

Genus IV. Acrognathus. Head large, flat, and broad; 1. A. boops. Cycloïdei Malacopterygei. Anguilliformes.

Genus V. Aulolepis. Form approaching to that of *Salmo.* Head high; muzzle pointed; jaws of equal length. Vertebræ higher than long. Pectorals have long slender rays. Scales large, subangular.
1. A. typus.

Genus VI. Alosa. Form symmetrical. Vertebræ very numerous; ribs sternal. A notch in the middle of the upper jaw.
1. A. elongata.

Genus VII. Megalops. Resembles *alosa;* but has a very large eye. Last dorsal terminates in a filament.
1. M. priscus.

Genus VIII. Clupea. Form symmetrical. No notch in the middle of the upper jaw. Sternal ribs. Dorsal in the centre of the back.
1. C. macropoma. 2. C. dentex. 3. C. Beurardi. 4. C. brevissima. 5. C. lata. 6. C. brevis. 7. C. tenuissima. 8. C. minima. 9. C. megaptera. 10. C. Sheuchzeri. 11. C. leptostea. 12. C. minuta. 13. C. Goldfussii. 14. C. catapygoptera.

Genus IX. Engraulis. Body elongated. Mouth very wide; muzzle pointed, and projecting beyond the lower jaw. Pectorals very large; dorsal opposite to the ventrals. No sternal ribs.
1. E. evolans.

Genus X. Halec. Head very broad and flat. Mouth very wide. Lower jaw-bone very narrow. No sternal ribs.
1. H. Sternbergii.

Genus XI. Platinx. Form elongated. Dorsal placed far back; pectorals very long. Vertebral column very stout. No sternal ribs.
1. P. elongatus. 2. P. gigas.

Genus XII. Cœlogaster. Allied to *Platinx*, but has an extended anal fin. Belly appears hollowed.
1. C. analis.

Genus XIII. Notæus. Body squat. Dorsal extends over most of the ridge of the back; ventrals *abdominal;* caudal rounded. Vertebræ higher than long.
1. N. laticaudatus.

Family XI.—ANGUILLIFORMES.

Body uniformly and greatly elongated. Scales very minute. No ventrals, and sometimes no pectorals. Teeth small, conical, and generally strong.

Genus I. Anguilla. Pectorals near the gills, which open on each side of the fins; dorsal commences at a certain distance from the nape.
1. A. latissima. 2. A. ventralis. 3. A. brevicula. 4. A. multoradiata. 5. A. pachyura. 6. A. branchiostegalis. 7. A. interspinalis. 8. A. leptoptera.

Genus II. Enchelyopus. Body much elongated. Dorsal prolonged to the nape. Thoracic cincture very slender.
1. E. tigrinus.

Genus III. Sphagebranchus. Gill-covers approximate under the throat. Vertical fins placed far back. Muzzle pointed.
1. Sph. formosissimus.

Genus IV. Ophiurus. Differs from *Anguilla* in having the termination of the dorsal and anal fins before reaching the end of the tail, which is thus finless, and terminates in a point.
1. O. acuticaudatus.

Genus V. Leptocephalus. Differs from *Anguilla* in having the gill-openings before the pectorals, and in having much more of the ribband form. Head extremely small, and muzzle pointed. Pectorals scarcely perceptible.
1. L. gracilis. 2. L. medius.

Ganoïds. Lepidoïds.

GEOLOGICAL FORMATIONS IN WHICH FOSSIL FISHES ARE FOUND.

Ganoïds. Lepidoïds.

Order. I.—GANOÏDS.

Family of Lepidoïds.

I. In the Devonian or Old Red Formation.

Catopterus macrolepidotus, Caithness, Orkney, Widel.
Osteolepis macrolepidotus, Cromarty, Caithness, Orkney.
„ microlepidotus, Caithness, Orkney.
„ arenatus, Gamrie in geodes.
„ major, Lethen-bar.
Acanthodes pusellus, Gordon Castle.
Diplacanthus striatus, Cromarty.
„ striatulus, Lethen-bar.
„ longispinus, Lethen-bar, Cromarty.
„ crassispinus, Caithness.
Cheiracanthus Murchisoni, Gamrie.
„ microlepidotus, Lethen-bar, Cromarty.
„ minor, Orkney.
Cheirolepis Traillii, Orkney.
„ uragus, Gamrie.
„ Cummingiæ, Lethen-bar, Cromarty.
Cephalaspis Lyelli, Hereford, Brecon, Whitbach.
„ rostratus, Whitbach.
„ Lewisii, Whitbach.
„ Lloydii, Whitbach, Wales.
Pterichthys Milleri, Cromarty.
„ productus, Lethen-bar.
„ latus, Lethen-bar.
„ cornutus, Lethen-bar.
„ testudinarius, Lethen-bar.
„ oblongus, Cromarty, Gamrie.
„ cancriformis, Orkney.
„ hydrophilus, Dura-den, Fifeshire.
Coccosteus decipiens, Orkney, Caithness.
„ oblongus, Lethen-bar.
„ cuspidatus, Cromarty, Gamrie.

II. Coal Formation.

Acanthodes Bronnii, Saarbrück.
„ sulcatus, Newhaven near Edinburgh.
Amblypterus macropterus, Saarbrück.
„ eupterygius, Saarbrück, Lebach.
„ latus, Saarbrück, Lebach, St Ingbert.
„ lateralis, Saarbrück, Lebach.
„ nemopterus, Newhaven, Inchkeith.
„ punctatus, Newhaven.
„ striatus, Newhaven.
Palæoniscus fultus, Massachusetts, Connecticut.
„ Agassizii, New Jersey.
„ macropterus, Massachusetts.
„ Egertoni, Staffordshire.
„ Monensis, Anglesey.
„ Duvernoyi, Appel by Kreutznach
„ minutus, Appel by Kreutznach.
„ Blainvillei, Muse by Autun.
„ Voltzii, Muse by Autun.
„ angustus, Muse by Autun.
„ Robisoni, Burdiehouse by Edinburgh.
„ striolatus, Burdiehouse by Edinburgh.
„ ornatissimus, Burntisland in Fifeshire.
„ carinatus, Newhaven.
„ Vratislavensis, Ruppersdorf, Bohemia.
„ lepidurus, Scharfeneck, Bohemia.
Catopterus gracilis, Connecticut.
„ parvulus, New Jersey.
„ anguilliformis, Connecticut.
Eurynotus crenatus, Burdiehouse.
„ fimbriatus, Newhaven.
„ tenuiceps, Massachusetts.
Platysomus parvulus, Leeds.
Gyrolepis Rankenei, Leeds.
Plectrolepis rugosus, Carluke.

III. Zechstein, or Magnesian Limestone Formation.

Amblypterus Olfersii, Ceara in Brazil.
Palæoniscus Freieslebeni, Mansfeld, Hesse.
Palæoniscus magnus, Mansfeld, Hesse.
Palæoniscus macropomus, Mansfeld, Ilmenau.
„ elegans, magn. limestone of England.
„ comptus, magn. limestone of England.
„ glaphyrus, magn. limestone of England.
„ longissimus, magn. limestone of England.
„ macrophthalmus, magn. limestone of England.
Platysomus gibbosus, Zechstein of Germany.
„ rhombus, Mansfeld.
„ striatus, magn. limestone of England.
„ macrurus, magn. limestone of England.
„ parvus, magn. limestone of Low Pallion, England.

IV. Trias, or Variegated Sandstone, Muschelkalk, and Keuper.

Palæoniscus catopterus, var. sandstone of Tyrone.
Amblypterus Agassizii, muschelkalk of Thuringen.
Gyrolepis Albertii, muschelkalk of Schwenningen, Lunéville.
„ tenuistriatus, muschelkalk of Schwenningen, Axmouth.
„ maximus, muschelkalk of Lunéville, Wickwarr.

V. Jurassic Formation.

a. Lias.

Dapedius politus, Lyme Regis.
„ granulatus, Lyme Regis.
„ punctatus, Lyme Regis.
„ Colei, Lyme Regis.
„ orbis, Whitby.
„ arenatus, Lyme Regis.
„ micans, Whitby.
Tetragonolepis semicinctus, Bronn, Neidingen.
„ confluens, Lyme Regis.
„ speciosus, Lyme Regis.
„ pustulatus, Lyme Regis.
„ radiatus, Lyme Regis.
„ leiosomus, Lyme Regis.
„ Leachii, Lyme Regis.
„ heteroderma, Lyme Regis, Wurtemberg.
„ pholidotus, Boll, England.
„ ovalis, Boll, England.
„ Bovei, Seefeld.
„ dorsalis, Gloucester.
„ monilifer, Banwell, Whitby.
„ angulifer, Stratford-on-Avon.
„ striatus, Whitby.
Amblyurus macrostomus, Lyme Regis.
Semionotus Leptocephalus, Boll.
„ Bergeri, Koburg.
„ latus, Seefeld.
„ rhombifer, Lyme Regis.
„ Nilssonii, Scania.
„ striatus, Seefeld.
Centrolepis asper, France, Germany, England.
Lepidotus gigas, Lyme Regis.
„ semiserratus, Whitby, Scarborough.
„ undatus, Lyme Regis.
„ rugosus, Lyme Regis, Whitby.
„ fimbriatus, Lyme Regis, Haring in Tyrol, Coburg.
„ ornatus, Seefeld.
„ frondosus, Zell near Boll.
„ speciosus, Seefeld.
„ parvulus, Seefeld.
„ serrulatus, Whitby.
„ pectinatus, Whitby.
Pholidophorus Bechei, Lyme Regis.
„ onychius, Lyme Regis, Chernock.
„ dorsalis, Seefeld.
„ limbatus, Lyme Regis.
„ Stricklandii, Whitby.
„ Hastingsiæ, Whitby.
„ latiusculus, Seefeld.
„ pusillus, Seefeld.
„ furcatus, Seefeld.
„ leptocephalus, Street.
„ pachysomus, Lyme Regis.
„ crenulatus, Lyme Regis.
„ Hartmanni, Ohmden.
Nothosomus octostychius, Street.

Ganoïds. Sauroïds.

b. Jurassic Proper.

Tetragonolepis Magneville, lower oolite of Caen.
„ mastodonteus, wealden of Hastings.
Semionotus Pentlandi, Castellamare.
„ minutus, Castellamare.
„ pustulifer, Castellamare.
Lepidotus lævis, Portland-stone of Soleure.
„ unguiculatus, Solenhofen, Stonesfield.
„ radiatus, French Jura.
„ palliatus, Kimmerage clay of Boulogne.
„ tuberculatus, Stonesfield.
„ notopterus, Solenhofen.
„ oblongus, Solenhofen.
„ minor, Purbeck calc. of Hildesheim.
„ Fittoni, Hastings sand of Tilgate.
„ Mantellii, wealden of Tilgate.
„ latimanus, Oxford clay of Chippenham.
Pholidophorus macrocephalus, calc. of Solenhofen.
„ microps, calc. of Solenhofen.
„ tenuiserratus, calc. of Kehlheim.
„ longiserratus, calc. of Kehlheim.
„ striolaris, calc. of Solenhofen.
„ Taxis, calc. of Solenhofen.
„ latus, calc. of Eichstadt.
„ micronyx, calc. of Kehlheim.
„ intermedius, calc. of Kehlheim.
„ latimanus, calc. of Solenhofen.
„ ornatus, calc. of Purbeck.
„ Flesheri, inferior oolite.
„ angustus, sandstone of Poland.
„ gracilis, calc. of Kehlheim.
„ minor, oolite of Stonesfield.
„ radians, calc. of Solenhofen.
„ uræoïdes, calc. of Solenhofen.
„ radiopunctatus, calc. of Solenhofen.
„ maximus, calc. of Solenhofen.
„ fusiformis, Castellamare.
Nothosomus lævissimus, calc. of Solenhofen.
Ophiopsis penicillatus, calc. of Purbeck.
„ dorsalis, calc. of Purbeck.
„ procerus, calc. of Solenhofen.
„ Münsteri, calc. of Kehlheim.
Notagus Zietenii, calc. of Solenhofen.
„ Pentlandi, Torre d'Orlando.
„ latior, Torre d'Orlando.
„ denticulatus, calc. of Kehlheim.
Propterus microstomus, calc. of Kehlheim.
Coccolepis Bucklandi, calc. of Solenhofen.

VI. Chalk Formation.

Lepidotus striatus, Vâche Noire in Normandy.
„ punctatus, white chalk of Kent.
„ temnurus, Brazil.
„ Cottæ, Hohenstein.
„ Virleti, Modon in Morea.

VII. Tertiary Formation.

Lepidotus Maximiliarii, calc. grossier of Paris.

Family of Sauroïds.

I. Devonian, or Old Red Formation.

Diplopterus affinis, Gamrie.
„ Agassizii, v. borealis, Orkney.
„ macrocephalus, Lethen-bar, Printscha.
Platygnathus paucidens, Caithness.
„ Jamesoni, Dura-den.
„ minor, Dura-den.
Dendrodus latus, Morayshire.
„ strigatus, Morayshire, Riga.
„ sigmoideus, Morayshire.
Lamnodus biporcatus, Morayshire, Riga.
„ Panderi, Morayshire, Riga.
Criodus incurvis, Morayshire, Riga.
Megalichthys priscus, Orkney.

II. Coal Formation.

Pygopterus Bonnardi, Muse near Autun.
„ Bucklandi, Burdiehouse.
„ lucius, Saarbrück.
„ Jamesoni, Burdiehouse.
„ Greenochii, Newhaven.
Megalichthys Hibberti, Glasgow, Carluke.
„ maxillaris, Leeds.
Diplopterus carbonarius, Stafford.
„ Robertsoni, Burdiehouse.
Acrolepis acutirostris, Carluke.
Orognathus conidens, Carluke.
Graptolepis ornatus, Carluke.
Pododus capitatus, Carluke.

Ganoïds. Sauroïds.

III. Zechstein, or Magnesian Limestone Formation.

Pygopterus Humboldti, Mansfeld, Nendershawen, Rigglesdorf, &c.
„ mandibularis, calc. magn. of East Tricksey, Terryhill.
„ sculptus, calc. magn. of East Tricksey, Terryhill.
Acrolepis Sedgwickii, calc. magn. of East Tricksey, Terryhill.
„ asper, Mansfeld.

IV. Trias Formation.

Saurichthys apicalis, Laineck, Benk, Göttingen, Hildesheim, Jena, bonebed at Axmouth; muschelkalk at Bareuth.
„ Mougeoti, muschelkalk at Lunéville, Bareuth.
„ acuminatus, bonebed at Austeliff.
„ longidens, bonebed at Austeliff, Pyrton-on-Severn.
„ semicostatus, muschelkalk of Benk, Laineck, Saxony, Hanover.
„ tenuirostris, muschelkalk of Bavaria.
„ costatus, muschelkalk of Benk, Laineck, Bareuth.
„ angustus, muschelkalk.

V. Jura Formation.

a. Lias.

Eugnathus chirotes, Lyme Regis.
„ orthostomus, Lyme Regis.
„ Philpotiæ, Lyme Regis.
„ minor, Lyme Regis.
„ opercularis, Lyme Regis.
„ polyodon, Lyme Regis.
„ speciosus, Lyme Regis.
„ fasciculatus, Whitby.
„ leptodus, Lyme Regis.
„ mandibularis, Lyme Regis.
„ ornatus, Lyme Regis.
„ scabriusculus, Lyme Regis.
„ tenuidens, Street.
„ giganteus, lias of Boll.
Ptycholepis Bollensis, lias of Boll, Lyme Regis, Whitby.
Conodus ferox, Lyme Regis.
Pachycormus macropterus, lias of Burgundy.
„ acutirostris, Whitby.
„ curtus, Whitby.
„ gracilis, Whitby, Wurtemberg.
„ heterurus, Lyme Regis.
„ latipennis, Lyme Regis.
„ latirostris, Whitby.
„ latus, Whitby.
„ macrurus, Lyme Regis.
„ leptosteus, Lyme Regis.
Caturus Bucklandi, Lyme Regis.
„ Meyeri, black schist of Western Rawensberg.
Thrissonotus Colei, Lyme Regis.
Sauropsis latus, Lyme Regis, Wurtemberg, Baden.
Leptolepis Bronnii, Lyme Regis, Neidingen, Bareuth, Caen, Baden, Oberland.
„ Jageri, lias of Boll.
„ longus, lias of Boll.
„ caudalis, Lyme Regis.
„ tenellus, lias of Baden.
„ filipennis, Street.
Aspidorhynchus Anglicus, Whitby.
„ Walchneri, Baden, Oberland.
Belonostomus acutus, Whitby.
„ Anningiæ, Lyme Regis.
Saurostomus esocinus, Baden, Oberland.
„ (nondescriptus), Lincolnshire.

b. Jurassic Proper.

Eugnathus microlepidotus, calc. of Solenhofen.
Pachycormus macropomus, Vâches Noires in Normandy.
Caturus furcatus, calc. of Solenhofen.
„ pachyurus, calc. of Solenhofen.
„ macrurus, calc. of Solenhofen.
„ maximus, calc. of Solenhofen.
„ microchirus, calc. of Solenhofen.
„ branchiostegus, calc. of Solenhofen.

Ganoïds. Cœlocanths.

Caturus latus, calc. of Solenhofen.
„ elongatus, calc. of Solenhofen.
„ macrodus, calc. of Solenhofen.
„ pleiodus, oolite of Stonesfield.
„ angustus, Portland-stone of Garsington.
Amblysemius gracilis, oolite of Northampton.
Sauropsis longimanus, calc. of Solenhofen.
„ mordax, oolite of Stonesfield.
Thrissops formosus, calc. of Kehlheim.
„ cephalus, calc. of Solenhofen.
„ micropodius (locality unknown).
„ intermedius, Upper Jura of Wethern.
„ salmoneus, calc. of Kehlheim and Solenhofen.
„ subovatus, calc. of Kehlheim and Solenhofen.
„ mesogastes, calc. of Solenhofen.
Leptolepis sprattiformis, schists of Pappenheim and Solenhofen.
„ Voithii, calc. of Kehlheim.
„ crassus, calc. of Solenhofen.
„ macrolepidotus, calc of Solenhofen.
„ polyspondylus, calc. of Solenhofen.
„ Knozzii, calc. of Solenhofen.
„ dubius, calc. of Solenhofen.
„ contractus, calc. of Solenhofen.
„ latus, calc. of Eichstadt.
„ paucispondylus, calc. of Kehlheim.
„ pusillus, calc. of Kehlheim.
„ macrophthalmus, Oxford clay of Chippenham.
Aspidorhynchus acutirostris, calc. of Solenhofen.
„ speciosus, calc. of Kehlheim.
„ ornatissimus, calc. of Kehlheim.
„ mandibularis, calc. of Eichstadt.
„ lepturus, calc. of Kehlheim.
„ euodus, Oxford clay of Chippenham.
Belonostomus sphyræoïdes. calc. of Solenhofen.
„ Munsteri, lithographic-stone of Bavaria.
„ tenuirostris, calc. of Solenhofen.
„ subulatus, calc. of Solenhofen.
„ ventralis, calc. of Solenhofen.
„ Kochii, calc. of Kehlheim.
„ leptosteus, oolite of Stonesfield.
„ brachysomus, calc. of Solenhofen.
Megalurus lepidotus, calc. of Solenhofen.
„ brevicostatus, calc. of Kehlheim.
„ elongatus, calc. of Kehlheim.
„ parvus, calc. of Kehlheim.
Macrosemius rostratus, calc. of Solenhofen.
„ brevirostris, oolite of Stonesfield.

VI. Chalk Formation.

Caturus, chalk of Kent and Lewes.
Aspidorhynchus Comptoni, South America.
Belonostomus cinctus, Lewes.

Family of Cœlocanths.

I. Devonian, or Old Red Formation.

Holoptychius giganteus, Elgin, Clashbennie, Gamrie, Glammis.
„ Flemingii, Dura-den, St Petersburg.
„ nobilissimus, Elgin, Clashbennie, Printscha.
„ Andersoni, Dura-den.
„ Murchisoni, Clashbennie.
„ Osmaliusii, Liege, Namur, Eifel.
Actinolepis tuberculatus, Elgin, St Petersburg.
Platygnathus Jamesoni, Dura-den, St Petersburg.
„ paucidens, Pomona in Orkney.
Glyptosteus favosus, Clashbennie, Elgin, St Petersburg, Ladoga, &c.
„ reticulatus, ornatus, Elgin, Nairn, Ladoga, &c.
Phyllolepis concentricus, Clashbennie.
Glyptolepis leptopterus, Elgin, Lethen-bar, St Petersburg.
„ microlepidotus, Lethen-bar.
„ elegans, Gamrie.
Dendrodus latus, Findhorn in Moray, Riga.
„ strigatus, Elgin, Riga, St Petersburg.
„ sigmoides, Elgin, St Petersburg.
„ tenuistriatus, St Petersburg.
„ minor, Megra.
Lamnodus biporcatus, Elgin, Riga, Cremona, St Petersburg.
„ Panderi, Elgin, Riga, Cremona, St Petersburg.
„ sulcatus, Elgin.
Cricodus incurvus, Elgin, Riga.
Asterolepis Asmusii, Riga, Megra.
„ ornata, Riga, Megra.
„ speciosa, Voronèle.
Asterolepis minor, Elgin, Riga, St Petersburg, Caithness, Orkney.
„ granulata, Riga.
„ Hœninghausii, Eifel.
„ Malcomsoni, Riga.
„ apicalis, Riga.
Psammosteus meandrinus, Ladoga.
„ paradoxus, Riga.
„ arenatus, Riga.
„ undulatus, Riga.

Ganoïds. Pycnodonts.

II. Coal Formation.

Holoptychius Hibberti, Burdiehouse.
„ sauroïdes, Burdiehouse.
„ falcatus, Greenside by Glasgow.
„ Portlockii, Ireland.
„ Garneri, Lanesfield.
„ granulatus, Manchester.
„ striatus, Great Millston near Edinburgh.
„ minor, North Stafford.
Cœlacanthus Phillipsii, Halifax.
„ lepturus, Leeds. Manchester.
„ Munsteri, Lebach in Bavaria.
Phyllolepis tenuissimus, Burdiehouse.
Hoplopygus Binneyi, Manchester.
Uronemus lobatus, Burdiehouse.

III.—Zechstein Formation.

Cœlacanthus granulatus, magnes. calc. of Durham, E. Tricksey.
„ gracilis, England.

IV.—Trias Formation.

Cœlacanthus minor, muschelkalk of Lunéville.

V.—Jurassic and Oolite Formation.

Undina striolaris, lithographic-stone of Bavaria.
„ Kohleri, lithographic-stone of Bavaria.
Ctenolepis cyclus, oolite of Stonesfield.
Gyrosteus mirabilis, lias of Whitby and Lyme Regis.

VI.—Chalk Formation.

Macropoma Mantelli, chalk of Lewes, Sussex, Cambridge, Chirnay.
„ Egertoni, gault of Specton.

Family of Pycnodonts.

I.—Zechstein Formation.

Globulodus elegans, Zechstein of Germany.

II.—Trias Formation.

Pycnodus priscus, Keuper, Tubingen-Wurtemberg.
Sphærodus annularis, Keuper, Tubingen-Wurtemberg.
„ minimus, coprolite-breccia of Tubingen-Wurtemberg.
Placodus gigas, muschelkalk of Bamberg, Lunéville.
„ Andriani, muschelkalk of Bamberg, Lunéville.
„ Munsteri, muschelkalk of Bamberg in Bavaria, and of Esperstadt in Thuringia.
„ rostratus, muschelkalk of Laineck.
„ impressus, variegated sandstone of Deux-Ponts.
Colobodus Hogardi, muschelkalk of Lunéville.

III.—Jurassic Formation.

c. Lias.

Sphærodus microdon, Lyme Regis.

b. Jura Proper.

Pycnodus rhombus, Torre d'Orlando.
„ gigas, Portland-stone of Switzerland and Germany.
„ Nicoleti, Portland-stone of Neufchâtel.
„ Bucklandi, calc. of Stonesfield.
„ didymus, calc. of Stonesfield.
„ rugulosus, sandy oolite of Northamptonshire.
„ umbonatus, forest marble.
„ ovalis, Stonesfield slate.
„ Hugii, Portland-stone of Soleure.
„ Mantelli, forest marble of Tilgate.
„ latirostris, oolite of Stonesfield.
„ obtusus, oolite of Stonesfield.
„ parvus, oolite of Stonesfield.
„ tristychius, oolite of Stonesfield.
„ biserialis, oolite of Little Gibraltar near Bedford.
„ trigonus, oolite of Stonesfield.

Ganoïds. Pycnodonts.

Pycnodus latiuens, Portland-stone of Soleure.
„ discoides, oolite of Little Gibraltar near Bedford.
„ gracilis, coral-rag of Hildesheim and Lindenberg, Hanover.
„ minutus, coral-rag of Hildesheim and Lindenberg, Hanover.
Gyronchus oblongus, calc. of Stonesfield.
Scrobodus subovatus, lithographic-stone of Solenhofen.
Microdon elegans, calc. of Solenhofen.
„ hexagonus, calc. of Solenhofen.
„ analis, calc. of Solenhofen.
„ radiatus, calc. of Purbeck.
„ abdominalis, calc. of Solenhofen.
„ platurus, calc. of Solenhofen.
Sphærodus gigas, Kimmeridge clay.
„ minor, Stonesfield clay.
Gyrodus macrophthalmus, calc. of Kehlheim.
„ frontatus, calc. of Kehlheim.
„ rugosus, calc. of Kehlheim.
„ umbilicus, oolite of Durrheim in Germany.
„ Jurassicus, Portland-stone of Soleure.
„ Cuvieri, Boulogne, Weymouth.
„ punctatus, oolite of Malten.
„ trigonus, calc. of Stonesfield.
„ radiatus, calc. of Caen.
„ Mantelli, calc. of Tilgate.
„ gracilis, calc. of Kehlheim.
„ analis, calc. of Kehlheim.
„ circularis, calc. of Solenhofen.
„ platurus, calc. of Solenhofen.
„ punctatissimus, calc. of Kehlheim.
„ rhomboidalis, calc of Kehlheim.
„ macropterus, calc. of Kehlheim.
„ perlatus, calc. of Stonesfield.
„ gibbosus, calc. of Kehlheim.

IV.—Chalk Formation.

Pycnodus Münsteri, greensand of Ratisbon.
„ complanatus, greensand of Ratisbon.
„ subclavatus, chalk of Maestricht.
„ cretaceus, chalk of Kent.
„ angustus, chalk of Kent.
„ elongatus, chalk of Lewes.
„ depressus, greensand of Ghent and Ratisbon.
„ marginalis, chalk of Kent.
„ Couloni, yellowstone of Neufchâtel.
„ minor, Speeton clay.
Acrotemnus faba, chalk of Kent.
Sphærodus crassus, chalk of Maestricht.
„ mitrula, greensand of Ratisbon.
„ Neocomensis, yellowstone of Neufchâtel.
Gyrodus cretaceus, chalk of Lewes.
„ angustus, chalk of Maidstone.
„ rugulosus, greensand of Ratisbon.
„ Münsteri, greensand of Ratisbon.
„ minor, Speeton clay.
„ mammillaris, chalk of Kent.

V. Limestone of Monte Bolca.

Pycnodus platessus, Monte Bolca.
„ orbicularis, Monte Bolca.

VI.—Tertiary Formation.

Pycnodus toliapicus, London clay of Sheppy.
Periodus Köningii, London clay of Sheppy.
Sphærodus lens, tertiary beds of Osnabruck.
„ irregularis, tertiary beds of Plienengen.
„ parvus, tertiary beds of Cassel.
„ cinctus, calc. grossier of Styria.
„ truncatus, tertiary beds of Osnabruck.
Gyrodus lævior, London clay of Sheppy.
Phyllodus toliapicus, London clay of Sheppy.
„ planus, London clay of Sheppy.
„ polyodus, London clay of Sheppy.
„ marginalis, London clay of Sheppy.
„ irregularis, London clay of Sheppy.
„ medius, London clay of Sheppy.
Pisodus Owenii, London clay of Sheppy.

Species of which the Geological Position is Doubtful.

Sphærodus depressus, Salzburg.
„ discus, Algarves in Portugal.
Sphærodus conicus, Ceylon.
„ oculus serpentis, Algarves.
Gyrodus runcinatus, (?)

Placoïds.

Family of Scleroderms.

I.—Chalk Formation.

Acanthoderma ovale, Glaris.
„ spinosum, Glaris.
Acanthopleurus serratus, Glaris.
„ brevis, Glaris.
Dercetis elongatus, Lewes.
„ scutatus, Westphalia.

II.—Limestone of Monte Bolca.

Blochius longirostris, Monte Bolca.
Rhinellus nasalis, Monte Bolca.
Ostracion micrurus, Monte Bolca.

III.—Tertiary Formation.

Glyptocephalus radiatus, London clay of Sheppy.

Doubtful.

Rhinellus furcatus, Mount Lebanon.

Family of Gymnodonts.

Diodon tenuispinus, Monte Bolca.
„ Scillæ, Monte Bolca (?)
„ Erinaceus, Monte Bolca (?)

Family of Lophabranchiates.

Calomostoma breviusculum, Monte Bolca.
Syngnathus opisthopterus, Monte Bolca.

Family of Acipenserids.

Acipenser toliapicus, London clay of Sheppy.
Chondrosteus acipenseroides, lias of Lyme Regis.

Order II.—PLACOÏDS.

I.—Silurian Formation.

Onchus, Murchisoni, Ludlow.
„ tenuistratus, Ludlow.

II.—Devonian Formation.

Onchus arcuatus, Bromyard.
„ semistriatus, Southstone rock.
Ctenacanthus ornatus, Wales.
„ serratulus, Kohlhusen.
Ptychacanthus dubius, Abergavenny.
Ctenoptychius crenatus, Meaga, Russia.
„ priscus, Scotland.

III.—Coal Formation.

Oracanthus Milleri, calc.-carbon of Bristol.
„ frustulosus, calc.-carbon of Bristol.
„ minor, calc.-carbon of Bristol.
„ confluens, calc.-carbon of Armagh.
Onchus sulcatus, calc.-carbon of Bristol.
„ hamatus, calc.-carbon of Bristol.
„ rectus, calc.-carbon of Armagh.
„ plicatus, calc.-carbon of Armagh.
„ falcatus, calc.-carbon of Armagh.
„ subulatus, coal, Rhuabon, Wales.
Clenacanthus major, calc.-carbon of Bristol.
„ tenuistratus, calc.-carbon of Bristol.
„ brevis, calc.-carbon of Bristol.
„ heterogyrus, calc.-carbon of Armagh.
„ arculatus, calc.-carbon of Armagh.
„ crenulatus, calc.-carbon of Armagh.
Gyracanthus formosus, calc.-carbon. of Burdiehouse, Newcastle, Sunderland, Alnwick, Burntisland.
„ tuberculatus, Sunderland.
„ Alnwicensis, Alnwick Castle.
„ ornatus, coal schists of Wales.
Sphenacathus serratulus, Burdiehouse.
Tristychius arenatus, Greenside near Glasgow.
Orodus cinctus, calc.-carbon of Bristol.
„ ramosus, calc.-carbon of Bristol.
Ctenoptychius apicalis, coal schists Stafford, Manchester.
„ pectinatus, Burdiehouse, Manchester.
„ denticulatus, Burdiehouse, Manchester.
„ cuspidatus, coal of Glasgow.

Placoïds.

Ctenoptychius dentatus, calc.-carbon of Armagh.
„ serratus, calc.-carbon of Armagh.
„ macrodus, calc.-carbon of Armagh.
„ crenatus, coal, Carluke.
Helodus simplex, coal schists of Stafford, Coalbrookedale.
„ lævissimus, calc.-carbon of Bristol.
„ subteres, calc.-carbon of Bristol.
„ gibberulus, calc.-carbon of Bristol.
„ turgidus, calc.-carbon of Bristol.
„ mitratus, coal, Carluke.
„ didymus, calc.-carbon of Armagh.
„ mammillaris, calc.-carbon of Armagh.
„ planus, calc.-carbon of Armagh.
Chomatodus truncatus, calc.-carbon of Armagh.
„ cinctus, calc.-carbon of Bristol.
„ linearis, calc.-carbon of Bristol.
Psammodus rugosus, calc.-carbon of Bristol, Esky, Geroldstein.
„ porosus, calc.-carbon of Bristol.
„ cornutus, calc.-carbon of Bristol.
Cochliodus contortus, calc.-carbon of Bristol, Armagh, Clifton.
„ magnus, calc.-carbon of Armagh.
„ oblongus, calc.-carbon of Armagh.
„ acutus, calc.-carbon of Armagh.
„ striatus, calc.-carbon of Armagh.
Pœcilodus Jonesii, calc.-carbon of Armagh.
„ parallelus, calc.-carbon of Armagh.
„ transversus, calc.-carbon of Armagh.
„ obliquus, calc.-carbon of Armagh, Carluke.
„ sublævis, calc.-carbon of Armagh.
„ angustus, coal, Carluke.
Pleurodus affinis, coal schist, Rhuabon, Carluke.
„ Rankinei, coal, Carluke.
Ctenodus cristatus, coal, Tong.
„ Robertsoni, Burdiehouse.
„ alatus, calc. of Ardwick.
Petalodus acuminatus, calc.-carbon of Durham, Yorkshire, Glasgow.
„ Hastingsiæ, calc.-carbon of Armagh.
„ psittacinus, calc.-carbon of Armagh.
„ lævissimus, calc.-carbon of Armagh.
„ rectus, calc.-carbon of Armagh.
„ radicans, calc.-carbon of Armagh.
„ marginalis, calc.-carbon of Armagh.
„ sagittatus, calc.-carbon of Armagh.
Cladodus mirabilis, calc.-carbon of Armagh.
„ striatus, calc.-carbon of Armagh.
„ marginatus, calc.-carbon of Armagh.
„ Milleri, calc.-carbon of Bristol.
„ conicus, calc.-carbon of Bristol.
„ acutus, calc.-carbon of Laughgal.
„ Hibberti, Burdiehouse.
„ parvus, Burdiehouse.
Diplodus gibbosus, coal, Carluke.
„ minutus, Burdiehouse.
Carcharopsis prototypus, calc.-carbon of Yorkshire, Armagh.

IV.—Zechstein Formation.

Gyropristis obliquus, magn. limest. of Belfast.
Hybodus major, muschelkalk of Lunéville, Bareuth, Breslau.
„ tenuis, muschelkalk of Lunéville, Bareuth.
„ dimidiatus, muschelkalk of Lunéville.
„ minor, bonebed of Bristol.
Leiacanthus falcatus, muschelkalk of Lunéville, Bareuth.
Nemacanthus monilifer, bonebed of Westbury.
„ filifer, bonebed of Westbury.
„ granulosus, muschelkalk of Leinech.
„ senticosus, muschelkalk of Leinech.
Hybodus plicatilis, muschelkalk of Schwenningen, Tübingen, Tarnowitz, Lunéville.
„ Mougeoti, muschelkalk of Schwenningen, Lunéville.
„ angustus, muschelkalk of Lunéville.
„ longiconus, muschelkalk of Lunéville, Gisemont.
„ obliquus, muschelkalk of Voges.
„ polycyphus, muschelkalk of Lunéville.
„ minor, bonebed of Bristol.
„ cuspidatus, Keuper, Tübingen, Rietheim.
„ sublævis, Keuper, Tübingen.
„ apicalis, Keuper, Hildesheim.
Strophodus angustissimus, muschelkalk of Lunéville, Wilhelmshall.
„ elytra, variegated sandstone of Deux Ponts, Lunéville.
Acrodus Gaillardoti, muschelkalk of Lunéville, Bareuth, Wilhelmshall.
„ lateralis, muschelkalk of Lunéville.
„ Braunii, variegated sandstone of Deux Ponts.
Acrodus minimus, bonebed of Aust Cliff, Lyme Regis.
„ acutus, sandstone of Tübingen.

Placoïds.

Ceratodus heteromorphus, muschelkalk of Wilhelmshall, Lunéville.
„ serratus, Keuper, Argovia.
„ latissimus, bonebed of Aust Cliff.
„ curvus, bonebed of Aust Cliff.
„ planus, bonebed of Aust Cliff.
„ parvus, bonebed of Aust Cliff.
„ emarginatus, bonebed of Aust Cliff.
„ gibbus, bonebed of Aust Cliff.
„ Dædaleus, bonebed of Aust Cliff.
„ altus, bonebed of Aust Cliff.
„ disauris, bonebed of Aust Cliff.

V.—Jurassic Formations.

a. Lias.

Leptacanthus tenuispinus, Lyme Regis.
Myriacanthus paradoxus, Lyme Regis.
„ retrorsus, Lyme Regis.
„ granulatus, Lyme Regis.
Asteracanthus Stutchburgi, Charmouth.
Hybodus curtus, Lyme Regis, Keynsham, Wurtemburg.
„ crassispinus, Lyme Regis.
„ reticulatus, Lyme Regis.
„ formosus, Lyme Regis.
„ ensatus, Lyme Regis.
„ lævisculus, Bristol.
Acrodus nobilis, Lyme Regis.
„ latus, Lyme Regis.
„ gibberulus, Lyme Regis.
„ undulatus, Lyme Regis.
„ Anningiæ, Lyme Regis.
Hybodus reticulatus, Lyme Regis.
„ pyramidalis, Lyme Regis.
„ medius, Lyme Regis.
Sphenonchus hamatus, Lyme Regis.
Thyellina prisca, Lyme Regis.
Anthropterus Rileyi, Bristol.
Squaloraja polyspondyla, Lyme Regis.
Cyclarthrus macropterus, Lyme Regis.
Ischyodon Johnsonii, Charmouth.

b. Inferior and Middle Jurassic.

Nemacanthus brevispinus, oolite of Stonesfield.
Leptacanthus longissimus, calc. of Caen.
„ semistriatus, Stonesfield.
„ serratus, Stonesfield.
Asteracanthus acutus, Bedford.
„ minor, England.
„ semisulcatus, Stonesfield, Purbeck (?)
Pristacanthus securis, Caen, Stonesfield.
Hybodus crassus, Towcester, Wasseralfigen.
„ apicalis, Stonesfield, Hastings.
„ dorsalis, Stonesfield, Hastings.
„ marginalis, Stonesfield, Tilgate.
„ leptodus, Oxford clay, Oxford.
„ pleiodus, Frame.
Ceratodus Phillipsii, oolite of Stonesfield.
Strophodus longidens, calc. of Caen.
„ magnus, Stonesfield, Dundry, Ranville.
„ tenuis, Stonesfield, Dundry.
„ irregularis, inf. oolite of Neuenburg.
„ radiato-punctatus, Kelloway.
„ favosus, Stonesfield.
Acrodus leiopteurus, oolite of Bath.
Hybodus grossiconus, Stonesfield, Caen.
„ polyprion, Stonesfield.
„ obtusus, oolite of Caen.
„ inflatus, oolite of Caen.
„ rariostatus, oolite (?)
Ischyodon Tessonii, Marne, Mont Vohayes, Pfallingen, Oxford.
„ emarginatus, Stonesfield.
Ganodus Colei, Stonesfield.
„ Owenii, Stonesfield.
„ rugulosus, Stonesfield.
„ neglectus, Stonesfield.
Psittacodon falcatus, Stonesfield.
„ psittacinus, Stonesfield.

c. Upper Jurassic.

Asteracanthus ornatissimus, Shotover, Soleure.
Hybodus striatulus, Hastings.

Placoïds.

Hybodus acutus, Shotover.
„ strictus, Portland.
„ subcarinatus, Tilgate.
Strophodus reticulatus, Oxford clay of Shotover.
„ subreticulatus, Portland stone of Soleure.
Acrodon hirude, Tilgate.
Hybodus dubius, Purbeck, Linkfield.
„ undulatus, Purbeck, Linkfield.
Sphenonchus elongatus, Tilgate.
„ Martini, Purbeck, Linkfield.
Aellopos elongatus, Kelheim.
„ Wagneri, Solenhofen.
Asterodermus platypterus, Solenhofen.
Euryarthra Munsteri, Solenhofen.
Notidanus Munsteri, Streitberg, Randen.
Oxyrhina paradoxa, Tilgate, Hildesheim, Rabenstein.
Lamna longidens, Rabenstein, Streitberg.
Ischyodon Egertoni, Kimmeridge clay of Shotover.
„ Bucklandi, Portland stone of Soleure.
„ Townsendii, Portland stone of Great Milton, Oxford.
„ Dutertai, Kimmeridge clay of Boulogne.
„ Dupenoyi, Kimmeridge clay of Boulogne.
„ Beaumontii, Kimmeridge clay of Boulogne.

VI.—Chalk Formation.

Ptychodus acutus, Lewes.
„ spectabilis, Lewes.
„ gibberulus, Lewes.
„ arcuatus, Lewes.
„ articulatus, Lewes.
„ mammillaris, England, Belgium, Belluno, Paris, Delaware.
„ decurrens, Lewes, Rouen, Bockum, Belluno, Ratisbon.
„ altior, Sussex.
„ polygyrus, Lewes, Quedlimburg.
„ latissimus, Lewes, Bockum, Bennatack, Belluno.
„ Mortoni, United States.
Hybodus sulcatus, Lewes.
Chimæra Mantellii, Lewes.
Spinax major, Lewes.
Acrodus rugosus, Maestricht.
„ transversus, Sussex.
Strophodus asper, Lewes.
„ punctatus, greensand of Kehlheim.
„ sulcatus, greensand of Maidstone.
Scylliodus antiquus, Kent.
Thyellina angusta, Baumberge near Munster.
Notidanus microdon, Sussex.
„ pectinatus, Sussex.
Corax pristodontus, calc. of Maestricht.
„ Kaupii, marl of Aix-la-Chapelle and Haldem.
„ falcatus, Kent, Sussex, Pl. Strehla, Quedlimburg.
„ appendiculatus, calc. of Maestricht, Salzgitter.
„ affinis, calc. of Maestricht.
Galeocerdo gibberulus, marl of Haldem.
„ denticulatus, calc. of Maestricht.
Sphyrna denticulata, Pl. Strehla.
Hemipristis serra (?) chalk of Ratisbon, Haldem.
Carcharias tenuis, greensand of Sentis.
„ acutus, marl of Bockum.
Odontus appendicutus, chalk of Sussex, Normandy, Delaware.
„ latus, Maestricht.
„ crassus, greensand of Ratisbon, Kehlheim.
„ semiplicatus, Quedlimburg, Pl. Strehla.
„ serratus, Maestricht.
Oxyrhina Mantellii, chalk of Kent and Sussex.
„ subinflata, greensand of Bohemia, Perte-du-Rhone.
„ Zippei, greensand of Ratisbon.
Lamna acuminata, chalk of Kent, Sussex, Yorkshire, Aix-la-Chapelle, Strehla.
„ gracilis, calc of Neufchâtel.
„ subulata, marl of Bognor, Quedlimburg, Ratisbon.
„ Rhaphidion, Lewes, Ratisbon.
„ Bronnii, calc. of Maestricht.
„ plana, chalk of Sentis.
Ischyodon Agassizii, greensand of Maidstone.
„ brevirostris, gault, England.
Psittacodon Mantellii, chalk of Kent.
„ Sedgwickii, Cambridge.

VII.—Tertiary Formation.

Ptychopleurus Faujasii, Paris.
Myliobates Brongniarti, Ghent.

Myliobates toliapicus, London clay of Sheppy.
„ Sternbergii, Brenta.
„ Owenii, London clay of Sheppy.
„ acutus, London clay of Sheppy.
„ canaliculatus, London clay of Sheppy.
„ lateralis, London clay of Sheppy.
„ marginalis, London clay of Sheppy.
Zygobates Studeri, molasse of Switzerland.
„ Woodwardii, crag of Norfolk.
Galeus Cuvieri, Monte Bolca.
Notidanus serratissimus, London clay of Sheppy.
„ primigenus, molasse of Switzerland.
Corax Egertoni, Maryland.
Galeocerdo aduncus, molasse of Switzerland.
„ minor, molasse of Switzerland.
Hemipristis serra, molasse of Switzerland and Suabia.
Glyphis hastalis, London clay.
Carcharodon megalodon, molasse of Dax, crag in Maryland.
„ rectidens, Noyant.
„ productus, Malta, Alzey, Apt.
„ polygyrus, molasse of Switzerland, Maryland.
„ sulcidens, Castell-Arquato, Soissons.
„ auriculatus, Dax.
„ angustidens, Kressenberg.
„ turgidus, Floxheim.
„ lanceolatus, Kressenberg.
„ toliapicus, Sheppy.
„ megalotis, Maryland.
„ disauris, Ghent.
„ subserratus, London clay.
„ Escheri, molasse, Kressenberg.
Otodus obliquus, London clay of Sheppy, Sussex.
„ lanceolatus, Kressenberg.
„ macrotus, Sheppy, calc. grossier of Véteuil.
„ tricuspis, Wilhelmshöle.
„ subplicatus, Bünde.
„ trigonatus, Kressenberg.
„ apiculatus, Véteuil.
Oxyrhina hastalis, molasse.
„ xiphodon, Paris, Dax.
„ trigonodon, Valley of the Rhine.
„ plicatilis, Castell-Arquato.
„ quadrans, molasse, Valley of Rhine.
„ leptodon, Worentop, Flenheim.
„ Desorii, molasse of Wurtemburg, Osnabrück, Bünde.
„ crassa, Valley of the Rhine.
„ minuta, Osnabrück.
Lamna elegans, Sheppy, Paris, Grignon, Dax, Bordeaux, Italy.
„ cuspidata, molasse of Valley of Rhine.
„ compressa, London clay, calc. of Chaumont.
„ denticulata, molasse of Switzerland, Valley of Rhine.
„ crassidens, pisiform iron ore of Maestricht.
„ Hopei, Sheppy.
„ verticalis, Sheppy.
„ contortidens, crag, Thiengen-molasse, Valley of Rhine.
„ dubia, molasse of Switzerland.
Ischyodon Helveticus, molasse of Switzerland, Olten.
Elasmodus Hunteri, Sheppy.
Psaliodus compressus, London clay.
Edaphodon Bucklandi, Bagshot sand.
„ leptognathus, Bagshot sand.
„ eurygnathus, London clay, Sussex.
Passalodon rostratus.
Trygon Gazzolæ, Monte Bolca.
„ oblongus, Monte Bolca.
Myliobates toliapicus, London clay.
„ goniophurus, London clay.
„ Dixoni, London clay.
„ striatus, London clay.
„ punctatus, London clay.
„ gyratus, London clay.
„ jugalis, London clay.
„ nitidus, London clay.
„ Colei, London clay.
„ heteropleurus, London clay.
„ Régleyi, Brussels.
„ angustus, Eckelsheim.
Aetobates irregularis, London clay of Sheppy, Sussex.
„ subarcuatus, London clay of Sheppy, Bartin.
„ arenatus, Swiss molasse.
Zygobates Studeri, Swiss molasse.
„ Woodwardii, crag of England.
Raja antiqua, crag.
„ ornata, Piacenza.

Ctenoïds.

VIII.—Uncertain Formations.

Ceratodus Kaupii.
Notidanus recurvus, tertiary (?)
Corax planus, chalk (?)
Galeocerdo latidens, tertiary (?)
Sphyrna prisca, chalk (?)
„ dubia, molasse (?)
„ lata (?)
Hemipristis pavidens, molasse (?)
Carcharodon subauriculatus, Maestricht (?)
„ semiserratus, Malta (?)
„ heterodon, Normandy (?)
„ leptodon, tertiary (?)
Otodus recticonus, Malta (?)
Oxyrhina retroflexa, tertiary (?)
Lamna acutissima, tertiary (?)
„ duplex, tertiary (?)
Ganodus curvidens (?)
Elasmodus Greenoughii (?)
Myliobates micropleurus (?)
„ Stokesii (?)
„ suturalis (?)
Aetobates sulcatus (?)

Order III.—Ctenoïds, arranged according to geological position.

I.—Chalk Formation.

Sphenocephalus fissicaudus, quaderstein of Westphalia.
Acrogaster parvus.
Hoptopteryx antiquus.
Beryx Zippei, flag-stone of Bohemia.
„ ornatus, chalk, Sussex.
„ radians, chalk, Sussex.
„ microcephalus, chalk, Sussex.
„ Germanus, quadersandstein of Westphalia.
Rhacolepis latus, chalk of Brazil.
„ buccalis, chalk of Brazil.
„ Olfersii, chalk of Brazil.

II.—Schists of Glaris.

Acanus ovalis.
„ Régleyi.
„ arcuatus.
„ oblongus.
„ minor.
Podocys minutus.
Fistularia Koenigii.

III.—Monte Bolca and Lebanon.

Pristigenys macrophthalmus, Monte Bolca.
Myripristis homopterygius, Monte Bolca.
Holocentum pygæum, Monte Bolca.
„ pigmæum, Monte Bolca.
Cyclopoma gigas, Monte Bolca.
„ spinosum, Monte Bolca.
Lates gracilis, Monte Bolca.
„ gibbus, Monte Bolca.
„ notœus, Monte Bolca.
Apogon spinosus, Monte Bolca.
Labrax lepidotus, Monte Bolca.
„ schizurus, Monte Bolca.
Smerdis miracanthus, Monte Bolca.
„ pygmæus, Monte Bolca.
Enoplosus pygopterus, Monte Bolca.
Dules temnopterus, Monte Bolca.
„ medius, Monte Bolca.
Pelates quinquedecimalis, Monte Bolca.
Serranna microstomus, Monte Bolca.
„ occipitalis, Monte Bolca.
„ ventralis, Monte Bolca.
Sparnodus macrophthalmus, Monte Bolca.
„ ovalis, Monte Bolca.
„ altivelis, Monte Bolca.
„ micracanthus, Monte Bolca.
„ elongatus, Monte Bolca.
Pagellus microdon, Monte Bolca.
„ leptosteus, Lebanon.
Dentex leptacanthus, Monte Bolca.
„ crassispinus, Monte Bolca.
„ breviceps, Monte Bolca.
„ microdon, Monte Bolca.
„ ventralis, Monte Bolca.
Pristepoma furcatum, Monte Bolca.
Odonteus sparoïdes, Monte Bolca.
Pterygocephalus paradoxus, Monte Bolca.
Callipteryx speciosus, Monte Bolca.
„ recticaudus, Monte Bolca.
Gobius macrurus, Monte Bolca.
„ microcephalus, Monte Bolca.
Acanthurus tenuis, Monte Bolca.
„ ovalis, Monte Bolca.
Naseus nuchalis, Monte Bolca.
„ rectifrons, Monte Bolca.
Semiophorus velifer, Monte Bolca.
„ velicans, Monte Bolca.
Ephippus longipennis, Monte Bolca.
„ oblongus, Monte Bolca.
Scatophagus frontalis, Monte Bolca.
Zanclus brevirostris, Monte Bolca.
Pomacanthus subarenatus, Monte Bolca.
Platax altissimus, Monte Bolca.
„ macropterygius, Monte Bolca.
„ papilio, Monte Bolca.
Pygæus gigas, Monte Bolca.
„ nobilis, Monte Bolca.
„ oblongus, Monte Bolca.
„ dorsalis, Monte Bolca.
„ nuchalis, Monte Bolca.
„ Coleanus, Monte Bolca.
„ Egertoni, Monte Bolca.
„ gibbus, Monte Bolca.
Toxotes antiquus, Monte Bolca.
Fistularia tenuirostris, Monte Bolca.
Aulostoma Bolcense, Monte Bolca.
Urosphen fistularis, Monte Bolca.
Amphisyle longirostris, Monte Bolca.
Rhamphosus aculeatus, Monte Bolca.
Rhombus minimus, Monte Bolca.

IV.—Tertiary Formation.

Lates macrurus, calc. grossier of Sèvres.
Labrax major, calc. grossier of Passy.
Smerdis ventralis, gyps. of Montmartre.
„ macrurus, lignite of Apt.
„ minutus, gyps. of Aix in Provence.
Perca lepidota, fresh-water calc. of Oeningen.
„ angusta, lignite of Ménat.
„ Beaumontii, gyps. of Aix in Provence.
Dentex Faujasii, calc. grossier, Nanterre.
Sargus Cuvieri, gyps. of Montmartre.
Cottus brevis, fresh-water calc. of Oeningen.
„ aries, gyps. of Aix, Provence.
„ papyraceus, lignite of Monte-Viale, in Vicentine.
Macrostoma altum, calc. grossier of Nanterre.
Holacanthus microcephalus, calc. grossier of Châtillon.
Platax Woodwardi, crag of Suffolk.
Sciænurus Bowerbankii, London clay of Sheppy.
„ crassior, London clay of Sheppy.
Mugil princeps, gyps. of Aix in Provence.

V.—Formation Unknown.

Smerdis latior (?)

Order IV.—Cycloïds arranged according to geological position.

Cycloïds.

I.—Chalk Formation.

Enchodus halocyon, chalk of Lewes.
„ Faujasii, chalk of Maestricht.
Istieus grandis, greensand of Westphalia.
„ macrocephalus, greensand of Westphalia.
„ microcephalus, greensand of Westphalia.
„ gracilis, greensand of Westphalia.
Osmerus Cordieri, greensand of Ibbenbusen.
Osmeroides Monasterii, greensand of Ringenrode, near Munster.
„ Lewesiensis, chalk of Lewes.
„ granulatus, chalk of Lewes.
Acrognathus boöps, chalk of Lewes.
Aulolepis typus, chalk of Lewes.
Tetrapterus minor, chalk of Lewes.
Hypsodon Lewesiensis, chalk of Lewes.
Saurocephalus lanciformis, chalk of New Jersey.
„ striatus, chalk of England.
Saurodon Leanus, chalk of Lewes.

Cycloïds.

Cladocyclus Lewesiensis, chalk of Lewes.
„ Gardneri, chalk of Brazil.
Calamopleurus cylindricus, chalk of Brazil.
Halec Sternbergii, flagstone of Bohemia.

II.—Schists of Glaris.

Palæorhynchum longirostre.
„ Egertoni.
„ Glarisianum.
„ latum.
„ medium.
„ Colei.
„ microspondylum.
Palimphyes longus.
„ brevis.
„ latus.
Archæus Glarisianus.
„ brevis.
Isurus macrurus.
Pleionemus macrospondylus.
Elopides Couloni.
Anenchelum Glarisianum.
„ isopleurum.
„ dorsale.
„ heteropleurum.
„ latum.
„ longipenne.
Neompteryx crassus.
„ elongatus.
Osmerus Glarisianus.
Clupea brevis.
„ megaptera.
„ Scheuchzeri.
Uropteryx elongatus.
Microspondylus Escheri.

III.—Monte Bolca and Lebanon.

Gasteronemus rhombeus, Monte Bolca.
„ oblongus, Monte Bolca.
Acanthonemus filamentosus, Monte Bolca.
Vomer longispinus, Monte Bolca.
Lichia prisca, Monte Bolca.
Trachinotus tenuiceps, Monte Bolca.
Vomer parvulus, Lebanon.
Carangopsis latior, Monte Bolca.
„ dorsalis, Monte Bolca.
„ analis, Monte Bolca.
„ maximus, Monte Bolca.
Amphistium paradoxum, Monte Bolca.
Ductor leptosomus, Monte Bolca.
Thynnus propterygius, Monte Bolca.
„ Bolcensis, Monte Bolca.
Orcynus lanceolatus, Monte Bolca.
„ latior, Monte Bolca.
Cybium speciosum, Monte Bolca.
Xiphopterus falcatus, Monte Bolca.
Holosteus esocinus, Monte Bolca.
Engraulis evolans, Monte Bolca.
Sphyræna Bolcensis, Monte Bolca.
„ gracilis, Monte Bolca.
„ Amici, Monte Bolca.
„ maxima, Monte Bolca.
Rhamphognathus paralepoides, Monte Bolca.
Mesogaster sphyrænoides, Monte Bolca.
Spinacanthus blennioides, Monte Bolca.
Labrus Valenciennesii, Monte Bolca.
Lophius brachysomus, Monte Bolca.
Atherina macrocephala, Monte Bolca.
„ minutissima, Monte Bolca.
Clupea macropoma, Monte Bolca.
„ dentex, Murazzo Struttiano.
„ Beurardi, Lebanon, Acre.
„ brevissima, schist of Lebanon.
„ lata, schist of Lebanon.
„ tenuissima, Radusa and Mondrino near Rimini.
„ minima, schist of Lebanon.
„ leptostea, Monte Bolca.
„ catopterygia, Monte Bolca.
„ minuta, Monte Bolca.
Platinx elongatus, Monte Bolca.
„ gigas, Monte Bolca.
Cælogaster analis, Monte Bolca.
Clupeina macrocephala, Monte Bolca.
Anguilla latispina, Monte Bolca.
„ ventralis, Monte Bolca.
„ brevicula, Monte Bolca.
„ branchiostegalis, Monte Bolca.
„ interspinalis, Monte Bolca.
„ leptoptera, Monte Bolca.
Enchelyopus tigrinus, Monte Bolca.
Sphagebranchus formosissimus, Monte Bolca.
Ophiurus acuticaudus, Monte Bolca.
Leptocephalus tænia, Monte Bolca.
„ gracilis, Monte Bolca.
„ medius, Monte Bolca.

Cycloïds.

IV.—Tertiary Formation.

Acanthopsis angustus, fresh-water limestone of Oeningen.
Cobites centrochir, fresh-water limestone of Oeningen.
„ cephalotes, fresh-water limestone of Oeningen.
Gobio analis, fresh-water limestone of Oeningen.
Tinca furcata, fresh-water limestone of Oeningen.
„ leptosoma, fresh-water limestone of Oeningen.
„ micropygoptera, fresh-water limestone of Steinheim.
Leuciscus Oeningensis, fresh-water limestone of Oeningen.
„ latiusculus, fresh-water limestone of Oeningen.
„ pusillus, fresh-water limestone of Oeningen.
„ heterurus, fresh-water limestone of Oeningen.
„ leptus, tripoli of Siebengebirge.
„ macrurus, lignite of Bonn and Stochen.
„ papyraceus, lignite of Bilin.
„ cephalon, lignite.
„ Hartmanni, calc. tert. of Steinheim.
„ gracilis, calc. of Steinheim.
„ brevis, (?)
Aspius gracilis, fresh-water calc. of Oeningen.
„ Brongniarti, lignite of Ménat.
Rhodeus elongatus, fresh-water calc. of Oeningen.
„ latior, fresh-water calc. of Oeningen.
Cyclurus Valenciennesi, lignite of Ménat.
„ minor, fresh-water calc. of Oeningen.
Lebiras cephalotes, tertiaries of Aix, Provence.
„ gobio, lignite of Sensen, Fichtelgebirge.
„ Meyeri, near Frankfort.
„ crassicaudus, clay of Pezaros, marl of Gesso, St Angelo.
„ perpusillus, fresh-water calc. of Oeningen.
Esox Otto, diluvial marl of Silesia.
„ lepidotus, fresh-water calc. of Oeningen.
Sphenolepis squamosus, Aix in Provence.
„ Cuvieri, plaster quarries of Montmartre.
Mallotus villosus, coast of Iceland.
Alosa elongata, tripoli of Oran.
Cœlocephalus salmoneus, London clay of Sheppy.
Megalops priscus, London clay of Sheppy.
Notœus laticaudus, gyps. of Montmartre.
Halecopsis lævis, London clay of Sheppy.
Clupea Goldfussii, environs of Bingen.
Anguilla multiradiata, calc. of Aix.
„ pachyura, fresh-water calc. of Oeningen.
Labrus Ibbetsoni, Swiss molasse.
Acanthonemus Bertrandi, Schio in Vincentine.
Zeus priscus, ?
Hemirhynchus Des Hayes, calc. grossier of Paris.
Cybium macropoma, London clay of Sheppy.
Goniognathus coryphœnoides, London clay of Sheppy.
„ maxillaris, London clay of Sheppy.
Tetropterus priscus, London clay of Sheppy.
Cœlorhynchus rectus, London clay of Sheppy.
„ sinuatus, London clay of Sheppy.
Sphyrænodus priscus, London clay of Sheppy.
„ crassidens, London clay of Sheppy.
Hypsodon toliapicus, London clay of Sheppy.
„ oblongus, London clay of Sheppy.
Cœlopoma Colei, London clay of Sheppy.
„ lævе, London clay of Sheppy.
Brachygnathus tenuiceps, London clay of Sheppy.
Rhynchorinus branchialis, London clay of Sheppy.
Pachycephalus cristatus, London clay of Sheppy.
Podocephalus nitidus, London clay of Sheppy.
Bothrosteus latus, London clay of Sheppy.
„ brevifrons, London clay of Sheppy.
Rhinocephalus planiceps, London clay of Sheppy.
Ampheristus toliapicus, London clay of Sheppy.
Ptychocephalus radiatus, London clay of Sheppy.

(T. S. T.)

ICONIUM, a town of Asia Minor, formerly the capital of Lycaonia, as it is now, by the name of Konieh, of Karamania, in Asia Minor. It lay at the foot of Mount Taurus, on the shores of the Lake Trogitis, about 120 miles inland from the Mediterranean. Till about the beginning of the Christian era, it was aplace of little interest or importance; but by the time of Pliny, it had become large and populous, and its territory formed a tetrarchy, embracing fourteen cities, some of them of considerable size. It was visited by St. Paul in A.D. 45, and again in A.D. 51. The church planted by the apostle continued to flourish, until, by the persecutions of the Saracens, and afterwards of the Seljukians, it was nearly extinguished. Under the empire, Iconium claimed, though on no good grounds, to be regarded as a Roman colony. At a later period it was wrested from the Emperors of the East, first by the Saracens and afterwards by the Turks. The adjacent provinces, which at this time fell into the hands of that people, were constituted into a kingdom, of which Iconium was made the capital. The kings took the title of Sultans of Iconium. But it was in the time of the crusades that the city reached the culminating point of its glory. See KONIEH.

ICONOCLASTS, a term which came into use in the eighth century, and signifies breakers of images. There existed at that time a fierce controversy between the Eastern and Western Churches about the lawfulness of using images in churches. Leo the Isaurian received the epithet of Iconoclast from passing an edict (A.D. 726) for the violent destruction of images. The disturbances to which the execution of this law gave rise settled down into a civil war which ultimately extended to Asia and Italy. In 730 Germanus, Patriarch of Constantinople, was degraded for his partiality to images by the council assembled by Leo. All the images, except that of the crucifixion, were ordered to be burned, and those who worshipped them to be punished. Copronymus, also called the Iconoclast, got an act passed condemnatory of images at the council which assembled in 754. Leo IV., who became Emperor in 775, had recourse to penal measures against image worshippers; but he was poisoned in 780 by his wife Irene, who mounted the throne, and at the second Nicene Council (A.D. 786) not only procured the revocation of all the previous edicts against images, but issued decrees against all who should maintain that God was the sole object of adoration. The tide, however, was turned by Leo the Armenian, in 814, and the same policy was pursued by his successors, Michael and Theophilus. But in 842 Theodora procured the reenactment of the edicts which had been passed by Irene in favour of idolatry.

The Iconoclasts in the beginning of the eighth century were zealously opposed by the Pontiffs Gregory I. and II. Hence as there were *Iconoclastæ* or *Iconomachi*, those who broke or opposed images, so there were *Iconoduli* and *Iconolatræ*, or those who offered adoration to images. The question finally produced a schism between the churches of the East and the West. The Latins held that images might be allowed to aid the memory, and the Eastern Church allowed pictures for the same purpose. The Latins, however, soon proceeded to increase their veneration for the images of saints, till at last they worshipped them. In 823 Claudius, Bishop of Turin, cast all the images, and even the cross, out of the churches. The Albigenses and Waldenses disapproved of image worship. Charlemagne engaged in the controversy, and four books which he published against the worship of images were approved of by the council of 300 bishops assembled at Frankfort-on-the-Maine in 794.

ICTINUS, a celebrated Greek architect, who flourished in the fifth century B.C. He was the contemporary of Pericles, under whose administration he planned, and built the famous Parthenon at Athens. This temple, which was of the Doric order, was completed in B.C. 438, seven years before the breaking out of the Peloponnesian War. To Ictinus was due the hardly less famous and splendid temple of Apollo Epicurius, at Phigalia in Arcadia, and the shrine of Eleusis, in which the mystic rites of Ceres were celebrated. None of the details of Ictinus' personal history are known.

IDA, in ancient geography, a mountain, or rather a mountain range of Asia Minor, an offshoot of the great Taurus range. It intersects the whole of Mysia, and some of its peaks attain a very considerable elevation. Gargarus, the highest, is about 4700 feet above the level of the sea; while Cotylus, the next in height, is about 3500. The other peaks, Dicte and Pytna, are considerably lower. A spur of the principal Idæan range, enclosing Troy in a kind of semicircle, formed the Troad. The whole range is described by the ancients as covered with woods which harboured great numbers of wild beasts; and as giving birth to a large number of small but famous streams, such as the Esepus, Granicus, Simois, Scamander, and Caresus.

There was another mountain of this same name in Crete. It was the highest peak of the range that traverses the whole island, and is now called Psiloriti. It is with the Cretan Ida that the legends of the early life of Jupiter are associated; and the Dactyli Idæi, the earliest workers in metals, are sometimes referred to this Ida, and sometimes to its Mysian namesake. See DACTYLI IDÆI.

IDEALISM is that scheme in philosophy, which, carried to its legitimate results as was done by Bishop Berkeley, regards all external phenomena as having no existence apart from a thinking subject. See METAPHYSICS.

IDES (Lat. *Idus*). See CALENDAR.

IDOLATRY. Traces of the existence of idolatry are found in the oldest books which we possess, *e.g.*, the Pentateuch and Job. It has been supposed that idolatry was conveyed from Egypt to India in the seventeenth century B.C., and in a modified form from India to the northern parts of Europe in the sixth century B.C. Idolatrous worship extended to all beings in heaven and earth, animate or inanimate, visible or invisible, and also the representations or images of these made by men themselves. One of the earliest forms of idolatrous worship was probably that of the sun, moon, and stars—the heavenly host. It rapidly extended however to other objects, and assumed more degrading aspects, as in Egypt, where beetles, bulls, &c., were worshipped; hence the sneer of Juvenal that Egypt was quite overrun with gods. For the correspondingly low species of modern idolatry called Fetichism see CONGO. The heathen gods and goddesses of antiquity, together with the attendant circumstances of their worship, will be referred to under the names of JUPITER, BACCHUS, &c. It is generally considered that idolatry originated in a deification of the unseen powers of nature, in consequence of which the more splendid objects of nature were worshipped, as the abodes or manifestations of these unseen powers. Perhaps, however, nearly coeval with this was the development of the notion which conceives of the Deity in human form and with human attributes. In the Roman empire idolatry was abolished by Honorius in A.D. 404. Constantine had ordered the demolition of idolatrous temples in 330.

In the first ages of Christianity images were neither worshipped nor used in the churches. The attempts of Romish writers to prove the contrary are by no means satisfactory. Baronius (*ad Ann.* 102) refers to a decree said to have been passed at Antioch by the apostles themselves, commanding believers to make images of Christ. But the first actual notice of such a decree is not to be found till seven centuries later. Tertullian (*De Pudicitia*, c. 10), as quoted by Bellarmine, speaks of chalices or cups on which was represented the parable of the good shepherd. But Tertullian and others of the Fathers held even painting and engraving to be forbidden by the second commandment. The

Idomeneus || Idumea.

passage quoted only proves the use of emblematical figures. As to the two brass statues referred to by Eusebius (*Eccl. Hist.*, book vii. 18), representing our Saviour performing a miracle, it is to be remembered that Eusebius considers the woman who erected the statues a pagan. Towards the close of the fourth century pictures of saints and martyrs were admitted into churches. Images followed in the next century, and out of pictures and images a species of Christian symbolism was built up, which represented visibly the leading facts and features of Christianity. Whatever may be said of the utility of images and pictures as thus the books of the poor, *Biblia Pauperum*, a means of instruction, the following centuries exhibit images of the Virgin, saints, martyrs, &c., honoured with observances substantially the same as those of the pagans to their false gods. Lights were burned before them, incense and prayers were offered, and hymns were sung to them, as well as miracles ascribed to them. The worship of images, which had thus gradually crept in, was interrupted by the great controversy which began to rage in the eighth century. (See ICONOCLASTS.) At the period of the Reformation, the Protestant churches condemned and abolished the use of images. The Mohammedans all along have done the same. The Council of Trent gave its deliverance in its twenty-fifth session on the subject of images, and declared that the images of Christ, the Virgin, saints, &c., were to be kept in the churches, and to receive due honour and veneration, not as though anything divine resided in them, but that by means of them the prototypes might be adored. This differs but slightly from the sentiments of the ancient pagans, for while many of them believed that the statues were inhabited by the gods whom the statues represented, others again, such as Plato, Seneca, &c., considered the statues as no more than blocks of wood or marble, by means of which the prototypes might be adored.

IDOMENEUS, one of the bravest of the Greeks in the Trojan War. He was the son of Deucalion, and was called Lyctius or Cnossius, from the Cretan towns of Lyctus and Cnossus, of which he is described as a native. Along with his nephew Meriones, he contributed eighty ships to the Grecian fleet, which was sailing against Troy. In the war itself he greatly distinguished himself, and when it came to a close returned home in safety. Other traditions say that being overtaken by a storm he vowed that he would sacrifice to Neptune the first living thing that met him on his reaching land. Under this rash vow he had to sacrifice his own son, and for this cruel act he was banished by his subjects. Sailing to Italy he landed in Calabria, where he built a temple in honour of Minerva. From Calabria he removed to Colophon, on the Asiatic coast, where he found a permanent abode. Dying there, he was buried on Mount Cercaphus.

IDRIA, an important mining town in Austrian Illyria, duchy of Carniola, and circle of Adelsberg, in an alpine valley, on a small river of the same name, and 23 miles W.S.W. of Laybach. The quicksilver mines of Idria, and those of Almaden in Spain, are the richest in Europe. They afford employment to 600 or 700 persons, of whom about 500 are miners. They have a regular uniform, and are enrolled in a corps. The annual product of the mines is restricted by government to 150 tons. The descent is by 757 steps cut out of the solid rock, and the greatest depth attained is about 140 fathoms. Formerly the labour of the mines was a punishment decreed on state prisoners, but now the occupation is eagerly coveted. Medical advice and medicines are furnished to the workmen gratis, and when disabled, they are provided for by government. The widows and orphans of miners are entitled to a pension. Pop. about 4000.

IDUMEA (in Gr. Ἰδουμαία, in Hebrew *Edom*). The name is derived from Isaac's son *Edom*, or Esau, the elder twin-brother of Jacob. It signifies *red*, and seems first to have been suggested by his appearance at his birth, when "he came out all red" (*i.e.*, covered with red hair), and was afterwards more formally and permanently imposed on him on account of his unworthy disposal of his birth-right for a mess of red lentiles. The region which came to bear his name, is the mountainous tract on the E. side of the great valleys El Ghor and El Araba, extending between the Dead Sea and the Elanitic Gulf of the Red Sea. Before the time of Esau this district had been called *Mount Seir*, a name indeed which it never entirely lost. The word *seir* means *hairy*, and, when applied to a country, *rugged, mountainous*; and so Josephus says that "Esau named the country 'Roughness' from his own hairy roughness." But another etymon derives the word from Seir, an earlier occupant of the place. Idumea.

The first mention made of Mount Seir in Scripture is in Gen. xiv. 6, where Chedorlaomer and his confederates are said to have smitten "the Horim in their Mount Seir." Among the earliest human habitations were caves, either formed by nature or easily excavated, and for the construction of these the mountains of Edom afforded peculiar facilities. Hence the designation given to the aboriginal inhabitants—*Horim, i.e.*, cave-dwellers, an epithet of similar import with the Greek *Troglodytes*. The extirpation of the Horim by the Esauites was, like that of the Canaanites by Israel, very gradual and slow. This much, however, we there learn of the political constitution of the Seirite aborigines, that, like the Esauites and Israelites, these Horim were divided into tribes, and these tribes were subdivided into families—the very polity which still obtains among the Arabs by whom Idumea is now peopled. Each tribe had its own *Alluf*, or leader. The primitive and pastoral character of the people is incidentally brought out by the circumstance that one of these chiefs was in the habit of tending asses.

Esau first married into two Canaanitish families of the Hittite and Hivite tribes; but anxious to propitiate his offended parents, he next formed a matrimonial alliance with one of the race of Abraham, viz., Mahalath, otherwise called Bashemath, daughter of Ishmael, and sister of Nebaioth, whose descendants, the Nabathæans, by a singular coincidence, obtained in after times possession of the land of Edom. Esau's first-born (by Adah or Bashemath, of the daughters of Heth) was Eliphaz, whose son *Teman* gave name to a district of the country. The Temanites were renowned for their wisdom. The chief speaker in the Book of Job is another Eliphaz, a Temanite—which is one of the circumstances that have led many to place the scene of that story in the land of Edom. The name of Teman was preserved to the days of Eusebius in that of Thaiman, a small town five Roman miles from Petra.

As a modern Arab *sheikh* is often found to exercise influence far beyond the sphere of his hereditary domain, so in the list of the Edomite *emirs* preserved by Moses we have perhaps only the names of the more distinguished individuals who acquired more or less authority over all the tribes. This oligarchy appears gradually to have changed into a monarchy, for, in addition to the above-mentioned lists, both of Horite and Esauite leaders, we have, at Gen. xxxvi. 31, a catalogue of eight kings (Bela, Jobab, Husham, Hadad, Samlah, Saul, Baal-hanan, Hadar or Hadad) who "reigned in the land of Edom before there reigned any king over the children of Israel." The period when this change to regal government took place in Idumæa can only be matter of conjecture. In the Song of Moses it is said that at the tidings of Israel's triumphant passage of the Red Sea the rulers or princes (*Alluf*) of Edom trembled with affright, but when, some forty years afterwards, application had to be made by the Israelites for leave to traverse the land of Edom, it was to the king (*Melek*) that the re-

Idumea. quest was addressed. The road by which it was sought to penetrate the country was termed "the *king's* highway," supposed by Robinson to be the Wady el-Ghuweir, for it is almost the only valley that affords a direct and easy passage through those mountains. It further appears that the monarchy was not hereditary, but elective (for no one is spoken of as the son or relative of his predecessor); or probably that chieftain was acknowledged as sovereign who was best able to vindicate his claim by force of arms. Every successive king appears to have selected his own seat of government: the places mentioned as having enjoyed that distinction are Dinhabah, Avith, Pagu or Pai. Even foreigners were not excluded from the throne, for the successor of Samlah of Masrekah was Saul, or Shaul, "of Rechoboth, on the river."

The unbrotherly feud which arose between Esau and Jacob was prolonged for ages between their posterity. The Israelites, indeed, were commanded "not to abhor an Edomite, for he was their brother;" but a variety of circumstances occurred to provoke and perpetuate the hostility. The first time they were brought into direct collision was when the Edomites, though entreated by their "brother Israel," refused the latter a passage through their territories; and they had consequently to make a retrograde and toilsome march to the Gulf of Elath, whence they had to "compass the land of Edom" by the mountain desert on the east. We do not again hear of the Edomites till the days of Saul, who warred against them with partial success; but their entire subjugation was reserved for David, who first signally vanquished them in the Valley of Salt (supposed to be in the Ghôr, beside *Usdum*, the Mountain of Salt); and, finally, placed garrisons in all their country. Solomon created a naval station at Ezion-geber, at the head of the Gulf of Elath, the modern Akaba. Towards the close of his reign an attempt was made to restore the independence of the country by the Idumæan prince, Hadad, who, when a child, had been carried into Egypt at the time of David's invasion, and had there married the sister of Tahpanhes the queen. If Edom then succeeded in shaking off the yoke, it was only for a season, since in the days of Jehoshaphat, the fourth Jewish monarch from Solomon, it is said, "there was no king in Edom; a deputy was king;" *i.e.*, he acted as viceroy for the king of Judah. For that the latter was still master of the country is evident from the fact of his having fitted out, like Solomon, a fleet at Ezion-geber. Yet there seems to have been a partial revolt of the Edomites, or at least of the mountaineers of Seir, even in the reign of Jehoshaphat; and under his successor, Jehoram, they wholly rebelled, and "made a king over themselves." It is probable that, after this date, the Jewish dominion was never completely restored. Amaziah, indeed, invaded the country, and took the chief city, Selah or Petra, and his successor, Uzziah, retained possession of Elath. But in the reign of Ahaz, hordes of Edomites made incursions into Judah, and carried away captives (2 Chron. xxviii. 17). About the same period Rezin, king of Syria, expelled the Jews from Elath, which was thenceforth occupied by the Edomites. It appears from various incidental expressions in the later prophets, that the Edomites employed their recovered power in the enlargement of their territory in all directions. They spread as far south as Dedan in Arabia, and northward to Bozrah in the Hhauran. When the Chaldæans invaded Judah, under Nebuchadnezzar, the Edomites became their willing auxiliaries, and triumphed with fiendish malignity over the ruin of their kinsmen the Jews, of whose desolated land they hoped to obtain a large portion to themselves. Their hereditary hatred of the Jews was kindled in greater fury than ever, and many dire denunciations of the "daughter of Edom" were made from heaven through the lips of the Hebrew prophets. From the language of Malachi, and also from the accounts preserved by Josephus, it would seem that the Edomites did not wholly escape the Chaldæan scourge; but instead of being carried captive, like the Jews, they not only retained possession of their own territory, but became masters of the south of Judah, as far as Hebron. Here, however, they were, in course of time, successfully attacked by the Maccabees, and about B.C. 125, were finally subdued by John Hyrcanus, who compelled them to submit to circumcision and other Jewish rites, with a view to incorporate them with the nation. The amalgamation, however, of the two races seems never to have been effected, for we afterwards hear of Antipater, an Idumæan by birth, being made by Cæsar procurator of all Judæa; and his son, commonly called Herod the Great, was at the time of Christ's birth, king of Judæa, including Idumæa; and hence Roman writers often speak of all Palestine under that name. Not long before the siege of Jerusalem by Titus 20,000 Idumæans were called in to the defence of the city by the Zealots; but both parties gave themselves up to rapine and murder. This is the last mention made of the Edomites in history. The author of a work on Job, once ascribed to Origen, says that their name and language had perished, and that, like the Ammonites and Moabites, they had all become Arabs. In the second century Ptolemy limits the name Idumæa to the country west of the Jordan. Idumea.

From the era of the Crusades down to the present century the land of Esau was, to Europeans, a *terra incognita*. Its situation was laid down on the best maps more than 100 miles from the true position, and as if lying in a direction where it is now known there is nothing but a vast expanse of desert. Volney had his attention drawn towards it, when at Gaza, by the vague reports of the Arabs, and in 1807 the unfortunate Seetzen penetrated a certain way into the country, and heard of the wonders of the Wady Mûsa; but the first modern traveller who "passed through the Land of Edom" was Burckhardt, in the year 1812. And it has been well remarked by Dr Robinson (*Amer. Bib. Reposit.*, vol. iii., p. 250), that "had he accomplished nothing but his researches in these regions, his journey would have been worth all the labour and cost expended on it, although his discoveries thus shed their strongest light upon subjects which were not comprehended in the plan or purpose either of himself or his employers." Burckhardt entered Idumæa from the north, and in the year 1818 he was followed in the same direction by Messrs Legh, Bankes, Irby, and Mangles. In 1828 Laborde and Linant found access from the south; and since then it has been visited and described by so many that the names of its localities have become familiar as household words.

The limit of the wanderings of the Israelites in the desert was the brook Zered, after crossing which they found themselves in the territory of Moab (Deut. ii., 13-18). This brook is supposed to be identical with the *Wady el-Ahsy*, which, rising near the Castle el-Ahsy, on the route to Mecca of the Syrian caravan upon the high eastern desert, penetrates through the whole chain of mountains to near the S.E. corner of the Dead Sea. It was thus the southern border of Moab and the northern of Edom, whence the latter region extended southwards as far as to Elath, on the Red Sea. The valley which runs between the two seas consists first of El-Ghor, which is comparatively low, but gradually rises into the more elevated plain of El-Arabah to the south. The country lying *east* of this great valley is the land of Idumæa. It is a mountain tract, consisting at the base of low hills of limestone or of argillaceous rock, then lofty mountains of porphyry forming the body of the range; above these, sandstone, broken up into irregular ridges and grotesque groups of cliffs; and again, farther back, and higher than all, long elevated ridges of limestone without precipices. East of all these stretches off indefinitely the high *plateau* of the great eastern desert.

Idumea.

Robinson and Smith estimated the height of the porphyry cliffs at about 2000 feet above the Arabah; the elevation of Wady Mûsa above the same is, perhaps, 2000 or 2200 feet, while the limestone ridges further back probably do not fall short of 3000 feet. The whole breadth of the mountainous tract between the Arabah and the eastern desert does not exceed 15 or 20 geographical miles. Of these mountains the most remarkable is *Mount Hor*, near the Wady Mûsa. While the mountains on the west of the Arabah, though less elevated, are wholly barren, those of Idumæa seem to enjoy a sufficiency of rain, and are covered with tufts of herbs and occasional trees. The wadys, too, are full of trees and shrubs and flowers, while the eastern and higher parts are extensively cultivated, and yield good crops. Hence Robinson thinks its appearance fulfils the promise made to Esau (Gen. xxvii. 39), "Thy dwelling shall be the fatness of the earth and of the dew of heaven from above." Yet many critics are of opinion (*e.g.*, Vater, De Wette, Geddes, Von Bohlen), that משמני should there be rendered "from," *i.e.*, "far away from, or destitute of," the fatness of the earth, &c.; and it is immediately added, "for thou shalt live by thy sword;" and it does not appear that Idumæa was ever particularly noted for its fertility. This mountainous region is at present divided into two districts. The northern bears the name of *Jebâl*, *i.e.*, "The Mountain," the Gebal of the Hebrews (Ps. lxxxiii. 7), and the Gebalene of the Greeks and Romans. Commencing at Wady el-Ahsy, it terminates, according to Burckhardt, at Wady el-Ghuweir, the largest place in it being Tufileh, perhaps the Tophel of Deut. i. 1. The southern district is *Esh-Sherah*, extending as far as Akabah, and including Shôbak, Wady Mûsa, Maan, &c. Burckhardt mentions a *third* district, *Jebal Hesma*; but Robinson says that though there is a sandy tract, el-Hismah, with mountains around it, on the east of Akabah, it does not constitute a separate division.

The whole of this region is at present occupied by various tribes of Bedouin Arabs. The chief tribe in the *Jebal* is the Hejaya, with a branch of the Kaabineh, while in *Esh-Sherah* they are all of the numerous and powerful tribe of the Haweitat, with a few independent allies. The Bedouins in Idumæa have of late years been partially subject to the Pasha of Egypt, paying an annual tribute, which, in the case of the Beni Sukhr, is one camel for two tents. The fellahin, or peasants, are half Bedouin, inhabiting the few villages, but dwelling also in tents; they too pay tribute to the Egyptian government, and furnish supplies of grain.

Could the scene of the Book of Job be with certainty fixed in Idumæa, we should then possess much curious and valuable information respecting both the country and people soon after it had been colonized by the descendants of Esau. (See Mason Good, Wemyss, and others, upon *Job*.) But all that we learn directly of the ancient Edomites from the historical books of Scripture represents them as not, indeed, neglecting agriculture or trade, yet, on the whole, as a warlike and predatory race, who, according to the prediction of their progenitor Isaac, "lived by their sword." The situation of the country afforded peculiar facilities for commerce, which seems to have been prosecuted from a very early period. "Bordering," says Volney, "upon Arabia on the E. and S., and Egypt on the S.W., and forming, from N. to S., the most commodious channel of communication between Jerusalem and her dependencies on the Red Sea, through the continuous valleys of El-Ghor and El-Araba, Idumæa may be said to have long formed the emporium of the commerce of the East." The era of its greatest prosperity was after the Nabathæans had become masters of the country, and founded the kingdom of Arabia Petræa, of which the renowned metropolis was Petra. The *religion* of the early Edomites was, perhaps, comparatively pure; but in process of time they embraced idolatry. In 2 Chron. xxv. 20, we read of the "gods of Edom," one of whom, according to Josephus (*Antiq.* xv. 7, 9), was called *Kotzé*. With respect to the striking fulfilment of the prophetic denunciations upon Edom, we need only refer the reader to the well-known work of Keith, who perhaps errs, however, in straining the sense of prophecy beyond its legitimate import, as well as in seeking out too literally minute an accomplishment. (On Idumæa generally, see C. B. Michaelis' *Diss. de Antiquiss. Idumæor. Hist.* in Pott and Ruperti's *Sylloge Comment. Theologic.*, part vi., p. 121; J. D. Michaelis' *Comment. de Troglodytis Seiritis*, in the *Syntagma Commentt.*, part i., p. 194; but especially, *Sketches of Idumea and its present Inhabitants*, by Dr E. Robinson, in the *Amer. Bib. Repository* for April 1833, p. 247; and the *Bib. Researches* of the same writer, vol. ii., p. 551.)

Idyll ‖ Iglau.

IDYLL (Gr. εἰδύλλιον, Lat. *Idyllium*, or *Edyllium*), a short highly-wrought descriptive poem, treating chiefly of the appearances and phases of external nature, and the sentiments and incidents of rural and especially of pastoral life. In its widest sense, the idyll comprehends, according to Wordsworth, in addition to bucolic poetry, strictly so called, the epitaph, the inscription, the sonnet, and most of the epistles of poets writing in their own persons. Idyllic writing was cultivated among the Greeks, but to no great extent; though the extant works of Theocritus, Bion, and Moschus, show that the Hellenic tongue was as well adapted for this as for the higher kinds of composition. Among the Latins, Virgil and Ausonius both wrote idylls; but the term, as used by them, comprised, as it now does, a much wider range of subject than the Greek idyll. In modern times the idyll was re-introduced as a species of poetry by the *provençal* poets, among whom Givaud Riquier was pre-eminent in this style. His fame was eclipsed, at a later age, by that of Marot, Ronsard, and Vauquelin. One of the best idylls of this age is that of Grotius, entitled *Myrtilus, sive Idyllium Nauticum*. The names of Racine, J. B. Rousseau, and Fontenelle, are found among those who affected the idyll in France. In Italy, Aquilano, Spagnuoli (surnamed the "Mantuan"), and Sannazario, all wrote good Latin idylls, and were followed by Bernard Tasso, Sammartino, Franco, Calino, and Rota, who employed their vernacular as the vehicle of their thoughts. At the close of the eighteenth century Bertola appeared, and was ranked by his countrymen with Gessner. Among the Spaniards, Garcilasso de la Vega alone is now esteemed as a pastoral poet. The fame of Cervantes and Vincent Espinel as idyll writers is lost in the glory of their success in other walks of literature. English literature, rich in other kinds of poetry, is poor in pastorals of genuine poetic merit. Spenser's *Shepherd's Calendar* was called by Dryden "the most excellent work of the kind that has been composed since Virgil." Excepting several of Milton's minor poems,—such as the *Lycidas, Il Penseroso, L'Allegro*, and the *Arcades*; Pope's *Windsor Forest*; Thomson's *Seasons*; Allan Ramsay's *Gentle Shepherd*; Goldsmith's *Deserted Village*, and a few others,—most of the expressly pastoral poetry of England is not worth reading. In Switzerland the name of Gessner is supreme in the department of the idyll; while in Germany those of Kleist and Voss were, till the appearance of Goethe, the acknowledged chiefs in that walk of literature.

IF, a small island off the S. coast of France, department of Bouches-du-Rhone, before the harbour of Marseilles. It is a naked rock, rising about 50 feet above the sea, and is wholly occupied by a strong fort.

IGLAU, a town, capital of a cognominal circle, in Moravia, Austria, on the River Iglawa, 49 miles W.N.W. of Brunn. It consists of the town proper, which is walled, and of three suburbs. Manufactures, woollen cloth, linen, paper, potash, &c., and an extensive transit trade. Pop. about 14,000.

Iglesias ‖ Ignatius.

IGLESIAS, a town of the island of Sardinia, 32 miles W.N.W. of Cagliari. It is finely situated amongst limestone hills, and abundantly watered by various springs. The surrounding country is highly productive of corn, wine, and fruits. Iglesias is the see of a bishop, and has a handsome episcopal palace, several convents, and a Jesuits' college. Pop. about 5000.

IGNATIUS LOYOLA. See JESUITISM.

IGNATIUS, *St*, one of the apostolical fathers, and Bishop of Antioch, was a Syrian, but the place and time of his birth is uncertain. He is called *Theophorus*, or *Deifer*, a name by some supposed to have been given him because he was the child whom our Lord took in his arms when correcting the ambitious views of his disciples (Mark ix. 36); but Ignatius himself gives the true meaning of the appellative as "one that has Christ in his heart;" and it is stated by Chrysostom that this father never saw Jesus Christ. By some he has been called a disciple of Peter, but the authority of the *Martyrium Ignatii* makes him, along with Polycarp, a hearer of St John. Little is known of his history, either before or during his episcopate, except that we gather from his works that he was filled with high conceptions of the dignity of his office, and, from the *Martyrium*, that he was anxious for the stedfastness of his flock during the persecution of Domitian, and indefatigable in promoting their edification. On the breaking out of the persecution under Trajan, Ignatius took no pains to avoid its fury, but seems rather to have courted the crown of martyrdom, and was brought before the emperor at Antioch. The conference or trial ended in his being sentenced to be thrown to wild beasts at Rome; a fate which he boldly met on the 20th December, on what was called "the feast of the thirteenth," *i.e.*, the thirteenth before the kalends of January; but the exact year is not known, various writers placing it at as wide intervals as A.D. 107, and A.D. 116. His remains were interred at Antioch, and his tomb was shown there in the time of Jerome.

But the principal interest in the name of Ignatius is gathered round his works, which, short as they are, have excited much controversy from an early period in the history of the revival of letters. In his way from Antioch to Rome, he is said to have written *seven* epistles, which are enumerated by Eusebius and Jerome; but there are extant *fifteen* letters ascribed to him, though only seven are considered genuine. Of these there are two copies, one shorter than the other, and criticism has generally given its verdict in favour of the least diffuse edition. The whole of the letters have been considered as spurious by some writers, but learned men have generally admitted the genuineness of the seven. The decisive testimony borne to episcopacy, and to our Lord's divinity, by these ancient documents, caused them to be closely scrutinized; and from the Reformation to the present day the controversy as to what Ignatius wrote, and what his expressions mean if admitted as genuine, has been carried on with some acrimony. The author of the *Centuriæ Magdeburgenses* first gave utterance to some doubts on the subject; Calvin followed more positively, and on subjective grounds declared the letters apocryphal, calling them *næniæ* and *larvæ*. In 1644 Archbishop Usher published his edition of the epistles, and contended for the genuineness of six of them; he added a valuable introduction and notes. Vossius followed, printing the text from a Medicean M.S. In 1666 Daillé fiercely attacked the whole collection, and this gave rise to Bishop Pearson's *Vindiciæ Ignatianæ*, which, for the time, put an end to the controversy.

The treasures of Syriac literature brought from Egypt to this country by Dr Tattam have revived the interest felt in the writings of Ignatius, and led to their renewed criticism. Among the MSS. purchased of the monks in the Desert of Nitria was found a Syriac copy of the Epistles to *Polycarp*, the *Romans*, and the *Ephesians* only; and these were edited and published, with notes, by the Rev. W. Cureton, in 1845. These translations are much shorter than the supposed Greek originals; and it is remarkable that some of the omitted or wanting portions are those which relate to episcopal authority, and the deity of Christ, and these are supposed by Mr Cureton to have been introduced into the Greek text as bearing on the Arian and Aerian heresies. That gentleman has since more fully considered the whole literature of the subject in his *Corpus Ignatianum*, and is a strenuous advocate for the genuineness of the Syriac or shorter recension. But, although this dictum has not yet been very strongly opposed, it is far from being generally submitted to, and it is probable the grounds of Mr Cureton's conclusions may yet be warmly contested. Further researches into the Syriac translations of theological works furnish evidence of a custom of abridging or making compends of the original treatises, and it is far from unlikely that this plan was pursued in making the version of the Epistles of Ignatius. It should be said, however, that previous to the discovery of this version, many critics—as Beausobre, Lardner, and Priestly—had expressed their conviction that the Greek copies had been largely interpolated. (H. B.)

Ignis ‖ Ilfracombe.

IGNIS FATUUS, a light supposed to proceed from phosphuretted hydrogen, appearing frequently in mines, churchyards, marshy places, and near stagnant waters. It was formerly thought to have something ominous in its nature, and to presage death or misfortunes. There have been instances of people being decoyed by these lights into marshy places, where they perished; and hence the names of *Ignis fatuus*, *Will-with-a-wisp*, and *Jack-with-a-lanthorn*, as if this appearance were an evil spirit which took delight in doing mischief. The general opinion is, that this light is produced by the decomposition of animal or vegetable matters, or by the evolution of gases which spontaneously inflame in the atmosphere. See PHYSICAL GEOGRAPHY.

IGUALADA (the ancient *Aquæ Latæ*), a town of Spain, province of Barcelona, on the left bank of the Noya, 34 miles N.W. of Barcelona. The streets of the old town are narrow and irregular, but those of the new, or modern portion, are generally regular and spacious. Among the public buildings are an ancient Gothic church, a town-hall, two convents, a clerical college, hospital, cavalry barracks, and a small theatre. Igualada formerly ranked as one of the wealthiest and most industrious cities of Spain, but of late years it has greatly declined. Its manufactures, which are still very considerable, comprise cotton and woollen stuffs, leather, hats, fire-arms, &c. Pop. 10,095.

ILCHESTER (formerly *Ivelchester*, from the River Ivel or Yeo, on which it stands), a market-town of Somersetshire, 33 miles S.S.W. of Bath. Under the Romans it was an important military station, and bore the name of Ischalis. Traces of its fortifications may still be seen, and numerous coins, urns, &c., have been discovered. It formerly returned two members to Parliament, but was disfranchised by the Reform Act. Ilchester was the birth-place of Roger Bacon.

ILDEFONSO, SAN, a town of Segovia, Spain, and 6 miles S.E. of Segovia. It stands on the northern slope of the Sierra de Guadarrama, at a height of 3840 feet above the level of the sea. Its royal palace of *La Granja* is the usual residence of the court during several of the hottest months. San Ildefonso is noted for its royal glass manufactory. Pop. about 3000.

ILERDA. See LERIDA.

ILE-DE-FRANCE, an old province of France, the capital of which was Paris. It now forms the departments of Seine, and Seine-et-Oise, and parts of those of Seine-et-Marne, Aisne, and Oise.

ILFRACOMBE, a seaport-town of Devonshire, on the

Ilissus ‖ Ille-et-Vilaine.

Bristol Channel, 43 miles N.W. of Exeter. The harbour is enclosed by rocky cliffs, and is also protected by a pier 850 feet in length. It affords secure anchorage to vessels of 230 tons, and has at the entrance a lighthouse and battery. Ilfracombe is in summer frequented for sea-bathing. The inhabitants are chiefly engaged in fishing and the coasting trade. Pop. (1851) 2919.

ILISSUS, in *Ancient Geography*, one of the small streams on which the city of Athens stood. It was not so large and important as the Cephissus, and differed from it in being wholly dried up under the scorching heat of summer, which the Cephissus does not seem to have ever been. It consisted of two principal streams, the larger of which rose on the northern slope of Hymettus, and flowing towards the city was there joined by the smaller, which, under the name of the Eridanus, rose on the western slope of Hymettus at a place now called Syriani. The combined stream then traversed the southern portion of the city, and, in winter, or after heavy rains, discharged itself into the Bay of Phalerum. In summer its channel now, as in ancient times, is quite dried up.

ILLE-ET-VILAINE, a department on the N.W. coast of France, lying between N. Lat. 47. 38. and 48. 37., and W. Long. 1. and 2. 14., bounded N. by the sea and the department of Manche, E. by Mayenne, S. by Loire Inferieure, and W. by Morbihan and Côtes-du-Nord, containing an area of 2597½ square miles. It is traversed E. and W. by a range of low hills, which decline on the one side to the English Channel, and on the other to the Bay of Biscay. Its principal rivers are the Ille and Vilaine. The former joins the Vilaine at Rennes, after a course of 18 miles through the department, and the latter which rises in Mayenne, flows past the towns of Vitré, Rennes, and Redon. This stream is tidal up to the port of Redon, and is navigable for barges as far as Rennes. The country, in many parts, is flat and marshy, with a number of stagnant lakes, a circumstance that renders the atmosphere very humid, while the prevalence of westerly winds keeps the temperature mild. Its soil is thin and not very fertile. Of 1,661,221 acres contained in the department, there are 980,150 arable, 327,262 waste (marsh, lakes, roads, &c.), 184,297 grass, 135,361 wood, 33,132 gardens and orchards, and 1020 vines and tobacco. The cereals consist of rye, oats, barley, flax, and hemp, none of which are raised to great extent. The annual amount of grain is about 1,200,500 quarters, or 2 quarters to each individual, a sum so small that importation must be carried on from the more fertile districts around. Both apples and pears are grown in large quantities, and make excellent cider or perry. Tobacco is raised at St Malo, and the vine is seen here and there throughout the country. It has been generally remarked, that agriculture is here in a very low state, from the smallness of the farms, few of which exceed 60 acres, while the average extent is 18 acres. The manufactures of the department are confined to linen, canvass, and cordage; the former is spun into excellent thread. The minerals of the department are few; granite, slate, and glass-quartz form the most profitable articles of mining, while iron is worked but with little success.

The cattle and horse trade is, perhaps, the most lucrative and extensive in the department, and both the oxen and horses of the country are justly celebrated. They belong to the small Breton breeds. The former are fattened in Normandy for the Paris market, where they realize high prices. From the coast also, large supplies of deep-sea fish, lobsters, crabs, and oysters, are despatched to the metropolis and other towns. Cheese, said to equal Gruyère, is made in considerable quantities. Communication with the coast and interior is effected by means of the rivers, a canal, and the railway to Paris. The Ille-et-Rance Canal, supplied with water from the former stream, connects the town of Rennes with those of Dinan and St Malo; and the Paris railway crosses the department by Vitré and Rennes. The population of the country is of Celtic origin, and speaks a mixed dialect of Gaelic and French, known by the name of the Breton dialect. The chief towns are Rennes, the capital in the centre of the department, and St Malo, an ancient and still flourishing seaport on the English Channel. Ille-et-Vilaine is divided into the six following arrondissements, with their respective populations:—

Arrondissements.	Cantons.	Pop. 1851.
Rennes	10	139,471
St Malo	9	123,585
Fongères	6	85,151
Vitré	6	83,509
Redon	7	82,287
Montfort	5	60,615
Total	43	574,618

Illinois

ILLINOIS, one of the United States of North America, is bounded N. by Wisconsin, E. by Lake Michigan and Indiana, from which it is separated for a third of its length by the Wabash River, S. by the Ohio, which separates it from Kentucky, and W. by the Mississippi. It lies between N. Lat. 37. and 42. 30., and between W. Long. 87. 49. and 91. 28. Greatest length from N. to S., 378 miles; greatest breadth, 212 miles; average breadth, 140 miles. Its area is estimated at 55,409 square miles, being only about 3000 square miles less than that of England and Wales. According to the census of 1850, little more than a sixth part of the state was under cultivation.

Illinois is one of the most level states in the Union. With the exception of a range of low hills in the S., and a good deal of broken land in the N.W., as well as a few elevations near the Illinois, and some lofty bluffs along the Mississippi, the state may be regarded as an extensive table-land, gently inclining towards the S.W. At the mouth of the Ohio the soil is only about 340 feet above tide-water in the Gulf of Mexico, and the highest elevation in the whole state does not exceed 800 feet above that standard. Its surface is occupied almost entirely by prairies, which are popularly distinguished by the names, "wet" and "dry," "alluvial" and "rolling." The wet prairies are peaty, indicating that they have once been morasses. Those of an alluvial nature are dry, with a rich black loam, and exceedingly fertile. They are covered with a coarse kind of grass, which grows to an enormous size. The soil of the high and "rolling" prairies is, in general, only of second-rate quality, and abounds in springs. Grape-vines are abundant. The prairies furnish an inexhaustible summer range for cattle. From the exceeding flatness of some of the plains, the rains that fall are allowed to stagnate, and thus render the situation unhealthy. The Grand Prairie, which is the largest tract of this description, is probably the highest table-land between the Mississippi and the Wabash. It extends from the county of Jackson, in a N.E. direction, to the Irroquois county, and varies in breadth from 1 to upwards of 12 miles. Although passing under one name, it does not consist of one single tract of land, but is broken up into several reaches of prairie ground, with stripes of wood running between them. It is rich and fertile, and several settlements have been located on its border, which is everywhere skirted with wood. The prairies, generally, are not plentifully supplied with timber, most of them being only interspersed with groups of trees, or skirted with stripes of forest. Much of the young wood is destroyed by the annual winter burning of the coarse grass, which covers at least two-thirds of the prairie land. In spring the prairies again become profusely decked with the greatest variety of beautiful and delicate flowers of every hue.

Illinois is distant from the sea, but is well provided with rivers. Nearly three-fourths of its boundary is formed by

Illinois. navigable rivers; and on the N.E. it has Lake Michigan for upwards of 60 miles. The Mississippi, which forms its entire western, and the Ohio, which forms the southern boundary, give commercial access to those valleys which bear their names. The Wabash, a noble stream which bounds the state on the E. for more than 100 miles, is navigable for more than that distance. For internal communication, the Illinois, which belongs entirely to this state, is navigable at all seasons for steamboats for 260 miles, to La Salle, where navigation is stopped occasionally by the little rapids, and where a canal branches off, connecting the river with Lake Michigan. The principal tributaries of the Illinois, which is itself formed by the junction of the Kankakee and the Des Plaines, are the Fox River, which rises in Huron territory, and has a course of 200 miles before it joins the Illinois; the Vermilion River, which falls into it from the S.E.; the Sangamon from the E., the Mackinaw from the N.E., and the Spoon River from the N.W. These are almost all navigable for considerable distances. The Sangamon is navigable for 140 miles. The Little Wabash and the Embarrass, which flow into the Wabash, are likewise navigable for upwards of 150 miles. The Rock River, which rises in Wisconsin, and falls into the Mississippi, after a course of about 300 miles, is navigable for some distance, but its upper course is impeded by rapids.

The climate of Illinois, extending as it does over a space of 5½ degrees of latitude, must necessarily be varied. The natural difference of temperature between the northern and the southern parts is, however, increased, by the numerous and large rivers which bound and intersect the country, and by its state of cultivation. Everywhere the winters are severe, the summers hot and long, and the temperature subject to frequent and sudden changes. In the southern parts of the state the summer heat is very oppressive and enervating; and is only occasionally relieved by fresh breezes from the prairies. In winter the snow falls to a considerable depth, and lies occasionally for three months; and many of the rivers remain frozen for the same length of time. In some parts of the state only a few inches of snow falls, and it quickly disappears.

Illinois possesses a vast extent of arable land. The soil, although varied, is generally highly productive, and for agriculture, it has been considered as unsurpassed by any state in the American confederacy. The soil in "the bottoms," or along the river valleys, such as those of the Rock River, the Sangamon, and Kaskaskia, consists chiefly of rich alluvial deposits, and is so productive as frequently to yield 40 bushels of wheat or 100 bushels of Indian corn to the acre. Nearly all the tracts adjacent to the rivers are of this character. "The American Bottom," as it is called, is the richest river alluvium, and has been cropped without deterioration for a century. It extends along the Mississippi for 90 miles; but in consequence of its liability to inundation, much of it is uncultivated. The prairies, although less productive, are still very fertile, and on account of their greater salubrity are preferred for farms, wherever wood is to be obtained. In 1850, there were 76,208 farms in Illinois, containing 5,039,545 acres of improved ground.

Important and valuable minerals abound in this state. Bituminous coal occurs in almost every county; and in some instances may be obtained without excavation. Vast beds are found on the bluffs adjacent to the "American Bottom;" and it has been reported that anthracite coal has been found in the county of Jackson. But the great coal region is an extensive tract which extends quite across the state from Missouri to Indiana, and from Iowa to Kentucky. Iron has been found in the southern part of the state, and is said to be plentiful in the northern. The great lead region is shared between Illinois, Iowa, and Wisconsin. Galena in the N.W. is nearly supported by this mineral. Silver has also been found in the west part of the state, and copper is obtained in several places. The other minerals found here are, zinc, gypsum, quartz, crystals, &c. Illinois.

Illinois possesses great facilities for manufactures, which have hitherto been very imperfectly developed. According to the census of 1850, the number of manufacturing establishments, producing each annually to the value of L.100 and upwards, was 3099. There were 16 woollen manufactories, employing a capital of L.30,900, and 178 hands, including 54 females, producing in all 336,995 yards of stuffs, and 137,000 lbs. of yarn; 96 tanneries, employing 275 hands and a capital of L.37,675; 31 furnaces, forges, &c., employing 482 hands, and producing 2700 tons of pig iron and 4160 tons of cast iron. The home-made manufactures were valued at L.231,180.

The total of the imports into this state from the Lakes in 1851 was L.1,564,190, and exports L.887,002. The foreign exports in 1852 amounted to L.10,265, and imports to L.966. The tonnage entered was only 1155, and cleared 3616.

The internal trade of this state is becoming considerable, and increasing in proportion to the means of internal communication. Its direct foreign commerce is exceedingly small and is chiefly with Great Britain.

The present constitution was adopted in convention on the 31st August 1847, and accepted by the people on the 7th March 1848. By it, one year's residence in the state entitles every white male citizen, 21 years of age, to a vote for all elective affairs. The executive power is vested in a governor and a lieutenant-governor, chosen by the electors for four years, the former receiving L.500 per annum, and the latter 3 dollars per day during the session. The legislature consists of a senate and house of representatives. The senate consists of 25 members elected for 4 years, and the house of representatives of 75 elected for 2 years. Each member receives 2 dollars a-day for 42 days, and 1 dollar a-day afterwards.

The justiciary consists of a supreme court of three divisions, each of which is presided over by a judge receiving a salary of L.250 each per annum; and 17 circuit courts, presided over by as many judges, each receiving 1000 dollars per annum. Illinois is entitled to 9 members in the national house of representatives, and to 11 electoral votes for the president of the United States.

The debt of the state, principal and interest, was, in January 1, 1855, L.2,798,923. During the two years ending November 30, 1854, there had been paid of the public debt, in addition to L.240,000 paid on account of accruing interest, the sum of L.55,007, making a total of L.790,007 paid during that time on account of the public debt. If the present rate of taxation is continued, and the present method of reducing the debt followed, it will be entirely extinguished in 1866. The rate of taxation in 1852 on each 100 dollars was 60⅓d cents.; in 1853, 49⅓d cents. During the two years, L.56,178 were received from the sale of 80,126·04 acres of state land, and 48,598·15 acres remained unsold December 1, 1854.

Illinois consists of 100 counties, which contain a number of thriving towns, many of which are increasing very fast in population. Chicago is much the largest, and has connected with it the greater part of the traffic of the state. Pop. in 1850, 29,963. In 1853, it is said to have increased to upwards of 60,000. The capital of the state is Springfield.

The following table shows the decennial increase of the population since 1810:—

Year.	Whites.	Free coloured.	Slaves.	Total.
1810.....	11,501	613	168	12,282
1820.....	53,788	506	917	55,211
1830.....	155,061	1,637	747	157,445
1840.....	472,254	3,589	331	476,183
1850.....	846,104	5,366	None.	851,470

In 1850 there were 1167 churches in this state. Of

Illuminati.

these there belonged to Methodists, 389; to different divisions of Baptists, 265; Presbyterians, 198; Christians, 67; Roman Catholics, 58; Congregationalists, 46; Lutherans, 40; Unionists, 31; Episcopalians, 27; minor sects, 46;—in all, 1167, providing accommodation for 636,478 persons.

In 1854, there were 4215 public schools in the state; 2492 being taught by males, and 1557 by females. The number of children receiving instruction was 136,371.

There are 4 colleges in the state, attended by about 250 students. There is also a theological seminary (Baptist), connected with Shurtleff College, at Upper Alton. At Chicago is the Rush Medical School, founded in 1842, having in 1850, 6 professors, 70 students, and 16 graduates. In 1854 the sum of 951,504·07 dollars was devoted to the purposes of education. Besides those connected with schools and colleges, there are 27 public libraries containing 19,916 volumes. The total number of newspapers and periodicals published in 1850 was 119, of which 73 were political, and 46 devoted to literature, science, religion, &c.

Illinois was within the limits of the cession which Virginia made to the United States in 1787. But it had been visited by the French traveller Marquette as early as 1673, and settlements were made at Cahokia and Kaskaskia before the close of the seventeenth century. By the treaty of 1763 between England and France this country came into the hands of the British, and at the Revolution in 1775 it became a part of the possessions of the United States. It constituted a part of the N.W. territory in 1789, and in 1800 it formed part of a separate territory under the name of Indiana, in conjunction with the state now bearing that name. A final division took place in 1809, when the present state was organised as the territory of Illinois, and was admitted into the Union in 1818, as an independent state. Since that period it has been steadily progressing in general industry.

Its internal improvements for some years past have been very great. Canals have been formed to compensate for the natural barriers to navigation in some of its rivers, and recently its great canal from Chicago to Peru, on the Illinois River has been completed, uniting the waters of Lake Michigan with the Mississippi; thus opening direct communication between the whole of the Lake district in the N., and the river navigation on the S. The system of railroads, projected on a grand scale upwards of 20 years ago, and which had been temporarily suspended, has been resumed some years ago on a still greater scale, and is being carried on with vigour. Chicago, its principal commercial city, was in 1853 connected with Rockford, St Charles, Aurora, and Peru within the state, and beyond it, either directly or indirectly, with Detroit, Cincinnati, New York, Philadelphia, and Boston. Besides these there were railroads uniting Springfield with Jackson, and Naples, Alton, and Quincy, with Columbus. When its railroads under construction are finished, Illinois will be surpassed for its railroad communication by but few states in the Union.

ILLUMINATI, *The Enlightened*, a name applied to the members of a secret society of the last century. It is said that a society had been formed by a disciple of Swedenborg, for the purpose of ostensibly bringing about a social reform in Europe; and that from this society, as well as from the societies of Jesuits and Freemasons, Adam Weishaupt, professor of canon-law at Ingolstadt, took the idea of forming a society whose professed object was, by one single tie, to unite men of all countries, in spite of different opinions, religions, and ranks; to instruct all classes; and to surround sovereigns with men of integrity, justice, truth, and courage. His adherents were at first called *Perfectibilists*, but afterwards designated themselves the *Enlightened*. From the ablest of his law students he chose apostles for his new scheme. These apostles he called *areopagists*, and sent to various parts of Europe to work out his system. Before the existence of the society was known at Ingolstadt, several *lodges* had been established in Bavaria, Suabia, Franconia, Milan, and Holland, numbering 1000 disciples. Weishaupt succeeded in gaining over the Baron de Knigge, and Bode the philosopher, to his system. The whole society formed a hierarchy which consisted of eight grades, independent of minor subdivisions, viz.,—the Novice, the Minerval, the *Illuminatus Minor*, the *Illuminatus Major*, the Scottish Cavalier, the Priest, the Regent, and the King. Young men between 18 and 30 were preferred, and Lutherans were taken rather than Catholics. The Baron de Knigge was a zealous promoter of their views. At the congress of Wilhelmsbad, 1783, when there were present men from all parts of the world, he made many converts. The society amounted to 2000, of whom he himself had converted 500. A dispute arose between Weishaupt and Knigge; the latter was deposed, retired to Brême, and wrote against the society. In 1785 the system was divulged, and Weishaupt retired to Ratisbon. On the seizure of the papers and documents of the leaders in the following year, Weishaupt fled to Halle, where he died in 1830, at the age of 83.

Illyria.

A new combination was soon formed under the name of the *Germanic Union*, the founder of which was Dr Bahrdt. Its political intrigues favoured and hastened on the French Revolution. Mirabeau, Talleyrand, and others, are said to have adopted the principles of the new union, which Bode is said to have expounded in person at the Masonic lodges of Paris. It has been doubted, however, whether the society ever attained to a perfect organization, or whether it ever exerted any extensive influence.

ILLYRIA, or ILLYRICUM. The kingdom of Illyria, as it was before the new territorial arrangement of Austria in 1849, represented only a comparatively small portion of the ancient Illyria or Illyricum. In its widest sense that term comprised all the country extending along the shores of the Hadriatic, from the mouths of the Po to the frontiers of Epirus. Inland it stretched from the sea to the banks of the Ister or Danube, and the Alps that separate Italy from Germany. On the E. it was bounded by Macedonia, and the barbarous tribes that once obeyed Macedonian sway. In a more limited sense it may be regarded as comprising the sea-board between the Naro (*Neretva*) and the Drilo (*Drin*), and reaching inland as far as the country of the Triballi. In course of time the "Illyricus Limes" were pushed forwards on all sides, and in the second century after Christ it comprised Noricum, the whole of Pannonia, the whole of Mœsia, Dacia, and Thrace. In the fourth century, Constantine having added to it Macedonia, Thessaly, and the whole of Greece, made it one of the four great quarters into which the Roman world was subdivided for the purposes of government. At a later period the provinces added by Constantine were detached, and annexed to the Eastern Empire, while the original Illyricum was reunited to the Empire of the West.

The inhabitants of this extensive region were known under the general title of Illyrii. Ethnologically they were a distinct race from their Sclavonic neighbours on the N., and their Epirot neighbours on the S.; but so little is known of their modes of life and language that it is impossible to trace with certainty their ethnical affinities. The subject has been investigated with much care and ability by Ritter von Xylander. The results of his researches will be found in full in vol. iii. of Prichard's great work. This much is certain, that from the old Illyrians have sprung the modern Albanians, or, as they are called by the Turks, the "Arnauts." These Albanians, though the country they now occupy represents part of Epirus, have nothing in common with the ancient Epirots. When they themselves began to be hard pressed by the Gauls and Sclaves on the E. and N., they retired southwards, seized Epirus,

Illyria.

and such of the inhabitants as escaped the sword were gradually merged in the Illyrian tribes. The earliest writers who mention the Illyrians describe them as tattooing their bodies, a practice which they shared with their neighbours of Thrace. Like that people, too, they sought to appease their gods by human sacrifices. Their women are described as enjoying much influence in politics as well as social life, and do not seem to have been very strictly bound by their marriage vow.

The Illyrians are first mentioned in history in the Peloponnesian War, when Thucydides describes them offering a fierce resistance to Brasidas and the Spartans. In B.C. 383 they are found amalgamated into a sort of kingdom, under the sway of a bandit chief, Bardylis by name. This Bardylis attacked Macedonia, defeated the king Amyntas, and took several cities. Some years later he again attacked the Macedonians, and defeated and slew Perdiccas. The war was renewed when Philip came to the throne, and by his energy the inroads of the Illyrians were checked, and their country partially subjugated. Clitus, the son of Bardylis, in vain endeavoured to recover from Alexander the territory which his father had lost to Philip. Soon after this the Illyrians became formidable by sea as buccaneers, and carried their devastations over the coasts of Italy and the islands of the Ionian Sea. Their coasts afforded great facilities for privateering, as they abounded in excellent harbours, which were difficult of access, and were only known to the pirates themselves. The Greeks, unable to protect themselves, applied to the Romans for aid. The Romans, whose commerce had suffered severely, demanded redress. Teuta, the Illyrian queen, not only refused it, but murdered the Roman ambassadors. War was accordingly declared against her, and in B.C. 229 a Roman army invaded her country, and was everywhere victorious. Teuta was obliged to sue for peace, which was only granted her on condition that she should surrender a large tract of the Illyrian sea-board, and send out no armed vessel south of the Gulf of Lyssus. Ten years later the Illyrians renewed their inroads, and the second Illyrian War was proclaimed, which ended in exactly the same manner as the first. During the Macedonian War they proved faithful to their Roman masters, and considerable additions were made to their territory; but in B.C. 168 they again rebelled, and the Romans having defeated and taken Gentius, their king, and stormed Scodra, their capital, annexed their entire country. The Illyrians, though conquered, were far from being finally subdued, and their constant outbreaks and revolts were only kept in check by the presence of an overwhelming force. Under the empire, when the Romans were securing their conquest in this part of the world by a chain of forts along the Danube, they recruited their legions from the warlike youth of Illyria; and the vanity of the conquered race was sometimes flattered by seeing a countryman of their own seated on the throne of the Cæsars. Claudius, Aurelian, Probus, Diocletian, and Maximian were all the sons of Illyrian peasants. In the sixth century the Sclaves invaded Illyricum, and, defying the power of the Byzantine emperors, erected the independent kingdoms of Croatia and Dalmatia. (See AUSTRIA, HUNGARY, and DALMATIA.) Venice and Hungary were the next invaders, and they in their turn were compelled by the Turks to relinquish the greater part of their conquests in Illyria. After the beginning of the fourteenth century the name of this country disappeared altogether as a geographical term from the map of Europe, till, in 1809, it was revived by Napoleon. In that year the peace of Presburg was concluded, in virtue of which Austria ceded to the French emperor the Hungarian provinces south of the Drave, part of the Tyrol, Dalmatia, and the crown lands of Carinthia, Carniola, and the Küstenland. When the peace of Vienna restored these countries to the House of Hapsburg, the three last named of these provinces were erected into the kingdom of Illyria. As thus constituted, the kingdom of Illyria lay between N. Lat. 44. 59. and 47. 8., and E. Long. 12. 36. and 16. 27., and was bounded on the N. by the provinces of Salzburg and Styria, E. by Styria and Croatia, S. by the Adriatic, and W. by Lombardy. Its length from N. to S. was 160 miles, its breadth was 110; its area fell a little short of 11,000 square miles. In 1822 the circle of Carlstadt and the Küstenland were detached from it by the Emperor Francis, and annexed to Hungary, with a view to developing the internal resources of that country. The kingdom of Illyria now exists only in name. In 1849 the Austrians remodelled the territorial distribution of their empire. The division of the Illyrian kingdom was abolished, and out of it were formed the three provinces of Kärnthen or Carinthia, Krain or Carniola, and Küstenland or the Littorale (sea-board). Each of these provinces will be found described under its special head.

Ilminster || Imeritia.

ILMINSTER, a market-town of Somersetshire, on the Ile, an affluent of the Parret, 10 miles S.E. of Taunton. It consists of two streets, one of which extends nearly a mile from E. to W., and is crossed by the other at right angles. The parish church is a large cruciform edifice with a square embattled and pinnacled tower. Ilminster possesses a well endowed grammar school, with four exhibitions at Oxford. Some woollen cloth, lace, and silk manufactures are carried on. Market-day, Wednesday. Pop. of parish (1851) 3299.

ILVA, the ancient name of Elba. See ELBA.

IMAGINATION is defined by Isaac Taylor to be "the power which the mind has to decompose its conceptions and to recombine the elements of them at its pleasure." See POETRY, &c., &c.

IMAUM, or IMAN, a minister in the Turkish empire, corresponding to our parish priest. He has the ordinary charge of a mosque, calls the people to prayer, and reads the prayers. The chief education of the Imans consists in acquaintance with the Koran. They are elected by the people, are independent ecclesiastically, and may quit their office if they choose. They wear wide turbans, differing in form from the common ones. It is death for a Christian to beat an Iman. The Iman who presides at the Friday prayers is of a higher grade than the ordinary Iman. The name is also applied to the founders of the four chief Mohammedan sects; thus Ali is the Iman of the Persians, and in this case the dignity or *Imanate* is hereditary.

IMBROS, or IMBRO, an island belonging to Turkey, in the Grecian Archipelago, and lying west from the entrance to the Dardanelles, in Lat. 40. 10. N., Long. 25. 50. E. It is 18 miles in length from E. to W., by about 10 in breadth, and is well wooded and mountainous. Its loftiest peak rises to the height of 1959 feet. The valleys are fertile, and produce wine, oil, cotton, &c. Pop. about 4000.

IMERITIA, or IMERETHI, a province of Russian Transcaucasia, forming part of the ancient Colchis; bounded N. by the main range of the Caucasus, E. by Georgia, W. by Mingrelia, and S. by Akhalzik. It is 90 miles in length from N. to S., by 75 in breadth. Area about 5000 square miles. The surface is generally uneven and rugged, being traversed by offshoots from the Caucasus, but the soil is of great fertility. The climate is very mild and favourable to the cultivation of the products of warm countries, being protected from the north winds by the lofty range of the Caucasus. In many parts the trees produce fruit twice a year. The loftier mountain slopes are covered with immense forests; lower down are extensive tracts of luxuriant pasture; while the valleys and plains produce abundant crops of wheat, barley, maize, tobacco, hemp, &c. The Rion and its tributaries are the only streams in the province. Game is abundant. There are no manufactures of importance. The chief exports are the productions of the coun-

Immaculate Conception || Impeachment.

try, including wine, silk, honey, wax, skins, wool, and fruits; chief imports—woollen, linen, and silk goods, iron and copper wares, jewellery, salt, and colonial produce. The slave trade, formerly considerable, has been abated by the Russians. Kootais, the capital, and only town in the province, is situated on the Rion, and contains about 3000 inhabitants.

In the fourteenth and fifteenth centuries Imeritia formed part of the kingdom of Georgia. It subsequently became independent and was governed by its own kings. Afterwards it was subdued by the Turks, who in 1770 were expelled by the Russians. It continued to be governed by its own kings till 1804, when one of them, in order to secure himself in the government against a rival, acknowledged the supremacy of Russia; and he and his successors were declared the lawful princes of Imeritia. Pop. about 100,000.

IMMACULATE CONCEPTION is the name given in the Church of Rome to the doctrine that the Virgin Mary was conceived in the womb sinlessly as Christ himself was. The first public controversy on this question arose A.D. 1140, at which time various churches, both in England and France, had begun to hold festal days in honour of the immaculate conception. Of the more important churches, that of Lyons was the first to celebrate this festival, and it was the opposition raised to it by Bernard that brought on the discussion. In the fourteenth century this doctrine was one of the points of controversy between the Dominicans and Franciscans, the two most powerful religious orders of the time.

On the side of the Franciscans great renown was acquired by the celebrated Scotus in defending the dogma, for he set himself specially to oppose Thomas Aquinas, the great oracle of the Dominicans, and hence arose the division of sects known as Thomists and Scotists. In the seventeenth century the old dispute between the Dominicans and Franciscans raged with greater fury than ever. Two kings of Spain, Philip III. and IV., sent to Rome for the express purpose of having the dispute authoritatively settled by the sovereign pontiff. These embassies were sent to three different pontiffs, Paul V., Gregory XV., and Alexander VII., but they all shrank from the task. It was obviously dangerous to decide against either of such powerful parties, and the pontiffs evaded the difficulty by declaring that the arguments of the Franciscans were of some weight, and by forbidding the Dominicans to attack the Franciscan doctrines publicly. Notwithstanding this vacillation on the part of the above-named pontiffs, the question seems to have been virtually settled in the fifth session of the Council of Trent, where it is said that the "Blessed and Immaculate Virgin Mary" is excepted from the decree concerning original sin. However, as the controversy continued from time to time to disturb the Church, it was finally decreed by the bull of Pio Nono, 8th December 1854, that the doctrine of the Immaculate Conception is an article of faith of the Church of Rome.

IMOLA (the ancient *Forum Cornelii*), a town of the Papal States, legation of Ravenna, and 25 miles W.S.W. of the town of that name. It stands on the river Santerno and the Æmilian way; and is surrounded by walls, with the protection of several towers and an old castle. It is a cathedral city, and contains numerous churches and convents, a college, hospital, theatre, literary academy, and public library. Imola is the centre of a considerable trade in wine and agricultural produce, and some manufactures of cream-of-tartar and woollen hosiery. Pop. about 10,000.

IMPEACHMENT, an accusation and prosecution for treason and other high crimes and misdemeanours. Any member of the Lower House of Parliament may impeach any one belonging either to that body or to the House of Lords. The method of proceeding is to exhibit articles on behalf of the Commons, by whom managers are appointed to make good their charge. These articles are carried to the Lords, by whom every person impeached by the Commons is always tried; and if they find him guilty, no pardon under the great seal can be pleaded to such an impeachment. (12th Will. III., cap. ii.)

Impressment || Imprisonment.

IMPRESSMENT for the naval service, by the king's commission, has been a matter of much dispute, and submitted to with great reluctance; though Sir Michael Forster strenuously contends that the practice of impressing, and granting powers to the admiralty for that purpose, is of a very ancient date, and has been uniformly continued by a regular series of precedents to the present time, from which he concludes that it is part of the common law. The difficulty arises from the fact that no statute has expressly declared this power to be in the crown, though many of them very strongly imply it. But whatever may be said as to the legality of this method of manning the navy, there can be no doubt that it is a gross invasion of natural liberty; and hence it has in recent times been very generally reprobated, not only as forming a great anomaly in a free country, where natural rights are in all other cases respected, but likewise as contrary to sound policy, and at variance with the principles on which recruitment ought to be conducted, excepting in those cases of imperious necessity which imply the suspension of all ordinary rights and laws.

IMPRISONMENT, a mode in England and Scotland of enforcing payment of debt; or performance of a covenant after judgment; and of securing persons accused of crimes for trial and sentence. It forms also one of the ordinary criminal punishments. Its history in Scotland curiously illustrates the progress of civilization in that country. The earliest warrants of imprisonment in that country for payment of civil debts were granted by magistrates of burghs, and still exist under the name of acts of warding. At a later period letters of four forms were issued under the royal signet; and the debtor, whether recusant or poor, was denounced as a rebel, and incarcerated for non-payment. This cumbrous method was followed by *letters of horning and caption*. Various other simplifications were effected in the years 1503, 1606, and 1612; till, by the statute 1st and 2d Vict., c. 114, sec. 8, it was declared that letters of horning and caption may be continued only at the creditor's option and expense, and a more rational course was substituted; the court which pronounced the judgment being empowered to grant a short and simple warrant of imprisonment on a charge to fulfil it being disobeyed. Such warrants also now pass, after charges of payment, on protests of bills of exchange, and on recorded bonds and formal deeds, containing clauses of registration for execution. The effect of denouncing a debtor as a rebel on a charge of payment being disobeyed, is to enable the creditor to accumulate the original debt and all arrears of interest into one principal sum, on which interest thereafter runs. The letters of caption, and the short warrant recently introduced, contain authority to break open the doors of any place within which the debtor may be concealed.

In England, if a man is once imprisoned till he make the satisfaction awarded by a court of law, no other or new process can be sued out against his lands or goods, and he must remain in prison, if his creditor please, till he make the satisfaction required, or obtain his discharge as a bankrupt, or take the benefit of the Insolvent Debtors' Act. After liberation he cannot be re-incarcerated on the same warrant. But it is no objection to the attachment of a debtor's property in Scotland that he is in prison for the same debt, nor even that his effects have been pointed or attached before his imprisonment, provided they have not actually been sold. If the sale take place either before or after his imprisonment, without producing a sum sufficient to extinguish the debt, the imprisonment may be enforced or continued for the deficiency. A debtor in Scotland may even be liberated and re-incarcerated on the same warrant; but where this is done oppressively, the court will interfere, and require the

Imprisonment.

creditor to justify his conduct by showing some intervening improvement in the circumstances of the debtor. Magistrates of prisons are bound to receive debtors with the necessary warrants, under pain of liability for the debt; and the imprisonment is required to be strict. On legal evidence of absolute necessity for the preservation of health, the necessary relaxation is allowed; but it must be withdrawn when the necessity ceases. If a debtor escape through negligence or connivance, or insufficiency of the prison, the magistrates are liable for the debt; but not if the escape were forcible and under night, or by an accident, provided the officials have done all in their power to prevent it, or to recover the person of the prisoner. An exception occurs in the case of a person imprisoned till he find security to appear in a subsequent suit; it being sufficient, though he temporarily escape, that he is timeously produced when required in the suit.

A royal commission having been issued in the reign of William IV., on the subject of imprisonment for debt in Scotland, the statute 5th and 6th Will. IV., c. 70, was passed, declaring it unlawful to imprison for a civil debt which does not exceed L.8, 6s. 8d., exclusive of interest and expenses, unless the debt be due to the crown, or for poor rates, local taxation, or for aliment. In England, by the 7th and 8th Vict., c. 96, § 58, imprisonment is unlawful for a judgment debt under L.20; and on mesne process it is no longer allowed except when the party is about to quit the country, and even then the discharge can be obtained on putting in bail. Under the new County Court Acts (9th and 10th Vict., c. 95, amended by the 13th and 14th Vict., c. 61) the county court judges have power to direct the imprisonment of a debtor for forty days in certain cases, and whatever may be the amount of the debt.

As to the imprisonment of offenders in order to trial for crimes, usually called apprehension, see ARREST. The course of proceeding before justices or magistrates is now regulated by the 11th and 12th Vict., c. 42. If no bail be allowed, the accused is committed to the common gaol or house of correction for safe custody until delivered by due course of law. By the recent statute 18th and 19th Vict., c. 126, with the consent of the accused, the charge may be summarily tried, instead of being sent to a jury at the sessions or assizes. The accused party must, in the first instance, be brought before the magistrate or justice for examination, and unless there appear reason for his immediate release, he is remanded to prison for further examination, and an inquiry into the evidence of his guilt is taken. If the evidence of guilt appear sufficient, the judge then grants a warrant of commitment. In small offences committed once or twice only, the trial before the judge proceeds immediately. In all other cases the injured parties and witnesses, in England, are bound over to prosecute at the sessions or assizes, while in Scotland the precognitions are reported to the Lord Advocate, who, by himself, or his deputes, directs how the cases shall be disposed of, either by abandonment of the charge or trial. If the offence is a bailable one, the party may be liberated on bail until the time of trial. The punishment of imprisonment is now limited so as not to exceed three or at the most four years, but frequently with the additional severity of hard labour, or solitary confinement, as directed by the 7th Will. IV., and 1st Vict., c. 90, § 5. Imprisonment is also sometimes inflicted in capital cases by way of commutation for death (11th Geo. IV., and 1st Will. IV., c. 39, § 7). Under the Scotch statute 1701, c. 5, the accused may take measures to have a day fixed, within sixty days, for his trial, and if the trial be not concluded within forty days afterwards, he is entitled to liberation. The day for trial before an inferior court must be within thirty days after the sixty. A party so liberated may be brought to trial in the superior court within an additional term of forty days; but unless the trial be concluded by that time, he is held for ever discharged from the criminal consequences of his offence. This statute is regarded as the *habeas corpus* of Scotland. In England, if any one conceive himself to be illegally detained in prison, he is entitled, by 16th Car. I., c. 10, to demand a writ to bring his body before the Court of the Queen's Bench or Common Pleas, who shall decide in regard to the justice of his commitment. Blackstone remarks that, by 31st Car. II., c. 2, commonly called the *habeas corpus* act (amended and made more effectual by the 56th Geo. III., c. 100), the methods of obtaining this writ are so plainly pointed out, that so long as that statute remain unimpeached, no subject of England can be long detained in prison, except in those cases in which the law requires and justifies such detention. (M. L.)

Improvisatori || Incense.

IMPROVISATORI, the name applied to those who exercise the faculty of declaiming in verse upon any subject whatever without previous preparation. In no country has it been practised so extensively as in Italy, where it was introduced by the *provençal* bards in the twelfth century. The first eminent improvisatore was Serafino d'Aquila, who was born A.D. 1466, and died A.D. 1500. He was followed and surpassed by many of his countrymen. In the beginning of the sixteenth century, the learned Greek refugees introduced into Italy their *Symposia*, and these entertainments were in great favour with Leo. X. After his death, the native language of the Italians was adopted in place of Latin, in which the improvisatori had previously declaimed. Perhaps the most successful of the class since then was Perfetti, who was born at Sienna 1680, and died at Rome 1747. He gained the laurel crown which had been awarded only to Petrarch and Tasso. The recitation of the improvisatori was often accompanied by music. The extemporaneous verses uttered on one single occasion amounted to hundreds, and even to thousands of lines. Whole tragedies were produced—the subjects being chosen by the spectators. The most celebrated improvisatrice was Corilla of Pistoia, but the printed works of this class of versifiers never rise above mediocrity.

IN CŒNA DOMINI, *i.e., at the Lord's Supper*, a name given to one of the Papal bulls, from its being annually read in the Romish churches on Holy Thursday. During the dark ages it was fulminated against those who showed any favour to heretics, or who imposed any taxes upon the clergy. Its present form was given it by Urban III. in 1627, after the Reformation, and consequently it specifies all the Protestant sects for anathema and excommunication. The bull extends to those who read or keep heretical books without permission from the Pope.

INCENSE, or FRANKINCENSE (*thus* and *olibanum*), a dry resinous substance, which when burnt (*incensum*) produces a pleasant perfume. Amongst ancient Pagan nations the perfume of incense was generally offered to the gods; and as the representative of God, the Persian sculptors exhibit incense burnt before the king. The word used to denote incense arising from spices (Exod. xxx. 1), is also used in Hebrew to describe the smoke arising from fat (Ps. lxvi. 15). Incense, as used by the Jewish priests, was a compound of stacte, onycha, galbanum, and pure frankincense. This compound was to consist of equal parts of each ingredient, to be broken into very minute particles, and deposited before the ark. It was to be used specially in the service of Jehovah; and its use in private life was forbidden (Exod. xxx. 34–38). The origin of incense in the Jewish worship, according to Maimonides (in *More Nevochim*), was to prevent the disagreeable effects of having such numbers of animals slaughtered for sacrifice. He accordingly regards the precept for burning incense as conducing to the reverence which should be felt in the sanctuary. But beyond this, it is to be remembered that incense is symbolical of prayer. (Ps. cxli. 2; Rev. viii. 3, 4.)

Inchbald.

The burning of incense formed part of the daily service of the ancient Jewish Church. The priests having drawn lots to ascertain who should offer it, the person destined took a large silver dish, in which was a censer full of incense; and being accompanied by another priest carrying some live coals from the altar, went into the temple, where, in order to give notice to the people, they struck upon an instrument of brass placed between the temple and the altar; and being returned to the altar, he who brought the fire left it there, and went away. Then the offerer of incense having said a prayer or two, waited the signal, which was the burning of the holocaust; immediately after which he set fire to the incense, the multitude continuing all the time in prayer.

INCHBALD, Mrs Elizabeth, an English actress, dramatic author, and novelist, was the daughter of a farmer, and was born in 1753 at Standingfield, near Bury St Edmunds, in Suffolk. She lost her father at an early age, and her mother, a giddy and foolish woman, was too gay to take any care of her up-bringing. Tired of the dull routine of a country-life, Miss Simpson conceived the idea of running away from home, and seeking fortune, and perhaps fame, on the stage. She arrived in London with a few shillings of money, a small bundle of clothes, and a great store of trashy romance in her head. In the course of her various adventures she made acquaintance with some of the directors and actors of the London theatres, but sought in vain to be admitted into any of their companies. Recounting her rebuffs, and the dangers of her position, to Mr Inchbald, one of the comedians of Drury-Lane, she so touched him by the narrative that he offered her his hand. There was a great disparity of years between them, but their union was perfectly happy. Inchbald trained her to the stage, and acted with her in the provincial theatres of England, and afterwards for four years in Edinburgh, with great applause. On his death in 1778, she began to write for the stage, to which she bade adieu as an actress in 1789. The success of her dramatic pieces, and the strict economy of her life, soon made her independent of the world; and her prudence, virtue, and refined manners, opened up to her all but the highest grades of the social scale. Her frugal habits remained with her to the last; and she denied herself many of the comforts of life in order that her invalid sister might want none of its luxuries. Some of the entries in her journal prove that she was not above a few of the little weaknesses of her sex. In her youth she had possessed a rare beauty, and in her diary she sometimes laments the effects of increasing years. One extract will serve as a sample: "1798. London. Rehearsing *Lover's Vows;* happy, but for a suspicion, amounting to a certainty, of a rapid appearance of age on my face." She died at Kensington, Aug. 1, 1821, in the sixty-ninth year of her age. Shortly before her death it became known that she had written the history of her chequered career, and she was offered L.1000 for the MS., which was with good reason believed to be both interesting and valuable. She refused the offer, however, and left strict orders that it should be destroyed after her death; and her orders were obeyed. The loss, however, was to some extent compensated by the publication in 1833 of her *Memoirs*, compiled chiefly from an autograph journal which she had kept for about 50 years. This work is one of the most interesting of its class.

Mrs Inchbald's plays amounted to nineteen in all. Some of them were very successful; and one of them, *Wives as they were, and Maids as they are*, still keeps the stage. Of far higher merit, however, as a work of art, is her *Such things are;* and scarcely inferior are, *The Married Man; The Wedding Day; The Midnight Hour; Every one has his Fault;* and *Lover's Vows*. In a literary point of view, these plays are thrown into the shade by her two novels, *A Simple Story*, 1791; and *Nature and Art*, 1796. These two works rank among the happiest productions of the female pen; and charm both by their views of life and sketches of character, their simple truth and naturalness, the high and pure moral which they teach, and the easy grace and lightness of their style. They have both been translated into French.

Inchcolm || Independents.

INCHCOLM, or Columba, an island in the Firth of Forth, forming part of the parish of Dalgetty, Fifeshire, and lying two miles S. of Aberdour. It is only about a mile in length; but is interesting as the site of an ancient monastery, founded by Alexander I. about 1123. The legend is, that this monarch, in passing the Firth of Forth, was overtaken by a violent storm, which drove him to this island, where he met with the most hospitable reception from a poor hermit, then residing in the chapel of St Columba, and who, for the three days during which the king remained there tempest-bound, entertained him with the milk of his cow and a few shell-fish. His majesty, from the sense of the danger which he had escaped, and in gratitude to the saint to whom he attributed his safety, vowed some token of respect, and accordingly founded here a monastery of Augustines, and dedicated it to St Columba. Allan de Mortimer, lord of Aberdour, who attended Edward III. in his Scotch expedition, bestowed half of those lands on the monks of this island for the privilege of a family burial-place in their church. The buildings erected in consequence of the piety of Alexander were extensive; and there is still to be seen a large square tower belonging to the church, with the ruins of the church and of several other buildings. The wealth of this place in the time of Edward III. proved so strong a temptation to his fleet, then lying in the Forth, as to suppress all the horror of sacrilege and respect to the sanctity of the inhabitants. The English landed, and spared not even the furniture more immediately consecrated to divine worship. But due vengeance overtook them; for, in a storm which instantly followed, many of them perished; and those who escaped, struck with the justice of the judgment, vowed to make ample recompense to the injured saint. The tempest ceased, and they performed the promised atonement.

INCHKEITH, a small island in the Firth of Forth, lying about halfway between the port of Leith and Kinghorn on the opposite shore. It is said to derive its name from the gallant Keith, who so greatly signalized himself by his valour in 1010, in the battle of Barry, in Angus, against the Danes; after which he received in reward the barony of Keith, in Lothian, and this little island. In 1549 the English fleet, sent by Edward VI. to assist the lords of the congregation against the queen-dowager, landed, and began to fortify this island, the importance of which they became sensible of, after their neglect of securing the port of Leith, so lately in their power. They left here five companies to cover the workmen, under the command of Cotterel; but their operations were soon interrupted by M. Desse, general of the French auxiliaries, who took the place, after a gallant defence on the part of the English. The Scotch kept possession of the island for some years; but at last the fortifications were destroyed by act of parliament, to prevent it from being of any use to the French. The French gave it the name of *L'Isle des Chevaux*, from the grass which it produced being very nutritious for horses. A lighthouse, with a revolving light, was erected on the island in 1805, and has proved highly beneficial to the shipping frequenting the Forth.

INCOMBUSTIBLE Cloth. See Amianthus; and Mineralogy.

INDENTURE, in *Law*. See Master and Servant.

INDEPENDENTS, a sect of Protestants, so called from their maintaining that each congregation of Christians, with its office-bearers, which meets in one house for public worship, is a complete church; has sufficient power to act

Independents.

and perform every thing relating to religious government within itself; and is thus *independent* of all extraneous control in spiritual matters, though still amenable to the judgment of sister churches which may express censure by withdrawing from fellowship with any church that seems to them to be walking disorderly.

The Independents, like every other Christian sect, derive their origin from the practice of the apostles in planting the first churches; but they were unknown in modern times till they arose in England during the reign of Elizabeth. The hierarchy established by that princess in the churches of her dominions, the vestments worn by the clergy in the celebration of divine worship, the book of common prayer, and, above all, the sign of the cross used in the administration of baptism, were very offensive to many of her subjects, who during the persecution of the former reign had taken refuge amongst the Protestants of Germany and of Geneva. Those men thought that the Church of England resembled, in too many particulars, the Church of Rome, which they believed to be antichristian; and they called perpetually for a more thorough reformation, and a purer worship. From this circumstance they were stigmatised by their adversaries with the general name of *Puritans*, as the followers of Novatian[1] had been in the ancient church. Elizabeth was not disposed to comply with their demands; and it is difficult to say what might have been the issue of the contest had the Puritans been united in sentiments, in views, and in measures. But the case was quite otherwise. That large body,—composed of persons of different ranks, characters, opinions, and intentions, and unanimous in nothing but in their antipathy to the forms of doctrine and discipline which were established by law,—was all of a sudden divided into a variety of sects. Of these, the most famous was that which was formed about the year 1581, by Robert Brown; a man insinuating in his manners, but unsteady and inconsistent in his views and notions of men and things.

This innovator differed not in point of doctrine either from the Church of England or from the rest of the Puritans; but he had formed notions, then new and singular, concerning the nature of the church and the rules of ecclesiastical government. He was for dividing the whole body of the faithful into separate societies or congregations; and maintained, that such a number of persons as, "by a willing covenant made with their God, are under the government of God and Christ, and keep His laws in one holy communion," ought to be considered as a church, and enjoy all the rights and privileges that are competent to an ecclesiastical community. These small societies he pronounced independent *jure divino*, and entirely exempt from the jurisdiction of the bishops, in whose hands the court had placed the reins of spiritual government; and also from that of presbyteries and synods, which the Puritans regarded as the supreme visible sources of ecclesiastical authority. He also maintained that the power of governing each congregation resided in the people, and that each member had an equal share in this government, and an equal right to order matters for the good of the whole society. Hence, all points both of doctrine and discipline were submitted to the discussion of the congregation, and whatever was supported by a majority of voices passed into a law. It was the congregation also that elected certain of the brethren to the office of pastors, to perform the duty of public instruction and the several branches of divine worship; reserving, however, to themselves the power of dismissing these ministers, and reducing them to the condition of private members, whenever they should think such a change conducive to the spiritual advantage of the community. It is likewise to be observed that the right of the pastors to preach was by no means of an exclusive nature, or peculiar to them alone; since any member who thought proper to exhort or to instruct the brethren was abundantly indulged in the liberty of "prophesying" to the whole assembly. Accordingly, when the ordinary teacher or pastor had finished his discourse, all the other brethren were permitted to communicate in public their sentiments and illustrations upon any useful or edifying subject. Such, at least, is the account usually given of Brown's views, but it receives very slender support from his extant writings.[2]

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The zeal with which Brown and his associates maintained and propagated these notions was ardent and active. He affirmed that all communion was to be broken off with those religious societies which were founded upon a different plan from his; and treated the Church of England more especially as a spurious church, the ministers of which were unlawfully ordained, whilst her discipline was popish and antichristian, and her sacraments and institutions destitute of all efficacy and virtue. The sect of this innovator, not being able to endure the severe treatment which their own zeal had brought upon them from an administration which was not distinguished for its mildness and indulgence, retired into the Netherlands, and founded churches at Middleburg in Zealand, and at Amsterdam and Leyden in the province of Holland. But their establishments were neither solid nor lasting. Their founder returned into England, and having renounced his principles of separation, took orders in the established church, and obtained a benefice. The Puritan exiles, whom he thus abandoned, disagreed amongst themselves, and having split into parties, their affairs gradually declined. This engaged the wiser part of them to mitigate the severity of their founder's plan, and to soften the rigour of his uncharitable decisions.

The person who had the chief merit of bringing about this reformation was one of their pastors called John Robinson, a man who possessed much of the solemn piety of the times, and no inconsiderable portion of learning. This well-meaning reformer, perceiving the defects which reigned in the discipline of Brown, and in the spirit and temper of his followers, employed the utmost zeal and diligence in correcting them, and in new-modelling the society in such a manner as to render it less odious to its adversaries, and less liable to the censure of those Christians who looked upon charity as the end of the commandments. Hitherto the sect had been called Brownists; but Robinson having, in his Apology, affirmed, "Cœtum quemlibet particularem, esse totam, integram, et perfectam ecclesiam ex suis partibus constantem immediate et *independenter* (quoad alias ecclesias) sub ipso Christo," the sect was henceforth called *Independents*, and the apologist was considered as its founder, though Robinson was not the first to use that term.

The Independents were much more commendable than the Brownists, whom they surpassed both in the moderation of their sentiments, and in the order of their discipline. They did not, like Brown, pour forth bitter and uncharitable invectives against the churches which were governed by rules entirely different from theirs, nor pronounce them on that account unworthy of the Christian name. On the contrary, though they considered their own form of ecclesiastical government as of divine institution, and as originally introduced by the authority of the apostles, nay, by the apostles themselves, they

[1] The followers of Novatian were called *Puritans*, because they would not communicate with the Catholic Church, under pretence that her communion was polluted by admitting those to the sacred mysteries who through infirmity had sacrificed to idols in times of persecution. These unhappy men were not received by the church till after a long course of penance. But the Novatians would not receive them at all, however long their penance, or however sincere their sorrow, for their sin. In other respects, the ancient Puritans were, like the English, orthodox in the faith, and irreproachable in their morals.

[2] See Hanbury's *Memorials*, vol. i., p. 20.

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had yet candour and charity enough to acknowledge that true religion and solid piety might flourish in those communities which were under the jurisdiction of bishops or the government of synods and presbyteries. This is put beyond all doubt by Robinson himself, who expresses his own private sentiments and those of his community in the following clear and precise words:—Profitemur coram Deo et hominibus, adeo nobis convenire cum ecclesiis reformatis Belgicis in re religionis, ut omnibus et singulis earundem ecclesiarum fidei articulis, prout habentur in harmonia confessionum fidei, parati simus subscribere. Ecclesias reformatas pro veris et genuinis habemus, cum iisdem in sacris Dei communionem profitemur, et, quantum in nobis est, colimus." They were also much more attentive than the Brownists in keeping on foot a regular ministry in their communities; for, whilst the latter allowed promiscuously all ranks and orders of men to teach in public, the Independents had, and still have, a certain number of ministers, chosen respectively by the congregations where they are fixed; nor is any person amongst them permitted to speak in public before he has submitted to a proper examination of his capacity and talents, and been approved of by the heads of the congregation.

Robinson presided as pastor of a church which had been formed at Leyden, composed principally of refugees from England, from 1609 till 1625, when he died. He was held in much esteem, not by his own congregation merely, but in the city generally, for his piety, his charity, and his learning. After he had been settled six years there, he became a member of the university, which placed him beyond the control of the civil magistrate, and secured to him certain fiscal privileges, such as exemption within certain limits, from duties payable on beer and wine, &c. Besides attending to the care of his flock he addicted himself to theological studies, and composed several treatises, chiefly of a controversial nature, on theological and ecclesiastical questions.[1] He was engaged in a protracted and somewhat vexatious strife with some of his fellow exiles connected with the church at Amsterdam, on subjects relating to church order, especially intercommunion with other churches, and the limits of the elders' power in the government of the church. On these questions Robinson (with whom the learned Ainsworth sided) advocated views such as are now generally entertained by Independents. He recognised as worthy of confidence and fraternity all churches holding sound doctrine; and he maintained the unlawfulness of elders acting in the government of the church apart from the body of the members. In common with all the Independents of that age, he held what they called "the tri-formed presbytery;" by which they meant an eldership composed of persons holding three distinct offices,—the pastor, the teacher, and the ruler.

The wish of the exiles was to return to their own land, and there to be allowed in peace to set up their altars and observe their ordinances; but the tyranny of their persecutors continuing to render it daily less probable that this end would ever be gained, they turned their thoughts across the Atlantic, and made preparations for transporting themselves and their households to the unoccupied regions of America, in the hope of finding there that liberty which their own country denied them. In this scheme of emigration Robinson took an active part. He was mainly instrumental in procuring the fitting-out of the Mayflower and the Speedwell, in which the first band of emigrants crossed the ocean to lay the foundations of that great commonwealth which now spreads its gigantic limbs from the Atlantic to the Pacific; and though death arrested his own steps before he could accomplish his purpose of joining those whom he had sent away before, he was so much the soul of the whole enterprise that he may be justly honoured as the founder of the states which owe their origin to the Pilgrim Fathers.

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In the meanwhile important changes had been transpiring in England. The severe measures of Bancroft the primate, against the Puritans, had resulted in the excision from the Anglican church of 300 clergymen, many of whom held views nearly akin to those of the Independents. Of this latter class the leader was Henry Jacob, who was for some time connected with Robinson at Leyden, and with whom, and not with Robinson, the use of the term *Independent* originated.[2] Jacob emigrated to New England in 1624, where he soon after died; but the church which he had founded in London continued to sustain itself amidst much persecution, and has preserved its succession unbroken to the present day. It numbers among its pastors Lathrop, Canne, Samuel How, and other men eminent in the history of religion in England. From this, as a nucleus, Independency gradually spread through England, and, in spite of the harsh measures of Laud and the court, came, in the middle of the seventeenth century, to occupy a dominant place among the powers by which the destinies of England were swayed. In the Westminster Assembly the Independents took an active share in the discussions which occupied that reverend body, especially on points of church order; "debating all things," says Baillie, "which came within twenty miles of their quarters," and astonishing him by their "great learning, quickness, and eloquence, together with their great courtesy and discretion in speaking." After the Restoration, they, in common with all Nonconformists, shared the sufferings which it was the pleasure of the dissolute sovereign to inflict upon all who would not in every particular assent to whatever the ruling powers might see meet to prescribe in religious matters. The wise and beneficent administration of William III. restored to them the enjoyment of liberty of worship by the Act of Toleration, which was passed in 1689, an act which, though its provisions fall short of what the true idea of religious liberty requires, was felt by the Dissenters to be a precious boon. In 1691 a union was effected between the Independents and the Presbyterians, on grounds which indicate that the latter had come to embrace to a great extent the ecclesiastical principles of the former. From this time forward English Presbyterianism became merged in Independency, the name only being retained by a few congregations which, inclining to Arianism or Unitarianism, called themselves Presbyterians for the sake of securing endowments which had been attached to their places of meeting. The general body of Independents, however, is divided into two great sections by differences of view on the subject of baptism; hence the Baptists often rank as a distinct sect, though really Independents. Under the House of Hanover the English Independents have suffered no persecution, but it was not till the repeal of the Test and Corporation Acts in 1828 that all civil disabilities were removed from them, and their right to social equality with their fellow-subjects legally acknowledged.

Among the names which adorn English literature, several are those of men who belonged to this religious body. It is sufficient to mention the names of Owen, Goodwin, Milton, Howe, Gale, Foster (celebrated by Pope in these lines:—

"Let modest Foster, if he will, excel
Ten Metropolitans in preaching well,")

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[1] His collected works were published in 1851, in 3 vols. 12mo.

[2] "Where each ordinary congregation giveth their free consent in their own government, there certainly each congregation is an entire and *independent* body-politic, &c." (Jacob's *Declaration and Plainer Opening of certain Points*, &c., p. 13.) This treatise was published in 1612. Robinson's *Apology* did not appear till 1619.

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Bunyan, Defoe, Watts, Doddridge, Ed. Williams, Robert Hall, John Foster, J. P. Smith, and Wardlaw, to justify this assertion. Of these several were Baptists.

In 1851, when the census was last taken, the Independents (exclusive of the Baptists) possessed in England and Wales congregations to the number of 3244; with an average attendance for the whole, on census Sunday (March 30), of 404,686; and in Scotland 168 congregations, with an average attendance for the whole of 57,466. In the latter estimate, however, are included two distinct bodies, which do not hold fellowship with each other, though at one on matters of church order. In Ireland and the Channel Islands the number of Independent congregations is about 30. In the British colonies it is estimated that there are 144 congregations. In the United States there are about 1500 congregations, of which at least 1000 are in New England. The number of members is computed at 160,000. The Independents have 9 colleges in England and 1 in Scotland for the education of their ministry.[1]

Though the Independents reject creeds of human composition as tests of orthodoxy and standards of truth, it must not be concluded that they doubt or disbelieve the doctrines deemed orthodox in other churches. Their predecessors in the last century were thought to be more rigid Calvinists than the Presbyterians themselves; as many of those may likewise be who in the present century admit not the confessions and formulas of the Calvinistic churches. They acknowledge as divine truth every doctrine contained in the Scriptures, but they think that scriptural doctrines are most properly expressed in scriptural language; and the same spirit of religious liberty which makes them reject the authority of bishops and synods in matters of discipline, makes them reject the same authority in matters of faith. In either case, to call any man or body of men their masters, would, in their opinion, be a violation of the divine law, since "one is their master, even Christ, and they are all brethren."

In support of their scheme of congregational churches, they observe that the word ἐκκλησια, which we translate *church*, is always used in scripture to signify either a *single congregation*, or the *place* where a single congregation meets. Thus that unlawful assembly at Ephesus brought together against Paul by the craftsmen is called ἐκκλησια, *a church* (Acts xix. 32, 39, 41). The word, however, is generally applied to a more sacred use; but still it signifies either the *body* assembling, or the *place* in which it assembles. The whole body of the disciples at Corinth is called *the church*, and spoken of as coming together into *one place* (1 Cor. xiv. 23). The place into which they came together we find likewise called *a church*; "when ye come together in the *church*—when ye come together into one place" (1 Cor. xi. 18, 20). Wherever there were more congregations than one, there were likewise more *churches* than one. Thus, "Let your women keep silence in the *churches*," ἐν ταις ἐκκλησιαις (1 Cor. xiv. 34). The whole nation of Israel is indeed called a *church*, but it was no more than a single congregation, for it had but one place of public worship, namely, first the tabernacle, and afterwards the temple. The catholic church of Christ, his holy nation and kingdom, is likewise a single congregation, having one place of worship, that is, heaven, where all the members assemble by faith and hold communion; and in which, when they shall all be fully gathered together, they will in fact be one glorious assembly. Accordingly we find it called "the general assembly and church of the first-born, whose names are written in heaven."

Besides these, the Independent can find no other description of a church in the New Testament; not a trace of a diocese or presbytery consisting of several congregations all subject to one jurisdiction. The number of disciples in Jerusalem was certainly great before they were dispersed by the persecution in which Paul bore so active a part. Yet they are never mentioned as forming distinct assemblies, but as one assembly meeting with its elders in one place; sometimes in the temple, sometimes in Solomon's porch, and sometimes in an upper room. After the dispersion, the disciples who fled from Jerusalem, as they could no longer assemble in one place, are never called a church by themselves, or one church, but the *churches* of Judæa, Samaria, and Galilee (Acts ix. 31; Gal. i. 22). Hence the Independent concludes, that in Jerusalem the words *church* and *congregation* were of the same import; and if such was the case there, where the gospel was first preached, he thinks we may reasonably expect to find it so in other places. Thus, when Paul on his journey calls the elders of the church of Ephesus to Miletus, he speaks to them as the joint overseers of a single congregation:—"Take heed to yourselves, and to all the flock over which the Holy Ghost hath made you overseers" (Acts xx. 28). Had the church at Ephesus consisted of different congregations united under such a jurisdiction as that of a modern presbytery, it would have been natural to say, "Take heed, to yourselves, and to the *flocks* over which the Holy Ghost hath made you overseers;" but this is a way of speaking of which the Independent finds no instance in the whole of the New Testament. The sacred writers, when speaking of all the Christians in a nation or province, never call them *the church* of such a nation or province, but *the churches* of Galatia (Gal. i. 2), *the churches* of Macedonia (2 Cor. viii. 1), *the churches* of Asia (1 Cor. xvi. 19). On the other hand, when speaking of the disciples in a city or town, who might ordinarily assemble in one place, they uniformly call them *a church*; as, the church of Antioch, the church at Corinth, the church of Ephesus, and the like.

In each of these churches or congregations there were bishops, sometimes called elders, and deacons; and in every church there seems to have been more than one elder, in some a great many, "who all laboured in word and doctrine." Thus we read (Acts xiv. 23) of Paul and Barnabas ordaining elders (to be bishops and deacons) in every church; and (Acts xx. 17) of a company of elders in the church of Ephesus, who were exhorted to "feed the flock, and to take heed to themselves and to all the flock over which the Holy Ghost had made them overseers." But of such elders as are to be found in modern Presbyterian churches, who neither teach nor are fit to teach, the Independent finds no vestige in the Scriptures, nor in the earliest uninspired writers of the Christian Church. The rule or government of this presbytery or eldership in a church is not their own, but Christ's. They are not lords over God's heritage, nor can they pretend to more power over the disciples than the apostles possessed. But when the administration of the apostles in the church of Jerusalem, and other churches where they acted as elders, is inquired into by an Independent, it does not appear to him that they did anything of common concern to the church without the consent of the multitude; nay, it seems they thought it necessary to judge and determine in discipline in presence of the whole church (Acts vi. 1–6, xv. 22; 1 Cor. v. 3, 4, 5). Excommunication and absolution were in the power of the church at Corinth, and not of the elders as distinguished from the congregation (1 Cor. v.; 2 Cor. ii.). The apostle indeed speaks of his delivering some unto Satan (1 Tim. i. 20). But it is by no means clear that he did it by himself, and not after the manner pointed at (1 Cor. v. 4, 5); even as it does not appear, from his saying, in one epistle, that

[1] See Mann's *Reports on Census Returns for Religious Worship in England and Scotland; Congregational Year Book for* 1856; Baird's *Religion in America*, p. 508.

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the gift was given unto Timothy by the putting on of *his* hands, that this was not done in the *presbytery* of a church, as in the other epistle we find it actually was. The trying and judging of false apostles was a matter of the first importance; but it was done by the elders with the flock at Ephesus (Rev. ii. 2; Acts xx. 28); and that whole flock did, in the days of Ignatius, all partake of the Lord's Supper, and pray together in one place.[1] Even the power of binding and loosing, or the power of the keys as it has been called, was by our Saviour conferred, not upon a particular order of disciples, but upon the church. "If thy brother shall trespass against thee, go and tell him his fault between thee and him alone; if he shall hear thee, thou hast gained thy brother. But if he will not hear thee, then take with thee one or two more, that in the mouth of two or three witnesses every word may be established. And if he shall neglect to hear them, tell it unto the church; but if he neglect to hear the *church*, let him be unto thee as an heathen man and a publican. Verily I say unto you, whatsoever ye shall bind on earth shall be bound in heaven," &c. (St Matth. xviii. 15–48.) It is not said, if he shall neglect to hear the one or two, tell it to the elders of the church; far less can it be meant that the offended person should tell the cause of his offence to all the disciples in a presbytery or diocese consisting of many congregations. But he is required to tell it to that particular church or congregation to which they both belong; and the sentence of that assembly, pronounced by its elders, is in a very solemn manner declared to be final, from which there lies no appeal to any jurisdiction on earth.

With respect to the constituting of elders in any church or congregation, the Independent reasons in the following manner:—The officers of Christ's appointment are either ordinary and permanent in the church, or they were extraordinary and peculiar to the planting of Christianity. The extraordinary were those who were employed in laying the plan of the gospel churches, and in publishing the New Testament revelation. Such were the apostles, the chosen witnesses of our Saviour's resurrection; such were the prophets inspired by the Holy Ghost for explaining infallibly the Old Testament by the things written in the New; and such were the evangelists, the apostles' ministers. These can be succeeded by none in that which was peculiar to them, because their work was completed by themselves. But they are succeeded in all that was not peculiar to them by bishops and deacons, the only two ordinary and permanent orders of ministers in the church. We have already seen that it belongs to the office of the bishop to feed the flock of Christ. The only question to be settled then, is, How men are ordinarily called to that office? for about the office of the deacon there is little or no dispute. No man now can pretend to be so called of God to the ministry of the word as the apostles and other inspired elders were, whom he chose to be the publishers of his revealed truth, and to whose mission he bore witness in an extraordinary manner. But what the apostles were to those who had the divine oracles from their mouths, that their writings are to us; and therefore as no man can lawfully pretend a call from God to make any addition to those writings, so neither can any man pretend to be lawfully called to the ministry of the word already written, but in the manner which that word directs. Now there is nothing of which the New Testament speaks more clearly than of the characters of those who should exercise the office of bishop in the church, and of the actual exercise of that office. The former are graphically drawn in the epistles to Timothy and Titus; and the latter is minutely described in St Paul's discourse to the Ephesian elders, in St Peter's exhortation to elders, and our Lord's commission to those ministers with whom he promised to be always present even unto the end of the world. It is not competent for any man or body of men to add to or take from the description of a gospel minister given in these places, so as to insist upon the necessity of any qualification which is not there mentioned, or to dispense with any qualification as needless which is there required. Neither has Jesus Christ, the only legislator to the church, given to any ministers or people any power or right whatsoever to call, send, elect, or ordain, to that office, any person who is not qualified according to the description given in his law; nor has he given any power or right to reject the least of them who are so qualified, and who desire the office of a bishop or elder. Let a man have hands laid upon him by such as could prove an uninterrupted descent by imposition of hands from the apostles; let him be set apart to that office by a company of ministers themselves, the most conformable to the Scripture character; and let him be chosen by the most holy people on earth; yet if he answer not the New Testament description of a minister, he is not called of God to that office, and is no minister of Christ, but is indeed running unsent. No form of ordination can pretend to such a clear foundation in the New Testament as the description of the persons who should be elders of the church; and the laying on of hands is of small importance in the mission of a minister of Christ; for now, when the power of miracles has ceased, it is obvious that such a rite, by whomsoever performed, can convey no powers, whether ordinary or extraordinary. Indeed it appears to have been sometimes used, even in the apostolic age, without any such intention. When St Paul and St Barnabas were separated to the particular employment of going out to the Gentiles, the prophets and teachers at Antioch "prayed and laid their hands on them." But did this ceremony confer upon the two apostles any new power or authority to act as ministers of Christ? Did the imposition of hands make those shining lights of the gospel one whit better qualified than they were before to convert and baptize the nations, to feed the flock of God, to teach, rebuke, or exhort, with all long-suffering and patience? It cannot be pretended that there was any special virtue in this ceremony. St Paul and St Barnabas had undoubtedly received the Holy Ghost before they came to Antioch; and as they were apostles, they were of course authorized to discharge all the functions of the inferior and ordinary ministers of the gospel. As in this instance, however, the imposition of hands appears to have been a mark of recognition of the parties as qualified for the work to which they were appointed, so Independents usually lay on the hands of the bishops with the same intent. In a word, whoever in his life and conversation is conformable to the character which the inspired writers give of a bishop, and is likewise qualified by his "mightiness in the Scripture" to discharge the duties of that office, is fully authorized to administer the sacraments of baptism and the Lord's Supper, to teach, exhort, and rebuke, with all long-suffering and doctrine, and has all the call and mission which the Lord now gives to any man; whilst he

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[1] The evidence upon which this is stated by Mr Glass, for the whole of this reasoning is extracted from his works, is probably the following passage in the epistle of Ignatius to the Ephesians: Ει γαρ ενος και δευτερου προσευχη, "For if the prayer of one or two be of such force as we are told, how much more prevalent must that be which is made by the bishop and the whole church? He, then, that does not come together into the *same place* with it, is proud, and hath condemned himself; for it is written, 'God resisteth the proud.' Let us not therefore resist the bishop, that we may be the servants of God." The sentence, as it thus stands by itself, certainly countenances Mr Glass's scheme; but the reader who thinks any regard due to the testimony of Ignatius will do well to peruse the whole epistle as published by Vossius.

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who wants the qualifications mentioned has not God's call, whatever he may have, nor any authority to preach the gospel of Christ, or to dispense the ordinances of his religion.

From this view of the Independent principles, which is faithfully taken from their own writers, it appears that, according to them, even the election of a congregation confers upon the man whom they may choose for their pastor no new powers, but only creates a new relation between him and a particular flock, giving him an exclusive right, either by himself or in conjunction with other pastors constituted in the same manner, to exercise among them that authority which he derives immediately from Christ, and which, in a greater or less degree, is possessed by every sincere Christian according to his gifts and abilities. Were the ministers of the gospel constituted in any other way than this; by imposition of hands, for instance, in succession from the apostles; the case of Christians would, in the opinion of the Independents, be extremely hard, and the ways of God scarcely equal. We are strictly commanded not to forsake the assembling of ourselves together, but to continue steadfast in the apostles' doctrine and fellowship, and in the breaking of bread, and in prayer. "But can any man," asks one of their advocates, "bring himself to believe, that what he is commanded to do in point of gratitude, what is made his own personal act, an act expressive of certain dutiful and pious affections, can possibly be restricted to the intermediate offices or instrumentality of others, who act by powers which he can neither give nor take away? To suppose a thing necessary to my happiness, which is not in my own power, or wholly depends upon the good pleasure of another, over whom I have no authority, and concerning whose intentions and dispositions I can have no security, is to suppose a constitution the most foolish and ill-natured, utterly inconsistent with our ideas of a wise and good agent." Such are some of the principal arguments by which the Independents maintain the divine right of congregational churches.

Sir James Mackintosh, in his *Historical Fragment*, gives a short notice of this body. "They disclaimed the qualifications of 'national,' as repugnant to the nature of 'a church.' The religion of the Independents could not, without destroying its nature, be established by law. They never could aspire to more than religious liberty, and they accordingly have the honour to be the first, and long the only, Christian community who collectively adopted that sacred principle. It is true, that in the beginning they adopted the pernicious and inconsistent doctrine of limited toleration, excluding Catholics as idolaters; and in New England, where the great majority were of their persuasion, punishing even capitally dissenters from opinions which they accounted fundamental. But as intolerance could promote no interest of theirs, real or imaginary, their true principles finally worked out the stain of these dishonourable exceptions. The government of Cromwell, more influenced by them than by any other persuasion, made as near approaches to general toleration as public prejudice would endure; and Sir Harry Vane, an Independent, was probably the first who laid down, with perfect precision, the inviolable rights of conscience, and the exemption of religion from all civil authority."[1]

For the History of the Independents, see Bogue and Bennet's *History of Dissenters*, 3 vols., Lond. 1833, 2d edit.; Price's *History of Nonconformity in England*, 2 vols., Lond., 1836; Hanbury's *Memorials relating to Independents*, 3 vols., 1839; Fletcher's *History of Independency*, 4 vols., 1847. For their Principles, see Owen's *Inquiry into the Nature, &c., of Evangelical Churches;* Davidson's *Ecclesiastical Polity of the New Testament*, 1848; Wardlaw's *Congregational Independency*, 1848, &c.

Inderabia ‖ India.

INDERABIA, or ANDERAVIA, an island in the Persian Gulf, lying 5 miles off the coast of Laristan, in N. Lat. 26. 40., E. Long. 53. 39. It is a low, level, and narrow island, about 3 miles in length.

INDEX EXPURGATORIUS. In the Romish Church the *Index*, or *Index Librorum Prohibitorum*, is the list of books which are forbidden to be read. The list of books allowed to be read, after certain corrections, is called the *Index Expurgatorius*. The prohibition to read certain books began very early. Constantine forbade the reading of the books of Arius; and the Council of Carthage, A.D. 400, forbade the reading of pagan books. When printing afforded a rapid dissemination of books, it was thought necessary to establish a censorship of the press, by which the circulation of works injurious to the Romish faith could be prevented. Hence, in popish countries an *imprimatur*, or official permission, was necessary before a book was allowed to be published. In 1546 the University of Louvain, in accordance with an edict of Charles V., published a list of books considered as dangerous. Lists of the same kind were also prepared at Rome, Paris, Venice, and Cologne. The management of the Index was fully systematized by a select committee of the Council of Trent, and the ten rules proposed by them were sanctioned by Pius IV. during the twenty-fifth session of the council, A.D. 1564. The Congregation of the Index, as confirmed by Pius V., have the power to supervise all books as to their bearing upon the faith and discipline of the Romish Church. (Peignot's *Dictionnaire des Livres Condamnés au feu, Supprimés, ou Censurés;* Mendham's *Account of the Indices, both Prohibitory and Expurgatory*, &c.)

INDIA. The general name of India has always had a very wide and rather indefinite application, both in ancient and modern times. It has been generally used to designate all those vast regions of the Asiatic continent which lie to the eastward of the Indus, which were accordingly distinguished by the ancients into two great divisions, namely, *India intra Gangem*, and *India extra Gangem*. The meaning of the name, which has long been a source of perplexity to the learned, has never been clearly ascertained. It is supposed to be of Persian origin, from the word Hind, or Heando, the term in the more ancient languages of Persia, which has been employed by the Greeks and Romans, and from them made its way into the modern languages of Europe. The progress of ancient discovery in India has been already narrated in our account both of Asia and Hindustan. Prior to the expedition of Alexander, all the knowledge which the Greeks possessed of India was derived from the report of the Persians. The geographical writers of ancient times—Eratosthenes, Strabo, and Pliny—procured more correct information from Alexander's officers; and in later times the ancients extended their knowledge of India by means of commerce. The general notion of the boundaries of India within the Ganges appears to have been as follows:—On the north they stated the boundary to be a range of mountains, the modern Himalaya, which they considered to be the extremity of the range of Mount Taurus, and which were named Paropamisus by the natives, or the mountains of Emodus and Imaus. The Indus was pointed out as the western boundary; and in later times, when the knowledge of Indian geography was extended, the Ganges was considered the boundary on the E., and the ocean on the S. Of the form and limits of this extensive region, known under the general appellation of India, the ancients entertained very erroneous notions. Of the country that lay between the Indus and the Ganges they had begun to acquire from travellers more accurate

[1] *View of the Reign of James II.*, p. 166.

India Rubber || Indian Territory.

information; but their accounts respecting Southern India were still imperfect. The different geographical writers enumerate many distinct tribes who were scattered over the country between the Indus and the Ganges; but they seem not to have had sufficient information for such a classification of the inhabitants; and little instruction is conveyed concerning India in such a list of uncouth names. Of India beyond the Ganges the ancients are still more imperfectly informed, nor do they seem to have affixed any limits to its extension eastward.

This term of India has been applied with great latitude by modern geographers. According to Mohammedan writers, it is understood to signify the country in immediate subjection to the Mogul sovereigns of Delhi. By Europeans, the limits of India have generally been considered as co-extensive with those of the Hindu religion. In the latter view, it includes all those extensive countries that lie between the Indus on the W. and China on the E., and that are bounded on the N. by Bukharia and Thibet, and on the S. by the Indian Ocean and the Bay of Bengal. A particular description of Hindustan, and of all these other countries, will be found under their respective titles, to which, therefore, the reader is referred.

INDIA RUBBER. See CAOUTCHOUC.

INDIAN TERRITORY, a central district of the United States of North America, lying between N. Lat. 33. 35. and 37. 0., and W. Long. 94. 20. and 100.; bounded N. by Kansas, E. by the states of Missouri and Arkansas, S. by Red River, which separates it from Texas, and W. by the state of Texas. It is 320 miles in length from E. to W., and 225 miles broad, and contains an area of about 72,000 square miles. The surface of the country is level, except in the south-eastern corner, where it is crossed by the Ozark Hills, and has a gradual declination eastwards to the Mississippi. The principal streams are the Arkansas, which flows through the country from N. to S., and Red River. Both are tributaries of the Mississippi, and are navigable for small steamboats. In the eastern half of the territory, where alone agriculture is prosecuted, the soil is fertile. In its western division, on the other hand, the country is flat, with a dry soil, and the water in the pools brackish. The inhabitants are wholly Indian, and comprise both the tribes native to the district, and those that have immigrated from E. of the Mississippi. The Indian Territory was allotted to the Red Men of the United States in 1854, for the purpose of giving those that had been dispossessed of their lands a safe and permanent abode. The measure has been already attended with beneficial results. The tribes from the E., who had long had intercourse with the whites, on arriving in their new country, at once commenced agricultural pursuits and rude manufactures, and now raise crops of grain and cotton sufficient for home consumption. The latter is for the most part spun by the women, but a few mills are gradually beginning to spring up. Hunting is pursued by the less civilized tribes of the western division, where the grizzly bear, wild goat, and deer are found, and the buffalo and wild horse roam in formidable herds. The chief of these tribes are the Osages, Kansas, Otoes, Omahas, Pawnees, and Puncahs. Of the eastern tribes which have immigrated into the Territory, and there enjoy each a district and constitution of its own, may be named the Creeks, Cherokees, Choctaws, Chickasaws, Seminoles, Senecas, and Quapaws. The first of these came from Georgia and Alabama, and now occupy the country N. of Canadian River. They have written laws and a liberal form of government, and are rapidly progressing towards civilization. The Cherokees, who claim consanguinity with the Creeks, are the most civilized of all the tribes in the Territory. They immigrated from the highlands of Carolina, Georgia, Alabama, and Upper Tenessee, in 1836, having sold their ancient possessions to the government, and took up their abode in the Indian Territory to the N. of Arkansas River. Their tract of land is divided into 8 districts, each returning, every four years, 5 members to the general council, which is made up of a committee and minor council; the former consisting of 16 representatives, and the minor council of 24, are held in the town of Tahlequah, N. of the Arkansas. The executive is vested in a chief, assisted by 3 assessors, chosen for four years by the general council. A printing press is established at Tahlequah, the capital, where newspapers are regularly published. The next two tribes, the Choctaws and Chickasaws, are kindred nations that formerly peopled the Mississippi valley, and now occupy the country S. of Canadian River. They amalgamated in their new home, and are now governed by the same laws. Their national council consists of 40 members, elected by qualified citizens. The four districts, however, into which their settlement is divided, are each governed by a chief, who has the right of a qualified veto on all laws passed by the national council. This tribe has a military organization, every male adult being subject to service, and each district supplying 53 captains, who are under the command of the general-in-chief. Their principal town, called Council House, is situated on Kiamishi River, a tributary of Red River. The only other tribes that inhabit the Territory are the Senecas and Quapaws, once powerful nations, but now rapidly becoming extinct. All these tribes dwell in villages, and follow the plough. Their progress in civilization is almost wholly attributable to the labours of the missionaries, who, in spreading the Christian faith, have not forgotten to sow the seeds of social comfort and advancement. There is no census of the population, which is roughly estimated at about 100,000 persons.

Indiana.

INDIANA, one of the United States of North America, is bounded, E. by the State of Ohio, S. by the River Ohio, which separates it from Kentucky, W. by Illinois, from which it is partly separated by the Wabash River, and N. by Michigan and Lake Michigan. It lies between 37. 51 and 40. 46. N. Lat., and 85. 49. and 88. 2. W. Long. Extreme length from N. to S., 276 miles; greatest breadth, 175 miles. Area 33,809 square miles.

Indiana may be generally characterized as a great plain, inclining towards the S.W. A range of hills extends along the Ohio from the mouth of the Great Miami to Blue River, and the shore of Lake Michigan is lined by large sandy hills, which rise to a height of 200 feet. In some other parts are to be found "knobs," but these are seldom of great extent or elevation. The surface of the country naturally divides itself into several extensive river valleys. The valley of the Ohio, comprising an area of about 5500 square miles, is a limestone tract, and was originally covered with forests. About one-third of it is rugged and broken, so as to be unfit for cultivation. The White River Valley, extending through the centre of the state, from the Wabash to the Ohio, contains about 9000 square miles. This district is almost uniformly level, and richly wooded, except in the west, where there are some ranges of low rugged hills, and several patches of prairie ground. The soil is of the richest kind. The Wabash Valley is much larger than the others, and contains upwards of 12,000 square miles. The eastern portion equals the White River Valley in fertility, but the other parts are not so productive. The northern part of the state, watered by the St Joseph and the Kankakee rivers, is somewhat more swampy than the Wabash Valley; and a large tract, comprising the sandhills on Lake Michigan, is covered only with stunted pines and burr oaks.

The state is well watered by numerous beautiful streams and rivers, but with the exception of the Ohio and Wabash, few of them are navigable. The Wabash is the largest river that has its course mainly within the state, and together with its branches, drains three-fourths of the entire surface. It rises in the W. of Ohio, and flows first in a

Indiana. N.W. direction, and then S.W. till it meets the boundary of Illinois, which it follows southward for more than 100 miles, till it falls into the Ohio, after a course of upwards of 500 miles; for 400 of which it is navigable for steamboats at high water. The Ohio forms the entire southern boundary of the state. The other principal rivers of Indiana are tributaries of the Wabash. The White River, the most important of these, is formed by the W. and E. Forks—two rivers, respectively about 300 and 200 miles long—which unite about 100 miles above its confluence with the Wabash. The Miami is formed by the St Joseph and St Mary in the N.E., and falls into the Ohio. The Upper St Joseph, with its tributaries, passes through the northern counties, and falls into Lake Michigan.

Indiana resembles the other western states N. of the Ohio in climate. They are generally milder than those on the Atlantic coasts, but very subject to sudden changes. The winter is very severe in the northern parts, but more genial in the southern. Except in the neighbourhood of wet prairies and swamps the climate is everywhere healthy.

Dr Owen, speaking of the geological position of Indiana, remarks, that "it possesses all the elements of extraordinary fertility." The richest soil is that of the river bottoms, where it is very deep and exceedingly fertile. The most productive are those enclosed by the River Hills, which run parallel to the Ohio and other rivers. The extensive valley of the Wabash is a tract of this description. Behind the River Hills, a table-land spreads out, forming what may be called the interior of the country, and here, instead of the bottom-lands or river-valleys, there are vast prairies. The soil of these is not so luxuriant, but is such as amply to repay the expense of culture. Even the wet and marshy parts of the state admit of being brought under cultivation. Indiana ranks fourth of the states of the Union in the absolute amount of Indian corn raised. It also produces large quantities of wheat, oats, and Irish potatoes, as well as a fair proportion of the other productions common to the Western States.

The number of farms in Indiana under cultivation in 1850 comprised 93,896 acres, and the extent of improved land was 5,046,543 acres; of unimproved, 7,746,879 acres. The value of the farms returned was L.27,277,034. The orchard produce was estimated at L.64,988, and market-garden products, L.14,573.

The chief minerals of Indiana are coal, iron, lime, marble, freestone, and some copper. Of these the first is by far the most important. It has been estimated that the coal beds of Indiana cover 7700 square miles, and are capable of yielding 50,000,000 bushels to the square mile. One coal deposit commences in Perry county, and extends N.W. into the county of Vermillion upwards of 150 miles.

The manufacturing capital of Indiana, in 1850, amounted to 7,941,602 dollars. The value of raw material, &c., consumed in the year had been 10,214,337 dollars. The products were valued at 18,922,651 dollars. There were on June 1, 1850, 4326 industrial establishments, producing annually to the value of 500 dollars and upwards. Of these, two were cotton factories, twenty-three woollen factories, nineteen iron works, and 358 tanneries.

Indiana has no direct foreign commerce, but it has a considerable transit trade, and exports large quantities of agricultural produce. The facilities for internal communication are great, and rapidly increasing. The principal canals are the Wabash and Erie Canal between Evansville, on the Ohio, and Toledo, on Lake Erie, 467 miles, of which 379 miles are in Indiana; and the White Water Canal, 68 miles long, uniting Lawrenceburg, on the Ohio, with Hagerstown. In 1853 the state had 755 miles of railroad completed, and 979 in course of construction. The principal railroads centre in Indianapolis, and radiate from that city in all directions. In 1854 the projected and incomplete railroads were the Evansville and Terre Haute (27 miles finished); Indianapolis and Lawrenceburg (63 miles finished); Indianapolis and Peru (30 miles finished); Junction, New Albany and Salem (83 miles finished); Fort Mayne and Muncie, Ohio and Mississippi, and Richmond and Logansport. Indiana.

Indiana is divided into 91 counties. Its capital is Indianapolis (pop. 8080), near the centre of the state; but the largest town is New Albany (pop. (1850) 8181); and there are a good many others very little inferior in size. The following table shows the state of the population during the present century:—

	White.	Coloured, Free.	Slaves.	Total.
1800.....	4,577	163	135	4,875
1810.....	23,890	393	237	24,520
1820.....	145,758	1,230	190	147,178
1830.....	339,399	3,629	3	343,031
1840.....	678,698	7,165	3	685,866
1850.....	977,605	10,811	none	988,416

The last census returned 537 deaf and dumb, 353 blind, 563 insane, and 938 idiotic.

By the ratio of the population, the state is entitled to send 11 representatives to Congress; and like the other states, 2 members to the Senate. The constitution of Indiana was framed in convention 10th February 1851, ratified by the people 4th August, and came into operation 1st November the same year. It provides that every white male citizen, of the United States, 21 years of age, who has resided in the state 6 months, is entitled to vote at the elections. Every white male of foreign birth, 21 years of age, who has resided in the United States 1 year, and in the state 6 months, may vote at next election, provided he has duly intimated his intention to become a citizen of the United States. Elections by the people are by ballot. Elections by the General Assembly *vivâ voce*.

The General Assembly consists of a Senate and a House of Representatives; the Senate of not more than 50 members, chosen for 4 years; the House of Representatives of not more than 100 members, chosen for 2 years. The governor has a salary of 1500 dollars and a furnished house; the lieutenant-governor and president of the senate 3 dollars a-day.

The justiciary consists of a supreme court of 4 judges, 13 circuit courts, and 44 courts of common pleas.

In 1850 there were in Indiana 1947 churches. Of these, 745 belonged to the Methodists; 412 to the various sects of Baptists; 267 to the Presbyterians; 182 to the Christians; 85 to the Friends; 63 to the Roman Catholics; 60 to the Lutherans; 53 to the Moravians; 24 to the Episcopalians; 15 to the Universalists; 10 to the Free, and 31 to the minor sects, having accommodation for 689,230 persons. The value of church property is 1,512,485 dollars.

The legislature of Indiana, by an act of 5th March 1855, made a new provision for a general system of common schools. A state board of education is established, consisting of the governor, secretary of state, state treasurer, and auditor, the attorney-general, and the superintendent of public instruction, who meet once a year. The superintendent, who is elected by the people for two years, must spend one day annually in each county. The board of trustees of each township, has the general custody and management of the school property and lands, and a limited power to levy taxes for building school-houses, and authority to employ teachers when the people do not appoint them. The funds are derived from various sources. In 1854 the total amount was 2,559,308 dollars; the number of schools was 2622; of scholars, 445,761; of teachers, 3,098; being males, 2,432, and females 666. Salaries of teachers, average per month, male, 23·01 dollars; female, 15·62 dollars.

In 1850, there were 11 universities and colleges, having

Indianapolis.

61 professors and teachers, and 1069 students. The universities have each a law faculty, and there are medical colleges at La Porte and Indianapolis, both in a flourishing condition. At Hanover is also the Indiana theological seminary (Presbyterian) a branch of the Hanover College. In 1850, the number of public libraries was 151, containing 68,403 volumes. The periodical press in 1850 consisted of 121 publications; of these one only was a monthly magazine, the remainder were newspapers, appearing at various intervals, from a day to a week.

Indiana stands among the first of the western states in respect of provision for the unfortunate. The principal of its benevolent institutions are the institution for the blind, having, in 1851, 52 patients; an asylum for the deaf and dumb, having, in 1854, 139 pupils; and the hospital for the insane, having, in 1854, 163 patients. Every deaf-mute, between the ages of 10 and 30, belonging to the state, is entitled to admission gratis into the asylum, where every attention is paid to the education and wants of the inmates.

The total revenue of the state, in 1854, from all sources, was..... 2,609,175 dollars.
Total warrants on the treasury for the same period, were..... 1,645,544 ...
Balance, 1st November 1854... 963,630 ...
State debt, prior to 1847 was, total...14,374,640 ...
Total debt was reduced to, 1st Nov. 1855..... 7,338,473 ...

In the early part of the 18th century, the French settled in Indiana. They occupied several posts as early as the year 1702. But like other French settlements, these remained nearly stationary till long after the American Revolution. They lived on terms of amity with the neighbouring savages, and became greatly assimilated to them in their manners and customs. They joined them in their hunting excursions, and subsisted more by the chase than the produce of agriculture. They even formed matrimonial alliances with them. Indiana formed, with Illinois, a territorial government in 1801. In 1809, it was separated from Illinois, and was admitted into the union as an independent state in December 1816.

The chief natural curiosities of Indiana are,—the Wyandotte Cave, in Crawford County, and Epsom Salts Cave, on the Big Blue River. The latter is situate on the side of a hill, 400 feet high. About 2500 yards from the entrance to the cave is a white column, 15 feet in diameter, and 30 feet in height, regularly fluted and surrounded by smaller and similar columns. The earth of the floor yields epsom salts, nitre, aluminous earth, and gypsum. Within the cave is a rude painting of an Indian Chief. Wyandotte Cave had been explored, previous to 1850, for 3 miles. In that year new chambers and galleries were discovered more extensive than the old, and abounding in stalactites and other calcareous concretions, some of great size and splendour.

INDIANAPOLIS, a city of the United States of North America, capital of Indiana, on the White River. 109 miles N.W. from Cincinnati. It is situate in an extensive and fertile plain, near the centre of the state. The town is regularly built, and the streets generally cross each other at right angles. The state-house, an elegant building, 180 feet in length by 80 in width, is surmounted by a dome, and has ten Doric columns in front. There are several iron foundries, flour mills, and manufactories of steam-engines, paper, &c. Indianapolis is the terminus of seven railroads, viz.,—the Madison and Indianapolis; the Lafayette; the Terre Haute and Indianapolis; the Indiana Central; the Indianapolis and Bellefontaine; the Peru and Indianapolis; and the Laurenceburg and Upper Mississippi railroad. Nearly all of the above are now in operation. Pop. (1853) about 12,000.

Indictment || Indigo.

INDICTMENT, in *Law*, one of the modes of prosecuting an offender. In English law, it is a written accusation of one or more persons of a crime or misdemeanor, preferred to, and presented upon oath by, a grand jury. In Scotch law, it is the name of the summons or libel upon which criminals are cited to take their trial before the High Court of Justiciary, and is drawn in the form of a syllogism. The criminal libels for jury trial before the sheriffs of counties are prepared in the same form.

INDIGO, a well known and very valuable vegetable dye, originally brought to Europe from India, as the name (a modification of *Indicum*) implies.

The indigo of commerce occurs in powder or in cubic cakes of a deep blue colour, which acquires a copper tint and lustre on the substance being rubbed. If pure, it is tasteless and inodorous, insoluble in water, and very slightly soluble in alcohol. By boiling it with very dilute sulphuric acid, a viscous matter is separated. Dilute alkaline solutions remove from it a brown colouring matter, and boiling alcohol a red one.

Chemists recognize two kinds of indigo, the *blue* and the *white*, which are mutually convertible; and a consideration of the processes by which this conversion is effected furnishes the *rationale* of the methods by which the dye is procured from the plants which yield it.

When purified commercial indigo, reduced to powder, is digested in water, with excess of lime, and a moderate amount of green sulphate of iron, so as to expose it to the deoxidizing action of the precipitated protoxide of the metal, it loses its blue colour and its insolubility, and forms a soluble compound with the lime of a yellow colour. If diluted hydrochloric acid be added to this solution, whilst air is excluded, a dirty white crystalline powder precipitates, which may be dried *in vacuo*, and constitutes the *white indigo*. It consists of carbon, hydrogen, oxygen, and nitrogen; and is most satisfactorily represented as a chemical compound by the formula $C_{16}\ H_6\ N\ O_2$.

If the addition of hydrochloric acid to the yellow lime-solution be made, with free exposure to the air, then the precipitate rapidly changes from white to blue, and returns to the condition of *blue indigo*. The formula for this is $C_{16}\ H_5\ N\ O_2$; so that it differs from *white indigo* by containing one equivalent less of hydrogen. An alkaline solution of white indigo yields the same blue precipitate, by simple exposure to the air, without addition of an acid; and one of the best methods of obtaining chemically pure indigo is to digest the powdered commercial dye in an alcoholic solution of weak caustic soda, along with honey or grape-sugar as the deoxidizer. On exposing the filtered liquid to the air, blue indigo separates in crystals. It may be sublimed without decomposition.

It is probable that indigo exists in the plants which yield it, as a soluble compound of its white modification with potash, soda, or lime. The indigo plants grow chiefly in the East and West Indies, in Central America, Africa, and Europe. They belong to different genera, but the most important is the genus *Indigofera*, of which the species *tinctoria* yields the greater part of the indigo of commerce, and the species *pseudo-tinctoria* the best. Besides these, the I. *disperma, argentea, anil, glauca, cinerea*, are largely cultivated. The *Wrightia tinctoria*, an evergreen native of the East Indies; the *Isatis tinctoria*, or *woad* of Europe; the *Polygonum tinctorium* of China; the *Baptisia tinctoria* of the United States; and other plants of the genera *Nerium, Isatis, Pergularia, Tephrosia, Amorpha*, &c., also yield indigo.

The *Indigofera tinctoria* grows about 2 feet high, with pinnate leaves and papilionaceous flowers, followed by the pods characteristic of the leguminous order of plants to which it belongs. The colouring matter is most abundant when the flower-blossoms are expanding, and occurs in

nearly the whole plant, but chiefly in the leaves. Two methods are followed in preparing the dye,—the one by fermenting a watery infusion of the fresh plant or leaves, the other by simply macerating in water the fully dried leaves. The fermentation process is followed in the East and West Indies; the maceration process in America. In conducting the former, cuttings of the entire plant are stratified in layers in a large cistern, and covered with a kind of frame-work of wood and bamboo twigs to prevent the plants rising out of the vat after they swell. Water is then pumped upon them, and fermentation soon commences, accompanied by the production of ammonia and the evolution of much carbonic acid. Gradually, also, the liquid changes from nearly white to grey, blue, and deep purple, and becomes covered with a copper-coloured scum. When the fermentation begins to abate, the liquid,—now of a yellowish-green colour,—is drawn off into a second open cistern, and beaten with oars; in short, exposed to a process like that of churning for hours. During this process carbonic acid is expelled; the oxygen of the air allowed to act freely on the soluble indigo, so as to change it into the insoluble blue dye, and the particles of the latter gathered into flocks or grains, which fall to the bottom. This pulpy precipitate is then passed through a strainer, raised to the boiling point, drained by a woollen filter, squeezed in a press, cut by a wire into cubes, and dried.

In the maceration process, the leaves, threshed from the stems, are dried and set aside. At first they yield, on maceration with water, no indigo; but, after some weeks' keeping, they change from a fine green into a blue-grey; and, if then soaked in water, yield a green solution, which, on exposure to the air, gradually deposits blue indigo.

Indigo dissolves in strong sulphuric acid; and the solution, after dilution with water, is largely used in dyeing. Cloth is also dyed by soaking it in the solution obtained by digesting in water indigo, sulphate of iron, and lime. White indigo adheres to the fabric, and changes into the insoluble blue modification on exposure to the air. (G. W.)

INDIVISIBLES, in *Geometry*, the elements or principles into which any body or figure may be ultimately resolved, which elements are supposed to be infinitely small. Thus, a line may be said to consist of points, a surface of parallel lines, and a solid of parallel and similar surfaces.

INDORE, a town of Hindustan, and the capital of the possessions of the family of the Mahratta chieftain known under the name of Holkar. It is an ill-built town, containing a few mosques and several Brahminical temples of no architectural pretensions. The houses belonging to the British resident and his assistants are well planned, and surrounded with groves and gardens. Indore was plundered in 1801 by Scindia, who had previously defeated Holkar at the head of above 30,000 men. In 1804 it was occupied by a British force under Colonel Murray, but was restored on the subsequent pacification in 1805. Distant S.W. from Delhi 494 miles. Lat. 22. 42.; Long. 75. 50.

The territorial possessions of the Holkar family consist of several detached tracts, some of them lying very remote from others. Their total area is returned at 8318 square miles, supporting a population of 815,164. The revenue is estimated at about L.222,000. An armed force is maintained by the ruler of the country, amounting to 7000 men. The founder of this family was Mulhar Rao Holkar, who, first a shepherd, and subsequently a soldier, rose to military distinction, and obtained a grant of the territory of Indore from the Peishwa in 1733. He was among the Mahratta leaders at the battle of Paniput in 1761, and died a few years later. His successors brought Indore to a distinguished state of military power; and, at the commencement of the present century, when the British government was engaged in arduous conflict with various enemies, the then ruler of the country, Jeswunt Rao Holkar, seized the opportunity to invade the British dominions. Lord Lake despatched against him 5 battalions of native infantry, and 3000 cavalry, under Colonel Monson, an officer of great bravery, but unfortunately destitute of a corresponding degree of judgment; the expedition consequently terminated disastrously, and the unhappy retreat of this force is characterized as one of the most lamentable events in the history of the British career in India. Jeswunt Rao, following up his success, captured, in 1804, the city of Muttra, and commenced the siege of Delhi, but retreated baffled upon the approach of Lord Lake. From this time the fortunes of the Mahratta chieftain rapidly declined. According to Sir John Malcolm, Holkar entered Northern India with 92,000 men, and left it with a force diminished to 35,000 horse and 7000 infantry. Jeswunt Rao Holkar died insane in 1811, and was succeeded by Mulhar Rao Holkar, in whose reign the intrigues and disturbances fomented by the different factions which distracted the state ripened into hostilities. These, however, were brought to a speedy termination by the decisive victory which, on the 21st December 1817, was gained at Mahidpore by the British army over that of Holkar. On the 18th January 1818 a treaty was concluded at Mundesore with the British government, that power engaging to extend the same protection to the territory of Holkar as to its own, and to maintain a field force for the preservation of internal tranquillity and for defence against foreign aggression; Holkar, on the other hand, ceded various territories, and engaged to reduce his army to the strength of 3000 cavalry. Mulhar Rao died in 1833. He was succeeded by an adopted son named Martund Rao Holkar, who subsequently yielded his throne to the superior claims of Hurree Rao Holkar. By this latter prince the throne was transmitted to an adopted son, Kumdee Rao Holkar, whose career was terminated by an early death, when it appeared that no person possessed any hereditary claim to the succession. At length, however, the choice fell upon a youth named Mulkerjee; whose elevation, it was avowed, was not in virtue of either adoption or hereditary claim, but of the express nomination of the British government. The young chief, educated under the auspices of the British government, displayed at an early age great capacity for public business, and drew forth, by his exemplary conduct, the approbation of the governor-general. In February 1852, upon the attainment of his majority, the young chief assumed the reins of government. (E. T.)

INDORSEMENT, in *Law*, anything written on the back of a deed, as a receipt for money received.

There is likewise an *indorsement*, by way of assignment, on bills of exchange and notes of hand, which may be done by merely writing a person's name on the back of the instrument.

INDRE, a department of Central France, consisting of part of the old province of Berry; lying between N. Lat. 46. 22. and 47. 15., and E. Long. 0. 52. and 2. 13.; bounded N. by the department of Loire-et-Cher, E. by that of Cher, S. by those of Creuse and Haute-Vienne, and W. by those of Vienne and Indre-et-Loire. It is 60 miles in length from N. to S., and 54 miles broad. Area 2629 square miles. The surface of the country, which slopes to the N.W., is generally flat, with undulations here and there, and rounded granite hills towards the S.E. The chief rivers of the department are the Creuse, Indre, and Claise. The Indre traverses the centre of the department for a distance of 80 miles, and passes the towns of La Châtre, Châteauroux, and Châtillon. In the S.W. the department is also watered by the Creuse and its feeder the Claise. None of these streams are navigable within the department. The quality of the soil is various. In the higher regions of Indre, to the E., there is a flat, dry, and flinty tract of land called the Champagne, forming one-fifth of the whole department. In the centre, and stretching westwards, the marshy tract of the Brenne occupies a tenth of the depart-

Indre-et-Loire.

ment. The other parts have a richer soil, which is either wooded or under cultivation. The climate of Indre varies considerably from the prevalence of northerly winds in the winter, and southerly in the summer. The Champagne in particular is subject to great extremes in temperature. The agricultural products of the country are unimportant. Large flocks of sheep graze on the plains, and their wool, which is of fine quality, forms a considerable branch of trade; while cereals, such as buckwheat, maize, flax, and hemp, are easily raised on the richer soils. In the neighbourhood of the towns and villages, grapes and other fruits are grown in considerable quantities. But the natural resources of the department are not adequately developed, and with greater agricultural skill there can be little doubt but that double the present amount of grain could be produced. There is, nevertheless, a sufficiency for the requirements of the population without having recourse to importation. Of 1,682,560 acres contained in the department, 992,214 are arable, 210,794 under grass, 185,366 waste (heaths, &c.), 166,607 woods and forests, 44,751 vines, 31,053 rivers, canals, &c., and 18,273 orchards, gardens, &c. There are also on an average 900,000 sheep, yielding yearly about 16,964 cwts of wool. The vine is little attended to, and the wine is consequently indifferent. Manufacturing industry is almost wholly confined to woollen yarn, made at Châteauroux and Argenton. Hosiery and paper-making, as well as the spinning of linen, are carried on in a small scale. Flour mills are very numerous on the banks of the rivers. The minerals of the department are of no great value. Coal, iron, marble, lithographic stone, and clay, are found, and worked in some places, but not with great profit, from the want of proper means of communication. A branch of the Orleans and Bourges railroad enters the department and passes by Issoudun and Châteauroux to Argenton.

Indre is divided into four arrondissements as follows :—

Arrondissements.	Cantons.	Communes.	Pop. 1851.
Châteauroux	8	84	102,949
Le Blanc	6	56	61,077
La Châtre	5	59	57,344
Issoudun	4	49	50,568
Total	23	248	271,938

Châteauroux, the capital of the department, had, in 1851, 14,276 inhabitants.

INDRE-ET-LOIRE, a department of Central France, formed chiefly of the old province of Touraine, and lying between N. Lat. 46. 45. and 47. 43., and E. Long. 0. 4. and 1. 18. It is bounded N. by the departments of Sarthe and Loire-et-Cher, E. by those of Loire-et-Cher and Indre, S. by those of Indre and Vienne, and W. by that of Maine-et-Loire. The department is 70 miles in length from N. to S., and 59 miles broad. Area 2360 square miles. Its surface, which inclines to the N.W., is very regular. The chief rivers are the Loire, Indre, Cher, and Vienne. The first flows through the centre of the department and receives the others as tributaries. The Cher joins the Loire near the town of Tours, the Indre joins it about 15 miles further down, and the Vienne about 10 miles further. The Loire and Vienne are navigable for some miles.

Indre-et-Loire, from the different characters of its soil, may conveniently be classified into five divisions. North of the Loire an extensive tract of country, flat and uncultivated, called the *Gâtines*, forms the first; that between the Loire and Cher, which is almost wholly under tillage, known by the name of the *Varennes*, forms the second; the *Champagne*, situated between the Cher and Indre, with a thin soil and great regularity of surface, the third; while the *Véron* and *Brenne* constitute the fourth and fifth divisions. The *Véron*, called also the *Jardin de la France*, is inclosed by the rivers Loire, Indre, and Vienne. It is the richest and most highly cultivated district of the department, but is subject to inundation. The *Brenne*, lying between the Claise and Creuse, forms a part of the marshy territory, known by the same name in the neighbouring department of Indre.

Induction || Indulgence.

The agricultural products of Indre-et-Loire vary much according to the great diversity of its soil. Wheat, rye, hemp, barley, oats, and potatoes, besides various kinds of fruit, are grown with the greatest ease in the divisions of *Véron* and *Varennes*, where the soil is deep and very fertile. The *Gâtines* district, on the other hand, is covered with moors and forests occupied almost solely by the beasts of the chase. In many places the vine is cultivated with success, and the wine of the department is held in estimation; while the mulberry-tree plantations are very productive in silk.

Of 1,510,780 acres contained in the department, there are 827,609 arable, 222,402 woods and forests, 155,628 waste, 86,499 vines, 82,690 under grass, 58,495 various (gardens, plantations, &c.), 50,600 roads, buildings, &c.

The exports from Indre-et-Loire are important, as its productions considerably exceed the consumption of the population. Wheat, hemp, wine and brandy, raw silk, chestnut oil, prunes and honey, are the principal articles of exportation. The cultivation of the vine is on the increase.

In minerals the department is not rich. Iron, marble, and mill-stone, constitute the chief products of this class, but none of them are worked to any great extent. Manufacture is almost entirely confined to woollen cloth, pottery, paper, iron, and the making of fancy goods. Communication is effected by the rivers Loire and Vienne, which are navigable for barges, and by the *Tours et Bordeaux* and *Orléans et Nantes* railways.

The department is divided into three arrondissements as follows :—

Arrondissements.	Cantons.	Communes.	Pop. 1851.
Tours	11	127	160,875
Chinon	7	87	90,137
Loches	6	68	64,629
Total	24	282	315,641

Tours, the capital of the department, had in 1851, 30,189 inhabitants.

INDUCTION. See Logic.

INDULGENCE, one of the greatest corruptions in the Church of Rome, consists in the pretended remission of sins upon payment of money, varying in amount according to the offence. The origin of Indulgences, as of many other innovations and abuses in that church, is to be traced to a gradual corruption of practices originally pure. It accorded both with reason and scripture that offenders should be punished, and doubtless the discipline exercised during the purest days of the church was a salutary one. But in process of time, especially during the dark ages, when the people were grossly ignorant, and the rulers of the church avaricious, offenders were allowed to obtain the relaxation of discipline by purchase. During the 12th century the different orders of its members vied with each other in extorting money from the people. The bishops granted Indulgences upon payment of money, to be applied professedly to religious purposes; while the monks, by the sale or exhibition of relics, bones, &c., earned sums rivalling in amount those collected by their ecclesiastical superiors. Both parties, when they got the money, could spend it as they chose.

The granting of Indulgences has been traced as far back as the beginning of the 9th century. During the time of the Crusades, Urban II. granted them to all who would go to Palestine to fight for the recovery of Jerusalem from the Infidels. The temptation was subsequently held out to those who should hire a soldier to go as a crusader. Shortly after the beginning of the 14th century, Pope Clement V. exposed Indulgences to public sale. In the 16th century, Leo X., in order to carry on the magnificent structure of St Peter's at Rome, published Indulgences, and a plenary remission, to all such as should contribute money towards it. Finding the project succeed, he granted to Albert, elec-

Indult ‖ Indus.

tor of Mentz and archbishop of Magdeburg, the monopoly of them for Saxony and the neighbouring parts, and farmed out those of other countries to the highest bidders, who, in order to make the most of their bargain, procured the ablest preachers to cry up the value of the commodity. The form of these Indulgences was as follows:—"May our Lord Jesus Christ have mercy upon you, and absolve you by the merits of His most holy Passion. And I, by His authority, that of His blessed apostles Peter and Paul, and of the most holy Pope, granted and committed to me in these parts, do absolve you, first from all ecclesiastical censures, in whatever manner they have been incurred; then from all thy sins, transgressions, and excesses, how enormous soever these may be, even from such as are reserved for the cognizance of the holy see, and as far as the keys of the holy church extend: I remit to you all punishment which you deserve in purgatory on their account; and I restore you to the holy sacraments of the church, to the unity of the faithful, and to that innocence and purity which you possessed at baptism; so that when you die, the gates of punishment shall be shut, and the gates of the paradise of delight shall be opened: and if you shall not die at present, this grace shall remain in full force when you are at the point of death. In the name of the Father, and of the Son, and of the Holy Ghost."

The manner in which national resources were drained and immorality increased by the sale of Indulgences was felt to be a grievance by several European countries. Many Catholics as well as Protestants were ashamed and indignant at the degrading traffic. At the Diet of Nuremberg in 1522, the Germanic princes, both Catholic and Reformed, protested against the infamous trade. Claude Espence, a Catholic divine, declared of the *Taxa Cameræ seu Cancellariæ Apostolicæ*, that more crimes could be learned from it than from all vicious books together. The book referred to contained a catalogue of the prices at which absolution could be purchased for all possible crimes from the holy apostolic see. Thus, for so many livres, a bishop may commit murder, adultery, &c., &c. The first great and fatal blow struck against the system was by Luther in his ninety-five propositions against the Indulgences, as hawked about by the impudent Tetzel. This mountebank had been appointed by the Archbishop of Mentz and Magdeburg as his agent in Germany for these licenses to sin. He employed the blustering oratory for which he was remarkable, in urging upon the Germans the duty of obtaining remission for their own sins and those of their friends, for the past, present, and future, by purchasing indulgences. The people were deluded by such assurances as that the souls of those undergoing purgatorial purification, escaped the moment the fee paid by friends tinkled in the strong box, &c. Luther's propositions against Tetzel were posted up at Wittemberg in 1517. Next year, when Luther took his degree of doctor at Frankfort-on-the-Oder, he was attacked by Tetzel and some others, but he ably maintained his ground against them, and the dispute began to divide Germany. Maximilian I. informed Leo X. of the state of the case, but the Pontiff paid little attention to the affair, and the history of the dispute became identified with the history of the Reformation.

INDULT, granted by the Church of Rome, to kings and cardinals, is the power of presenting to benefices. The power of nominating to the bishoprics within his realm, was granted to Francis I. of France, upon the abolition of the pragmatic sanction, A.D. 1516. By the agreement between Paul IV. and the college of cardinals, A.D. 1555, the latter have the disposal of the benefices depending upon them.

INDUS. This great river of Asia has its rise in Thibet, at the N. of the Kailas mountain, regarded in Hindoo mythology as the mansion of the gods, in about Lat. 32., Long. 81. 30. It first takes a north-westerly direction for about 460 miles, when it is joined by the river of Dras, which, rising in the mountains of Cashmere, and receiving several streams both from the E. and W., discharges a considerable volume of water at its confluence. At Makpon-i-Shagaron, in Lat. 35. 48., Long. 74. 30., the Indus emerges from the mountainous region, and turning S. (a course which it thenceforth continues to the sea), takes its way through the country N. of Attock. Close above this last mentioned town, and at the distance of 870 miles from its source, the Indus receives on the western side the great river of Cabool. Both rivers have a large volume of water, and as they meet amidst numerous rocks, the confluence is turbulent, and attended with great uproar. The town of Attock is situate about 1000 feet above the sea level, and about 17,000 feet below the source of the Indus, which falls therefore 16,000 feet in 870 miles, or at the average rate of about 19 feet per mile. The length of its channel from Attock to the sea is 942 miles, and, consequently, in that lower part of its course it falls little more than one foot per mile. For about 10 miles below Attock, the river, though in general rolling between high cliffs of slate rock, has a calm, deep, and rapid current; but for 100 miles further down to Kalabagh, it becomes an enormous torrent. Lieutenant Wood, describing this section of its course, observes, "It here rushes down a valley, varying from 100 to 400 yards wide, between precipitous banks from 70 to 700 feet high." From Kalabagh, southwards, to Mittunkote, distant about 350 miles, the banks either right or left, are in several places so low, that the first rise of the river covers the country round with water, extending, as the inundation advances, as far as the eye can reach. On entering the plain, the water loses its clearness, and becomes loaded with mud. Two or three miles below Mittunkote, and about 490 miles from the sea, the Indus receives the waters of the Punjnud, the channel which conveys the collected streams of the Punjab. Above the confluence, the breadth of the Indus is less than that of the other river, but in consequence of the greater depth and velocity, the former has the greater volume of water. Wood found that the Indus near the confluence had a breadth of 608 yards, a velocity of about 5 miles an hour, a depth of 12 or 15 feet, and discharged 91,719 cubic feet per second. The Punjnud had a breadth of 1766 yards, a velocity of about 2 miles an hour, a depth of 12 or 15 feet, and discharged 68,955 cubic feet per second. Below the junction, the Indus in its lowest state is 2000 yards wide. Its aspect in this part is well described by Major Boileau. He says, "At the place where we crossed the Indus, almost immediately below its junction with the Punjnud, its stream is 2047 yards, or nearly a mile and a quarter in breadth, at a place where its width was unbroken, either by islands or sandbanks. The banks are very low, and the water very muddy, having just began to rise from the melting of the snow at its sources, nor is the stream of very great depth, except in the main channel; but with all these drawbacks, it is a magnificent sheet of water, a very prince of rivers." Below Mittunkote, the river passes in succession the towns of Sukkur, Bukkur, Sehwan, Hydrabad, and Triecal. The last mentioned of these towns is situate in Lat. 25. 9., Long. 68. 21., and here the delta commences; all the country below it, and contained between the Fulailee branch on the E., and the extreme western branch of the river, being, with little exception, alluvial, and obviously deposited by the stream. At about 5 miles below Tatta, and 60 miles from the sea, the Indus divaricates into two great branches, the Buggaur, which flows westward, and the Sata, which maintains the previous course of the Indus southwards, and is, in strictness, the continuation of that river. The lower part of the delta is intersected by rivers and creeks in almost every direction, like the delta of the Ganges; but it so far differs from the latter, that it has no trees on its surface, the dry parts being

Indus.

Infalistatio || Infeftment.

covered with brushwood, and the remainder, by much the largest part, being noisome swamps or muddy lakes. It is remarkable that the influence of the tides is not felt at a greater distance than 60 or 65 miles from the sea. At the mouths of the different branches, the rush or influx of the tide is high and dangerous, running, as has been estimated, at the rate of 4 miles an hour, though varying greatly at different places. From the sea up to Hyderabad, the Indus is in general about a mile in breadth, varying in depth from 2 to 5 fathoms. The river begins to swell in the middle of July, from the melting of the snows, and continues to increase until the end of August. The most eastern of the estuaries connected with the Indus is the Koree Mouth, from which, proceeding westward, the remaining creeks or estuaries most worthy of notice, occur in the following order:—The Seer, Mull, Kaha, Kookewarree, Kedywarree (discharging the waters of the Sata), Hujamree, Jooa, Durbar, Pitteeanee, Coondee, Pitty, and Gizree. The spring-tide rises 9 feet. The length of the navigable part of the river from the sea to Attock has been ascertained by measurement to be 942 miles, that of the upper part is about 870 miles, making a total length in round numbers of 1800 miles. The average declivity of the water-course from the locality of the source to Attock is, per mile, 19 feet; from Attock downwards to Kalabagh, a distance of about 110 miles, it is 20 inches; from this last place to Mittunkote, a distance of about 350 miles, it is 8 inches, and thence to the sea 6 inches. The Indus appears destined to become an important channel of commercial communication. (E. T.)

INFALISTATIO, an ancient punishment of felons, by throwing them amongst the rocks and sands, chiefly used in port-towns. It is the opinion of some writers, that *infalistatus* implied some capital punishment, by exposing the malefactor upon the sand till the next tide carried him away; and of this custom, it is said, there exists an old tradition. However, the penalty seems to have taken its name from the Norman *falese*, or *falesia*, which signified not the sands, but the rocks and cliffs adjoining, or impending over the sea-shore. *Commisit feloniam ob quam fuit suspensus, ut legatus vel alio modo morti damnatus, ... vel apud Dover* infalistatus, *apud Southampton submersus.*

INFANT, in *Law*. See PARENT AND CHILD.

INFANTRY. See ARMY.

INFEFTMENT, is the act of giving symbolical delivery or possession of heritable subjects, either in absolute property, redeemably, or in liferent; or in security, or relief of, any obligation. It is called in England and Scotland *seisin* or *sasine*. Without this act, the deed conveying or burdening an heritable subject, is incomplete, and may be defeated by the subsequent deeds, or by the legal diligence, of the creditors of the disponer. In all civilized countries some ceremony is required to mark and give warning to the public, of the transference of a right in lands. In the Roman law, as in our own, the distinction was recognised between a right or claim to the subject, and a right in it,—the latter requiring something to denote the possession which is necessary to complete the right. As actual delivery or possession may sometimes be inconvenient or impracticable, symbolical delivery in presence of witnesses is in many cases allowed both in England and Scotland, and has been so from an early period. The like is common among the other nations of Europe. Something of the kind existed among the Jews (see *Ruth* iv., 7). In our country writing must be employed to denote the various and changing conditions of a transference of heritable property, which become necessary by the progress of commerce. In England, the seisin following on such writing is given by going to the land, and there, in presence of witnesses, called to attest the transaction and give notoriety to it, the feoffer or his attorney delivers to the feoffee or his attorney, a clod or turf, or a twig or bough there growing, saying, in substance, "I deliver these to you in the name of seisin of all the lands and tenements specified in this deed of conveyance." If it be a house the seller walks out, giving the ring or latch of the door to the buyer or his attorney, who enters. In these cases, the manner, place, and time of the ceremony, are endorsed on the deed, together with the names of the witnesses. In judicial proceedings, if the plaintiff recover in an action whereby the seisin or possession of land is awarded, writs are directed to the sheriff of the county, commanding him to give actual possession to the plaintiff, which may be done forcibly if necessary; or, if the possession be yielded peaceably, by symbolical delivery, which is held to be a sufficient execution of the writ. In Scotland when lands are voluntarily sold or burdened, the disponer usually embodies in the disposition or bond what is called a precept of sasine, for infefting the disponee or creditor. In virtue of that precept it was, until lately, indispensable that the bailie of the granter should appear on the ground with a notary public and two witnesses, before whom the disponee or his attorney delivered the conveyance to the bailie, and required him to execute the precept. The bailie then delivered the conveyance to the notary to be read and published, after which the bailie delivered the symbols to the attorney, who, having received them, took instruments in the hands of the notary; which ceremonies were narrated in a document called the instrument of sasine, subscribed by the notary and witnesses. In that instrument all conditions and real burdens, designed to be effectual against third parties, were engrossed. The symbols consisted of earth and stone for the lands or tenements, with the addition of a penny for any right of annualrent; a sheaf of corn for parsonage teinds; a net and coble for fishings; clap and happer for mills, &c. The instrument of sasine was then required, by the Scotch statute 1617, c. 16, to be registered for publication within sixty days from its date, either in a general register of sasines, kept at Edinburgh for Scotland, or in a particular register appointed by the statute, which most frequently, though not in every case, was the shire within which the lands are situated. If the instrument were not recorded within the sixty days, it was of no avail against third parties; though it remained effectual against the granter of the precept and his heirs. In the case of two competing and duly recorded instruments, the priority of registration, though it were but an hour, gave the preference. It must then be engrossed at full length in the public record; any omission or essential error being fatal. Much of this has been simplified by the recent statute of 8th and 9th Vict., c. 35, which allows the precept in reference to property not held burgage to be abbreviated in this style,—"I desire any notary public to whom these presents may be presented, to give to the said A. B., or his foresaid sasine (or liferent sasine, &c., as the case may be), of the lands and others above disponed, but always under the burden of the real lien (as the case may be) before specified." The notary public, then, without going to the lands, or delivering any symbols, extends his instrument, narrating shortly the deed containing the precept, with any assignations of it that may have been granted; and narrating also all the real burdens or conditions intended to be effectual against third parties, and, after inserting the precept, he concludes the instrument with words like these,—"In virtue of which precept, I hereby give sasine (or liferent sasine, &c.) to the said A. B. of the lands and others above described (adding in case of burdens or reserved rights, &c.), but always under the burden of the real right of," &c. This instrument, subscribed by the notary before witnesses, may be recorded at any time, and it is effectual against third parties from the date of its being presented and entered, in order to be recorded, which is now held to be the date of the infeftment. All this is extended to lands and other heritages in Scotland held in burgage tenure by the 10th

Infeftment.

Inferiæ || Ingenhousz.

and 11th Vict., c. 49. A search, therefore, in the different records—that is, in the general and particular, or burgh records, according to the locality of the heritage—shows the incumbrances or burdens affecting infeftment; and it is held to be a breach of an agent's duty to his client to omit to cause such a search to be made in these records, and in others kept for the purpose of publishing the heritages in Scotland, which are under legal attachment, and the parties who are inhibited from doing anything by which their heritable property may be affected. Without a recorded infeftment, actual possession of lands in Scotland does not secure a buyer against the subsequent acts of a seller, or the diligence of his creditor; and with it actual possession is not necessary. In all competitions, the priority of the presentment for registration of an instrument of sasine, gives the preference. The ancient forms are now in disuse; they were expensive, and their multiplicity often occasioned fatal errors; while practically their object, that of giving intimation to the public, is equally attained by recording the simplified instrument, which is readily discovered by a search in the public records. (M. L.)

INFERIÆ. See FERALIA and FERIÆ.

INFORMATION, in *Law*, is nearly the same in the crown office as that which in other courts is called a *declaration*. Informations are of two sorts; first, those which are partly at the suit of the king, and partly at that of a subject; and, secondly, such as are only in the name of the king. The former are usually brought on penal statutes, which inflict a penalty on the conviction of the offender. The latter are of two kinds—1*st*, those filed *ex officio* by the attorney-general; 2*d*, those at the citation of some private person.

INFORMER (*informator*), in *Law*, a person who informs against, or prosecutes in any of the king's courts, those that offend against any law or penal statute.

Informers were very common both in Greece and in Rome. Every corner of the streets was infested with persons who made it their constant business to pick up stories, and catch at every occasion to accuse persons of credit and reputation. These persons were called by the Greeks Συκοφανται; for a more particular account of whom see SYCOPHANT.

Amongst the Romans, informers were of two sorts, *mandatores* and *delatores*. These played into each other's hands; the former marking down such persons as they pretended to have found guilty of any misdemeanour, and the latter prosecuting them. What tended to increase the number of these pestilent wretches was, that the informers were entitled to a fourth part of the effects of the person convicted. Wicked princes rewarded and countenanced this mischievous tribe; but Titus set on foot a most diligent search after them, and punished such as he found with death or banishment. Trajan also is praised by Pliny for pursuing similar conduct.

INGENHOUSZ, JOHN, an eminent physician and natural philosopher, was born at Breda in 1730. He was first established in medical practice there, but removed to London in 1767, particularly with a view to study the improved methods of inoculation then recently introduced. Having become acquainted with Sir John Pringle, at that time President of the Royal Society, he was by him recommended to the Austrian ambassador, for the purpose of inoculating the imperial family at Vienna, the Empress Maria Theresa having lost two of her children by the natural small-pox. He accepted this engagement in 1768, and having been perfectly successful in his operations, he was remunerated by the grant of a pension of L.600 a-year for life, together with the titles of Aulic Counsellor and Physician to the Imperial Family. He was also consulted, in his medical capacity, by many others of the most distinguished personages at Vienna, and he enjoyed the particular esteem of the Emperor Joseph II., who was fond of receiving him in his cabinet, and of witnessing the exhibition of a variety of physical experiments, with which it was always the delight of Ingenhousz to amuse and instruct his acquaintance of both sexes. The following spring he went to Italy, and inoculated the Grand Duke of Tuscany. He was made a Fellow of the Royal Society in May 1769; but he appears to have remained some years in Italy, for he was at Leghorn in January 1773; in March he dates from Salzburg; and in November 1775 from Vienna. The next year he was in London; and, in the winter of 1779, he went to Paris. The latter part of his life he spent principally in England, which, notwithstanding his dislike to the chilliness of the climate, was always his favourite residence, and "where he enjoyed during many years," to use his own words, "that felicity which a free and independent man finds in the pursuit of knowledge and wisdom, in the society and friendly intercourse of those who have distinguished themselves by their learning."

Ingenhousz.

Dr Ingenhousz was cheerful in his disposition, and often playful in his conversation. Though his pursuits were chiefly scientific, he was not destitute of taste for literature and poetry. He had a particular predilection for Lucan, and for the Cardinal de Polignac, and would frequently recite passages from their poems with great energy, and with a strong German accent. Nor did he disdain the comforts of commercial opulence, and he was often a visitor at the magnificent villa of the late Mr Rucker of Roehampton. He had been introduced there by his friend Dr Brocklesby, who was in many respects of a perfectly congenial disposition, and who had great pleasure in prevailing on him to partake occasionally of his own hospitality, when his table would otherwise have been solitary. He died the 7th September 1799, at Bow Wood, in Wiltshire, the house of the Marquis of Lansdowne, who had long known and esteemed him.

Dr Ingenhousz's principal publications are—1. *Experiments on the Torpedo* (*Phil. Trans.* 1775, p. 1). Mr Walsh had lately gained considerable reputation by his account of the effects of the torpedo. These experiments, which were made off Leghorn in company with Dr Drummond, are merely illustrative of the properties of that animal, which are now better known; and they afford no decided test of the electrical nature of the phenomena.

2. *Methods of Measuring the Bulk of Mixtures of Common Air, and Nitrous Air, with Experiments on Platina* (*Phil. Trans.* 1776, p. 257). The eudiometrical apparatus is described as an improvement on Fontana's. The experiments are intended to show that platina is not an alloy of iron and gold, since it may be deprived of all magnetic properties by repeated cupellation.

3. *A Way of Lighting a Candle by an Electrical Spark* (*Phil. Trans.* 1778, p. 1022). A very small charged jar setting fire to pulverised resin, strewed on cotton.

4. *On the Electrophorus*, p. 1027. This is a Bakerian lecture, read by appointment of the president and Council of the Royal Society, relating to the instrument then lately invented by Professor Volta, and which had been made known to the author by the Archduke Ferdinand. Its action is explained upon the elementary principles of the Franklinian theory. The next article in the volume contains some experiments of Mr Henly in confirmation of the doctrines here advanced.

5. *On a New Inflammable Gas* (*Phil. Trans.* 1779, p. 576). A powerful explosion is produced by the detonation of the vapour of a single drop of ether with oxygen gas. The author takes occasion to investigate the elasticity of the gas evolved by the detonation of gunpowder; and agrees with Bernouilli in estimating it as equivalent to near 2500 atmospheres. It may here be remarked, that notwithstanding Bernouilli's general accuracy, and great mathematical talents, he has fallen into a very singular error, in comparing the force of gunpowder with the daily labour of men; and has accidentally made the force of one pound equivalent to the daily work of 100 men, while, in fact, the force of 40 pounds is only equivalent to the daily labour of a single man.

6. *On a Mode of Suspending Magnetical Needles*, p. 537. Proposing that a hollow needle should be immersed in linseed oil, so as to press with a small portion of its weight only on its axis, in order that the friction may be greatly diminished.

7. *Improvements in Electricity*, p. 661. On plate machines of

Ingolstadt glass and pasteboard, and on a riband machine. A Bakerian lecture.

Ingulphus.

8. *Experiments on Vegetables*, London, 1779. This volume is chiefly occupied by the detailed proofs of the author's principal discovery, that vegetables in general pour out a portion of oxygen gas in the sunshine, while they rather diminish its proportion at night and in the shade. It is dedicated to Sir John Pringle, and was translated into French by the author, Paris, 1786; Second edition, 2 vols. 8vo, 1787–9; into Latin by Scherer, Vienna, 1786; and into Dntch by Dr Van Breda, of Delft, with others of his works.

9. *On the Salubrity of the Air at Sea, and at Places far removed from the Sea* (*Phil. Trans.* 1780, p. 554). From the imperfection of the test employed, it was easy to imagine that some differences were discovered, which subsequent observations have shown to have no existence.

10. *Nouvelles Expériences et Observations*, 2 vols. 8vo, Paris. On different subjects of natural philosophy. In German by Molitor, *Vermischte Schriften*, Vienna, 1784.

11. *On the Influence of the Vegetable Kingdom in the Animal Creation* (*Phil. Trans.* 1782, p. 426). Asserting the accuracy of his experiments, and denying some statements of Dr Priestley; advancing, in particular, many arguments to prove that the air obtained is really supplied by the vegetables, and not by the water in which they are usually immersed, in order to collect it. Dr Ingenhousz was, on all occasions, anxious to support his claim to this very interesting discovery; and he insisted that Priestley's earlier experiments, on the green matter contained in stagnant water, had little or nothing in common with his own, because that matter was, in fact, of an animal nature. He was in the habit of collecting the gas from cabbage leaves, and of keeping it bottled up in his pocket; and he was prepared with some coils of iron wire fastened into the corks, in order to exhibit the brilliant phenomenon of their combustion to his friends; the public being at that time less accustomed to this dazzling exhibition, than it has become in later years, when elementary lectures on chemistry have been more commonly addressed to mixed audiences than heretofore.

12. *Essay on the Food of Plants*, 8vo, London, 1798. From the French.

13. Dr Ingenhousz also inserted some essays in different volumes of the *Journal de Physique*; but they possess less originality and importance than his English publications.

(Chalmers' *Biographical Dictionary*, xix., London, 1815, 8vo; Kesteloot in *Biographie Universelle*, xxi., Paris, 1818, 8vo.) (T. Y.)

INGOLSTADT, a town of Bavaria, circle of Upper Bavaria, on the left bank of the Danube, 35 miles S.W. of Ratisbon. It was once a place of great strength, having in 1800 withstood for three months the French under Moreau; and its fortifications, which were demolished after its capture, have been recently rebuilt on an improved plan, and include a *tête-du-pont*, and numerous round towers of massive masonry. The town contains a royal palace, nine churches, an hospital, and several charitable institutions. Its university, founded in 1472, where Dr Faustus studied, was in 1800 transferred to Landshut, and afterwards to Munich. Its manufacture of woollen cloths, which was formerly extensive, has, with its other branches of industry and trade, fallen into decay, so that the town is too large for its present population, amounting to about 10,000.

INGULPHUS, the reputed author of the *Historia Monasterii Croylandensis*, or History of the Monastery of Croyland, or as the place is now called Crowland, in Lincolnshire. The genuineness of this work was for several centuries undisputed; but the researches of modern antiquarians, and especially of Sir Francis Palgrave, have proved it to be a mere monkish invention of the thirteenth or fourteenth century, and in point of authenticity little better than a historical novel. The last portion of the work is occupied with an autobiography of the author. From it we learn that Ingulphus was born of English parents in the city of London. Educated at Westminster, he prosecuted his studies at Oxford, and surpassed all his fellow-students in his knowledge of the Aristotelic philosophy, and the rhetoric of Cicero. This distinction seems to have turned his head; for, according to his own account, he began from this time to despise the humble roof of his father, and affecting the palaces of kings or princes, to be invested and clothed in soft and splendid raiment. In the year 1051 William of Normandy came over to England on a visit to the Confessor, and Ingulphus, who had been for many years past a special favourite of the Queen Edgitha, contrived to have himself introduced by her to her noble guest. The monk completely gained the favour of the Norman duke, who took him over in his train to France, and made him his secretary. His influence at the court of the Conqueror soon became unbounded, and Ingulphus confesses that he did not always use it discreetly. For several years his smiles were sought and his frowns dreaded by the courtiers. At the end of that time a pilgrimage to the Holy Land was proposed by the Archbishop of Mentz, and Ingulphus with thirty others of the Norman court determined to take part in it. Though the pilgrims arrived in safety at Constantinople, and were afterwards received with great kindness by the Patriarch Sophronius at Jerusalem, yet the expedition turned out in the end a very disastrous one. Ingulphus was only too glad to return in safety to Normandy, where he became a monk in the abbey of Fontenelle. In this quiet retreat he remained till 1075, when he was invited over to his own country by his former benefactor (who had by this time established himself on the throne of England), and was instituted as Abbot of Croyland, where he remained till his death, December 19th, 1109. His influence with the Conqueror enabled him to secure for that abbey many valuable privileges and immunities, besides the reconstruction and enlargement of the building itself, which had been destroyed in the year 870 by the Danes.

Inhibition.

The *Historia Monasterii Croylandensis*, was first published in an imperfect form by Sir Henry Savile in his *Scriptores Rerum Anglicarum post Bedam*, Lond. 1596. The MS. from which he printed was an incomplete copy, breaking off at the place where the French text of the laws of William the Conqueror is introduced. The history and fate of this MS. are quite unknown. Ingulphus' autograph was, after the dissolution of the monasteries, kept in the church of Croyland, where it was guarded with great care in a chest locked with three keys, which were entrusted to the churchwardens of the parish. Selden endeavoured, but in vain, to get access to the treasure, and when Fulman made inquiries for it, he learned that it was not to be found. Of the three copies of the autograph which once existed, the first was that imperfect one used by Sir Henry Savile; the second was the property of Marsham, and was the basis of Fulman's edition; the third, from which Selden published the laws of the Conqueror, belonged to the Cottonian Library, and perished in the fire which destroyed so many other valuable MSS. Of these three the most complete was Marsham's, which was printed entire along with the continuation by Peter of Blois in the *Rerum Anglicarum Scriptorum veterum Tomus Primus*, Oxford, 1684. Ingulphus' work, as its name implies, is a history of the Abbey of Croyland from the year 664 to 1089; while the continuation brings it down to 1117. In addition to the simple annals of the monks, however, it is in some sort a political history of the time, and contains many long and important charters of Edgar and his successors. The many curious anecdotes, incidents, and episodes, too, which it embodies, combined to make it one of the most interesting relics of the middle ages. Its authenticity, however, has been fairly disproved, and the continuation by Peter of Blois, must also be given up as the monkish figment of a later date. The demonstration, both from internal and external evidence of the forgery, as given by Sir F. Palgrave, is too minute and detailed to be quoted. It is given in full in his article on Anglo-Saxon History in the *Quarterly Review*, vol. xxxiv., to which we are indebted for many of the details in the foregoing notice.

INHIBITION, a form well known in the law of Scot-

Inhibition. land, by which a debtor is prevented from voluntarily alienating or burdening his estate to the prejudice of the particular creditors who may adopt this remedy. According to its style, the debtor is required to refrain from doing anything by which his estate may be dilapidated; but it has long been decided that it is inoperative against his moveables. It applies, however, not only to all the heritable estate belonging to him at the date of inhibition, but to all the heritage which he may acquire within forty years afterwards. The extinction of the debt to secure which it is used puts an end to the restraint, as the inhibition has reference only to a particular creditor and a particular debt. To be effectual it must be formally served on the debtor, personally, or at his domicile, published against third parties at the head burgh of the county within which the lands are situated, and recorded within forty days afterwards, either in the county record or in the record kept for the whole of Scotland, the former called the particular, and the latter the general, record of inhibitions. A party dealing with a debtor can thus, by searching these records, ascertain whether he be under inhibition, except for the period during the running of these forty days, the inhibition being effectual from its service, though it may not be recorded till the last of the forty days. Even during these forty days, the inhibition may be discovered by enquiries at certain public offices. Any debt constituted by bond, bill, or decree, and any action raised to compel payment, affords a warrant for inhibition, even although the term of payment be not come, or be only contingent. Where, however, the debt is not past due, the court will recal or restrict the inhibition according to circumstances, if it appear to be used oppressively, or on insufficient grounds. When the debt is future, it is readily recalled, on security being found by the debtor. The effect of inhibition is not to give the creditor who employs it any preference over the other creditors at its date, but only against parties who afterwards become creditors; neither does it confer any benefit on those who have not used it for themselves, so that a sale of heritage by an inhibited debtor, or a bond granted by him over his heritage, is only disregarded in a question with the inhibiting creditor, and not with those who did not resort to inhibition, or who only became creditors afterwards. As it only prohibits voluntary sales or securities, it leaves the debtor at liberty to complete whatever he was under a prior legal obligation to perform. A subsequent disposition, therefore, granted in fulfilment of prior minutes of sale, will not be affected by it, nor a subsequent infeftment on a prior disposition or bond. Neither does it hinder a creditor, provided he were a creditor prior to the inhibition, from carrying off the debtor's estate in payment of his debt by the act of the law, or by adjudication, as it is called, to the prejudice of the inhibitor. If a debtor die, the inhibition does not extend to, unless it be renewed against, his heir. A similar diligence is known in Scotland, under the names of judicial and voluntary *interdiction*, for the protection of persons of facile disposition and easily imposed on. Such a person, or one described in the action raised for the purpose of laying him under restraint as a person "lavish and prodigal, of weak and facile disposition, easily imposed on, and liable to be concussed to do deeds to his leison or prejudice," may be prevented from executing any such deeds, without the consent of interdictors, by decree of the Court of Session, at the instance of his next of kin or heir-apparent, or even *ex propria motu* of the judge. Letters of interdiction are then raised on the decree, served, published, and recorded, as in the case of inhibitions. The party himself may also grant a voluntary bond of interdiction, in which, after expressing his own consciousness of his facility, he may bind himself not to grant any deed without the consent of certain persons named by him, as interdictors. Letters of interdiction then follow on this bond, which are served, published, and recorded in the manner already mentioned. When either of these proceedings is adopted, the effect is to restrain the interdicted person from alienating or burdening his lands within the shire where the publication and registration have taken place, without the consent of the interdictors, but not to restrain him from disposing of his moveables, nor doing any thing affecting heritage onerously and rationally. The object of the appointment of interdictors is only to save him from doing what is prejudicial. The interdiction is at an end by the death of the interdictors, and it may be recalled by the sentence of a judge, finding either that it should never have been gone into, or that the occasion for it has passed away. The consent of the interdictors to its recal, as being no longer required, is sufficient. The registers of interdictions are the same as those for inhibitions. Injunction ‖ Ink.

INJUNCTION, in *Law*, is a prohibitory writ forbidding certain acts to be done, and is in the nature of an *interdictum* in the civil law. The usual objects of such writ are to stay or restrain proceedings at law, to prevent the infringement of copyright or of a patent, from committing waste by felling timber, or ploughing ancient pastures, from pulling down buildings, or obstructing ancient lights. This writ may be obtained at any stage of a cause, according to circumstances, and even immediately on a suit being instituted, without notice to the other side, upon sufficient reason being shown by affidavit. Formerly *common* injunctions were obtainable to stay proceedings at law, but by the 15th and 16th Vict., c. 86, § 58, the practice is an application for *special* injunctions. And now, by the new Common Law Procedure Act, 1854, sect. 79, in all cases of breach of contract, or other injury, a writ of injunction may be obtained at law against the repetition or continuance of such breach of contract or other injury, or the committal of any breach of contract or injury of a like kind arising out of the same contract, or relating to the same property or right. This remedy at law may be claimed in the same action in which damages for the injury are sought to be recovered. Injunction is a proceeding very like what is known in Scotland under the name of *Interdict*, or *Interim Interdict*, which is just an order of court pronounced, on cause shown, for stopping any proceedings complained of as illegal. The party asking such a measure must set forth both a title and an interest to obtain it. Sometimes the circumstances under which it is sought are so urgent that it is given at once on the peril of the party asking it, leaving the question of right to be afterwards determined. It is then called an interim interdict.

INK. The term *ink* is usually restricted to the fluid employed in writing with a pen. Other kinds of ink are indicated by a second word, such as *red ink*, *Indian ink*, *marking ink*, *sympathetic ink*, *printers' ink*, &c. Common ink is, however, sometimes distinguished as *writing ink*; its usual ingredients are a decoction of galls and a solution of sulphate of iron, together with gum, to prevent the black precipitate from subsiding. By exposure to the air, the proto-gallate and proto-tannate of iron become per-gallate and per-tannate, a change which accounts for the subsequent blackness of writing executed with pale ink.

In making ink, it is important to regulate the proportion of sulphate to the galls. Mr Lewis gives the proportion of 3 parts galls to 1 part sulphate of iron, but this will vary with the quality of the galls. For 12 gallons of ink, 12 lbs. of nut galls should be bruised and boiled for 3 hours in a copper with 9 gallons of water, the loss by evaporation being made up by occasional additions of water. The decoction is allowed to settle in a tub, the clear liquor is drained off, and the lees are strained. 5 lbs. of gum Senegal are to be dissolved in hot water just sufficient for the purpose, and the mucilage is to be filtered and added to the clear decoction. 5 lbs. of green sulphate of iron is

also to be dissolved separately, and well stirred in. When the ink thus formed is tolerably dark in tint, the clear portion should be drawn off into bottles, and be well corked up. To prevent the ink from becoming mouldy, 1 grain of corrosive sublimate, or 3 drops of kreasote, may be added to each pint of ink. Some makers use bruised cloves, and various perfumes: logwood, sumach, and other vegetable astringents, and also sulphate of copper have been used, but not with good effect.

Mr Brande gives the following recipe:—Aleppo galls, bruised, 6 oz.; sulphate of iron, 4 oz.; gum-arabic, 4 oz.; water, 6 pints. Boil the galls in the water, then add the other ingredients, and keep the whole in a well stopped bottle, occasionally shaking it. In two months strain off the ink into glass bottles which are to be well corked.

Such ink as the above is liable to become yellow in the course of time, from the decay of the vegetable matter, while mere rust or per-oxide of iron remains. By the careful application of an infusion of galls the writing may be made legible, a plan which has been adopted with success in the recovery of certain ancient manuscripts. Ink is also liable to fade on paper made from inferior rags and bleached by an excess of chlorine; this substance, together with acids and alkalies, effectually destroys writing ink, an objection which did not apply to the writing ink of the ancients, for this was made of finely divided charcoal mixed with some mucilaginous fluid, and resembling a black paint, while modern ink has more of the character of a dye. *Indian* or *China* ink may be made with lamp-black, purified with potash lye, mixed with a solution of glue, and dried. If the lamp-black be levigated with pure gelatine, an ink of good colour is produced, although it has not the shining fracture and is not so permanent on paper as genuine China ink. Camphor and other perfumes are added to this ink, and the lamp-black is said to be formed by collecting the smoke of the oil of sesame.

The want of duration in common writing inks has led to many suggestions for superseding vegetable astringents in their composition. The permanent character of carbonaceous inks would probably obtain a demand for them, if they could be made sufficiently fluid for rapid writing. Some years ago, Professor Traill suggested an acetic solution of gluten as the basis of an indelible writing ink. The gluten is obtained by kneading the dough of wheat flour in a stream of water until the starch is completely separated. The gluten should be kept for from 24 to 36 hours in water, and then be digested in acetic acid of sp. gr. 1·033 to 1·034, in the proportion of 3 parts gluten to 20 of the acid. By means of a gentle heat a greyish-white saponaceous fluid is obtained, which may be kept for a long time. Colour is given by from 8 to 12 grains of the best lamp-black and 2 grains of indigo, well incorporated with each fluid ounce of the vehicle. An aroma may be imparted to the ink, by digesting bruised cloves, pimento, or cinnamon, in a portion of the original acid. This ink is of a beautiful black colour, cheap, and cannot be removed by water, chlorine, or dilute acid. It is not adapted for writing on parchment, but may be used on paper with a steel pen, which should be washed after being used.

Another kind of ink, said to be well adapted for steel pens, is made as follows:—Exhaust 10 parts of logwood with a sufficient quantity of boiling water to furnish 80 parts of liquid. To 1000 parts of this decoction add gradually 1 part of yellow chromate of potash; the liquid becomes first reddish-brown, and finally bluish-black; gum, or any other addition, is injurious. This liquor is an actual solution, and may be filtered; no deposit is formed in it, and the writing is not removed by immersing the paper in water.

Blue writing inks have been largely substituted for the black. Stephen's ink is made by dissolving Prussian blue (previously washed in dilute muriatic acid) in a solution of oxalic acid. According to Hornung, blue ink is best prepared as follows:—Mix 4 parts of perchloride of iron in solution with 750 parts of water; add 4 parts of cyanide of potassium in solution; collect the precipitate, wash it with several additions of water, and allow it to drain until it weighs about 200 parts; add to this 1 part of oxalic acid, and promote the solution of the cyanide by agitation. Such an ink may be kept for a long time. The Rev. J. B. Reade prepares a blue writing ink which is free from acid, and therefore can be used with steel pens as follows:—To a solution of iodide of iron add half the weight of the iodine employed in obtaining it; pour this mixture into a semi-saturated solution of yellow prussiate of potash, employing a weight of this salt nearly equal to the whole weight of iodine used in the above iodide solution. Decomposition takes place; the cyanogen of the prussiate of potash and the iron combine, and are precipitated in a solid form; the potassium of the prussiate and the iodine combine to form a neutral iodide of potassium, which remains in solution with a slight excess of iodide of iron. Filter and wash the solid precipitate of cyanogen and iron, and dissolve it in water, thus forming the blue ink required. A portion of the precipitate added to ink made from galls greatly improves its quality. Mr Reade has formulæ for various other inks, the whole of which form the subject of a patent.

A permanent writing ink is said to be obtained by triturating the finely divided charcoal employed in the manufacture of Indian ink with a solution of silicate of potash. A similar kind of ink may be obtained by heating leather with caustic potash, and adding gelatinous silica to the black carbonaceous matter thus produced, so as to saturate the potash. A decoction of cochineal mixed with a solution of silicate of potash furnishes a *red* ink of a very permanent character.

Sir George Stewart Mackenzie some years ago patented a plan for writing with a *colourless* ink on paper prepared so as to produce either black or blue characters. The clear fluid used as ink is a dilute solution of per-muriate of iron, or some other per salt of iron. The paper is prepared in the course of its manufacture, after the sizing and before the finishing, by brushing in certain powders, the powder for producing dark writing with a clear fluid ink consisting of 3 parts by weight of powdered gall-nuts, 1 part anhydrous ferro-cyanide of potassium, 1 part carbonate of lime and 3 parts rice flour; for blue writing 1 part anhydrous ferro-cyanide of potassium, and 6 or 7 parts rice flour. The same patent also contains a formula for preparing a black indelible ink, by making a stiff paste of the finest lamp-black with a strong mucilage of gum-arabic, and diluting this paste with a solution of 1 part per-muriate of iron to 7 parts water. Copies may be taken on prepared copying paper of writing executed with this ink. The usual plan for copying writing by means of a copying machine is to write the original document with common ink containing a little sugar.

A good *red* ink may be prepared from 2 oz. of the best Brazil wood, ½ oz. pounded alum, ½ oz. crystals of tartar, boiled with 16 oz. of rain or distilled water down to half; ½ oz. gum-arabic is to be dissolved in the strained liquid; and lastly, there is to be added to it a tincture made with 1½ drachm of cochineal, and 1½ oz. of alcohol, of sp. gr. 0·839.

There are many recipes for coloured inks for which there is little or no demand. *Sympathetic* ink is a solution of a salt of cobalt; the chloride, the nitrate, and the sulphate of cobalt, form inks which are colourless and invisible on paper, but if held near the fire the writing becomes of a beautiful blue. As the paper cools moisture is absorbed and the colour disappears; but it may be reproduced by heat. The addition of a salt of nickel gives a green colour, so that, in

Inkermann.

preparing what are called *magic* or *chemical landscapes*, the sky may be painted with pure chloride, and the trees and the grass with a solution containing nickel. Acetate of cobalt gives an azure blue; chloride of copper a gamboge yellow; chloride of cobalt an olympian green; and bromide of copper a fine brown.

Sympathetic inks. A diluted solution of muriate of copper forms a delicate sympathetic ink, which is invisible until gently heated, when the letters assume a fine yellow colour; and they become again invisible when the paper cools.

Letters written with a solution of acetate of lead are invisible till exposed to the action of sulphuretted hydrogen.

A weak infusion of nut-galls, or other astringent vegetable, will form letters that become legible when touched with a solution of some salt of iron.

Letters written with ferro-cyanide of potass become legible when touched with a solution of sulphate of iron.

The ink used for *marking* linen is commonly a solution of nitrate of silver written with a pen upon the linen, previously moistened with a solution of potash or soda. In this process the oxide of silver is precipitated upon, and combines with the cloth very firmly. It may, however, be removed by dipping the linen into chlorine water until the silver is converted into a chloride, which may be known by the white colour of the stain; then rinsing in soft water, and washing in water containing ammonia, which quickly dissolves the chloride of silver. Mr Reade prepares a *marking ink* by rubbing together in a mortar nitrate of silver and the proper equivalent of tartaric acid in a dry state. By the addition of water, crystals of tartrate of silver are formed, and the nitric acid is set free; this acid is neutralized by the addition of liquor ammoniæ, which also dissolves the tartrate of silver. Gum, colouring matter, and water, can next be added, in quantities which may be varied at pleasure.

Printers' ink is prepared by boiling linseed or nut oil in an iron pot, kindling it and allowing it to burn for half an hour; the vessel is then closely covered over to extinguish the flame; it is again boiled, and the last remains of the grease are by some makers removed by means of slices of bread; that which remains is a fine elastic drying oil, which may be mixed with lamp-black for black ink, with vermilion for the finer works in red ink, or the pigment may be varied according to the colour. For *copper-plate printers' ink* the oil is not boiled so much, and Frankfort black is used for the carbon. For further details on the subject of printers' ink we must refer to the article PRINTING. A curious account of inks is contained in the work of Caneparius, *De Atramentis cujuscunque generis*, Rotterdami, 1718. (C. T.)

INKERMANN, a ruined city, in the south of the Crimea, at the head of the harbour of Sebastopol, and situated on the rocks to the right of, and overhanging the valley of Tchernaya. These ruins are cut out of the solid rock, and in many respects resemble those of Idumæa. They consist of columns, tombs, and the remains of palaces hewn out on the face of the cliff which rises perpendicularly for several hundred feet above the plain. The builders of these stupendous temples and mausoleums are merely subjects of conjecture; their handiwork, however, has a peculiar interest from its being the only remains of its kind in Europe.

It was on the heights, on the other side of the valley, opposite to the ruins, that the desperate battle took place between the Russians and the allied French and English troops on the 5th November 1854. At the commencement of the siege of Sebastopol in that year, the right attack rested on the declivities of the plateau overlooking the Tchernaya, called the "Heights of Inkermann." These were held by the English, who, from inadvertency erected no defensive works to secure their position, excepting a small battery without guns. The Russian general, Dannenberg, was aware of this, and on the 5th November attempted to carry the heights, and thus oblige the Allies to raise the siege. His troops, from 30,000 to 40,000 strong, animated by the presence of the Emperor's two younger sons, Michael and Nicholas, and supported by heavy guns placed on a neighbouring hill, commenced scaling the acclivity at 5 o'clock in the morning, concealed from view by a dense fog. Before attaining the summit, however, they were met by the British "guards," and some companies of the line, who, with the courage of despair, and against fearful odds, kept the assailants at bay for nearly five hours until reinforced by the French, with whose assistance the Russians were at length forced down the hill, after a struggle which raged for eight hours, and which was a series of the most desperate hand-to-hand encounters. The loss on both sides was heavy. About 9000 Russians were killed or wounded, and about 5000 of the Allies. Each side lost a general; the Russians, General Soimanoff, and the English, General Cathcart.

Inland Navigation || Inns of Court.

INLAND NAVIGATION. See NAVIGATION, *Inland*.

INN, a river of Europe, one of the principal affluents of the Danube. It rises in a lake in the southern part of the Swiss canton of Les Grisons, and follows a N.E. course until it falls into the Danube at Passau. It flows through the deep and narrow valley of the Engadine, through Tyrol and Bavaria, and latterly forms the boundary between Bavaria and Austria. Its length is about 250 miles.

INNS OF COURT are so called, according to some, because the students there are to serve and attend the courts of judicature; or because these colleges anciently received none but the sons of noblemen, and the better sort of gentlemen, who, as Fortescue affirms, were to be there qualified to serve the king in his court. In the time of Fortescue, there were about two thousand students in the inns of court and chancery, all of whom were *filii nobilium*, or gentlemen born. But this custom gradually fell into disuse; so that in the reign of Queen Elizabeth, Sir Edward Coke does not reckon above one thousand students, and the number at present is perhaps not greater. For this Judge Blackstone assigned the following reasons: "1. Because the inns of chancery being now almost totally filled by the inferior branch of the profession, are neither commodious nor proper for the resort of gentlemen of any rank or figure; so that there are very rarely any young students entered at the inns of chancery. 2. Because in the inns of court all sorts of regimen and academical superintendence, either with regard to morals or studies, are found impracticable, and therefore entirely neglected. 3. Because persons of birth and fortune, after having finished their usual courses at the universities, have seldom leisure or resolution sufficient to enter upon a new scheme of study at a new place of instruction; wherefore few gentlemen now resort to the inns of court, but such for whom the knowledge of practice is absolutely necessary, *i.e.*, in such as are intended for the profession."

Our inns of courts, justly famed for the production of men of learning in the law, are governed by benchers. They still enjoy the exclusive privilege of conferring the rank or degree of barrister-at-law, without which no one can practise as an advocate in the superior courts at Westminster. As a qualification for the call, the student must have kept commons for three years, and have attended a certain number of the lectures delivered by the *readers*.

The inns of court are—the Inner Temple and Middle Temple, formerly the dwelling of the Knights Templars; and Lincoln's Inn and Gray's Inn, which anciently belonged to the Earls of Lincoln and Gray.

INNS *of Chancery* were probably so called, because anciently inhabited by such clerks as chiefly studied the forming of writs, which regularly belonged to the cursitors, who are of chancery.

Inner-leithen ‖ Innocent.

These are Clifford's Inn, Clement's Inn, New Inn, Staple Inn, and Barnard's Inn. Furnival's Inn, Lyon's Inn, and Thavies Inn, have ceased to exist as law societies.

Originally these were preparatory colleges for younger students; and many were entered there, before they were admitted into the inns of court. Now they are mostly occupied by attorneys, solicitors, and others, and an admission to them is no longer of any avail to the student in his progress to the bar. See BARRISTER.

INNERLEITHEN, a pleasantly situated village and watering-place of Scotland, county of Peebles, near the confluence of the Leithen and the Tweed, 6 miles E.S.E. of Peebles. It is much frequented in summer and autumn by visitors from all parts of the country. The publication in 1824 of Scott's novel of *St Ronan's Well*, of which it was supposed to furnish the scenery and incidents, contributed greatly to bring it into notice. Pop. of parish, 1236.

INNOCENT, the name assumed by a line of bishops, who at various times have occupied the pontifical throne. The first of the name was made Pope of Rome in 482, and died in 517. The second, succeeding Honorius II. in 1130, died in 1143. The third ascended the chair of St Peter in 1198, and died in 1216. The fourth reigned from 1243 to 1254; and the pontificate of the fifth only extended over five months of the year 1276. The sixth was the only one of the name who was not a native Italian; he was a Frenchman, and succeeded Clement VI. in 1352, and died in 1362. The seventh reigned from 1403 to 1406; and the eighth from 1485 to 1491; while the ninth, elected in 1591, only enjoyed his elevation for two months. The tenth succeeded Urban VIII. in 1644, and reigned for eleven years. The eleventh became pope in 1676, and died in 1689. The twelfth reigned from 1691 to 1700; and the thirteenth, the last of the name, from 1721 to 1724.

By far the most remarkable of the popes who have reigned under this name, and, after his model Hildebrand, perhaps the greatest of all the successors of St Peter, was Innocent III. At the time of his elevation he bore the name of Cardinal Lotharius. He was the son of Thrasimund, Count of Segni, of the famous house of Conti, and of Claricia, a scion of the old and noble family of the Scotti. He is believed to have been born at Rome about the year 1161, and to have been educated at the celebrated school of St John of the Lateran. From Rome he removed to Paris, at that time the first theological school in the world, and distinguished himself there by the zeal and intensity with which he pursued his studies. He next set himself to master the science of law, especially the canon law, at the University of Bologna, and soon became as eminent in it as he had been in theology at Paris. In 1181 he returned to Rome, and, after rapidly passing through the lower grades of church office, was made a cardinal-deacon by his uncle, Clement III. He now began to take a leading part in the administration of church affairs; but on the death of his uncle he withdrew himself from the world, and in his retirement composed his celebrated treatise *De Contemptu Mundi, sive de Miseriis Humanæ conditionis*. This work is really what its title imports; but, while it exhibits a deep knowledge of human nature, a thorough contempt for the ordinary motives of human action, it shows also a spirit that would have but little tolerance for the weaknesses of man if these interfered either with the claims of duty or the schemes of ambition.

The death of Celestin III., on the 8th January 1198, recalled him from his retreat. On the very day that that pontiff died, the College of Cardinals, without a dissenting voice, elected him to the vacant throne. It was in vain that he wept and protested his unworthiness and his youth. Whether his tears were sincere, or merely masked a hypocritical humility, he was at length persuaded to accept the tiara. He was then only thirty-seven years of age, and, though he was connected with some of the leading families of Rome, he owed his rise solely to the force of his character and his reputation for the most austere virtue. Once firmly seated on his throne, he began to carry out the great design that till his latest day was dearest to his heart, of restoring to the papacy its supremacy over all the powers and principalities, both temporal and spiritual, of the world. His boundless ambition, his wide views, his boldness guided and tempered by craft, and his unity of purpose, all pointed him out as the man of that age who alone could, if indeed any one could, carry out that great design, and recall the splendid age of the seventh Gregory. A less considerable man certainly than Hildebrand, Innocent yet succeeded for a time in doing what it had cost his great prototype his throne, and almost his life, to attempt. The first care of Innocent was to re-establish the papal authority in Rome itself. The prefect of that city had for many years past been a nominee of the Emperor of Germany. Innocent now compelled him to accept office from his hands, and to swear allegiance to himself. He next abolished the consulate, and made the senate immediately dependent upon himself, and thus rid his capital of even the shadow of the imperial authority. It is not likely that, under ordinary circumstances, he would have had it in his power to effect these changes without a struggle; but the actual condition of the empire at this moment was such as to favour his designs. The emperor, Henry VI., had just died; and, though shortly before his death he had caused his infant son to be crowned, two rivals came forward to dispute the claims of the child monarch. These were,—Philip of Swabia, his uncle; and Otho, duke of Brunswick. Innocent at first favoured the claims of this latter, who, at his coronation in 1209, swore that he would renounce in favour of the pope all claim to the disputed succession of Matilda, constituting by far the most valuable part of what is now known as the patrimony of St Peter. The new emperor, however,—whose rival, Philip, had been murdered by the Count Palatine of Bavaria,—not only failed to observe his oath, but attached Apulia and Sicily, which he claimed as fiefs of the empire. Innocent immediately excommunicated and deposed him, and crowned in his room the young Frederic of Sicily, son of the late emperor Henry VI. The electors were soon persuaded to approve his choice, and the young prince, after a desperate resistance, was enabled to make good his claim. While thus asserting the rights of the church abroad, Innocent was doing his best to improve its internal organization. His first step in this direction was to put an end to the venality of the Roman court, at that time a living scandal throughout Christendom. For this purpose he often held the consistory, a usage which had long fallen into abeyance. He kept his ear open to all complaints, caused justice to be impartially administered, and himself pronounced sentence on the most important cases. On these occasions he displayed so deep a knowledge of law, and so excellent a judgment, that the ablest lawyers came to hear his decisions; and these decisions were afterwards often quoted by the civil tribunals. Again he showed his ecclesiastical zeal by rekindling throughout Europe the old crusading fire. He caused a crusade to be preached in the principal states. The first act of the expedition was to besiege and storm the Hungarian city of Zara, which was done contrary to the views and without the sanction of the pope. His ire was only appeased when he heard that Constantinople had been taken and pillaged, and the Empire of the East for a time overthrown. Innocent owed an old grudge to the Byzantines. At the outset of his reign he had written to the Patriarch of Byzantium to acknowledge the supremacy of Rome, which that dignitary, backed by the civil power, had refused to do, and

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Innsbrück. Innocent had too much work on hand to enforce his claim at that time. He was now avenged, and his wrath against the misguided zeal of the Crusaders was completely appeased. He was no less careful for the interests of morality. Himself a man of austere virtue, he saw with anger and disgust the laxity of morals that then prevailed in most of the European courts. The most conspicuous and powerful sinner who drew down his vengeance on this account was Philip Augustus of France. This prince had repudiated his wife, Ingelburge of Denmark, and had married Agnès de Méranie. Innocent excommunicated him, and put his kingdom under an interdict. The ban was not raised for eight months, at the end of which time the French king felt constrained to propitiate the pontiff's wrath by taking back his first wife, and dismissing her substitute, who soon after died of grief. A similar event occurred in Spain. The King of Leon had married his cousin, a daughter of the King of Portugal. Innocent excommunicated him, but he continued obdurate, and the pope laid both Leon and Portugal under a ban. Still more formidable was Innocent's quarrel with King John of England; which, after much violent recrimination on both sides, resulted in the complete humiliation of that monarch. (The details of this unhappy affair are given in full under the head ENGLAND.) But, of all the sins against which Innocent set his face with the most uncompromising severity, heresy was in his eyes the greatest, and its extirpation was with him a matter at once of duty and of policy. To these motives must be attributed the rigour, not to say cruelty, with which he persecuted the Albigenses, the only people who in that age were found bold enough to think for themselves in matters of religion. (See ALBIGENSES.) Though the measures which Innocent devised against this people were in the end successful, he did not live to see their final triumph in his own day. A violent fever, which terminated in paralysis, carried him off, July 16, 1216. Innocent's works were collected and published at Cologne in 1552 and 1575, and at Venice in 1578. His formal treatises consist of Discourses, Homilies, and a Commentary on the Seven Penitential Psalms. Far more important than these are his Letters and Decretals, of which the best edition is that of Baluze, Paris, 1682. This edition contains an excellent life of Innocent by an anonymous biographer.

INNSBRÜCK, or INSPRÜCK, a city of Austria, capital of the Tyrol, on the River Inn, 84 miles N.N.E. of Trient. In beauty of situation it is surpassed by few cities in Europe. It stands in the middle of the valley of the Inn, at the height of 1884 feet above the sea, and is hemmed in on both sides by mountains from 6000 to 8000 feet high. The name, Innsbrück (Inn's Bridge), is derived from a wooden bridge which crosses the river. During the War of Independence in 1809 this bridge was the centre of a bloody action, in which the peasants, under Hofer, completely routed the French. Innsbrück consists of an old and a new town, and of several suburbs. The houses are mostly in the Italian style, with flat roofs, and frequently ornamented with frescoes. Many of them have arcades below, occupied with shops. Among the public buildings the most interesting is the Franciscan church, which, among other fine works of art, contains the tomb of the emperor Maximilian I., one of the most splendid monuments of the kind in Europe. It is ornamented with twenty-four bas-reliefs, representing the principal actions of his life, and surrounded by twenty-eight colossal bronze statues of distinguished men, including the most distinguished members of the House of Austria. It contains also the mausoleum of the Archduke Charles of the Tyrol and his wife, and the grave of Hofer, surmounted by a marble statue of the hero. The palace built for Maria Theresa in 1770 is an extensive building, with gardens along the Inn, forming an agreeable promenade. Projecting in front of the Fürstenburg, the former residence of the counts of Tyrol, is the "Golden Roof," a kind of oriel window, covered with a roof of gilt copper. The university has faculties of law, medicine, and philosophy, and had, in 1853-4, 22 professors, with 278 students. Instruction is entirely gratuitous, and there are exhibitions for students to the amount of L.1200 annually. The Ferdinandeum museum is devoted to the productions of the Tyrol, in art, literature, and natural history. The chief manufactures are silk, woollen, and cotton stuffs, leather, gloves, glass, and cutlery. Innsbrück has also an important transit trade. Pop. 15,000.

Inquest || Inquisition.

INQUEST. See CORONER.

INQUISITION, in the Church of Rome, a criminal tribunal charged with the detection and punishment of heresy, apostacy, and other crimes against religion.

This formidable jurisdiction, created for the purpose of checking free inquiry in matters of religion, and maintaining the unity of the faith, was first instituted about the beginning of the thirteenth century, when Innocent III. appointed a commission to prosecute and punish the heretics of Narbonne. In 1203 the pope employed Pierre de Castelnau and Raoul, monks of Cîteaux attached to the monastery of Frontfroine, in Narbonne, to preach against the heresy of the Albigenses. They made a considerable impression, and especially in Toulouse and its neighbourhood their success encouraged the pope to introduce into the Catholic Church inquisitors independent of the bishops, who should, as delegates of the Holy See, have the right of prosecuting heretics.

With this view, he named as apostolic legates the abbot of Cîteaux and the two monks Castelnau and Raoul, who received orders to reclaim heretics to the Catholic faith, and to excommunicate and hand over to the secular power such as still remained obdurate. To carry out this plan more easily, he called upon Philip II. of France and the leading French nobility to prosecute heretics of every rank, and to seize their property; promising them plenary indulgences as the reward of their zeal. But the papal legates experienced great difficulties in the execution of their mission, which was distasteful to the bishops; the king of France took no part in the affair; and the counts of Toulouse, Foix, Béziers, Carcassonne, and other great lords of the provinces, refused to persecute a race of men in whose religious views they took no interest whatever, and whose piety and skill in the useful arts made them good and valuable retainers. The legates were consequently discouraged; the Pope, however, exhorted them to persevere, and at the same time addressed new briefs to the French king, to the archbishop of Narbonne, and to the bishop of Béziers, censuring their coldness and lack of zeal for the church.

In these circumstances, Castelnau and Raoul commenced preaching to the heretics, and even held conferences with some of their leaders; but, as might have been expected, the number of persons converted by them was exceedingly small. Arnauld, abbot of Cîteaux, the principal legate, then summoned to his assistance twelve abbots of his order, elected by a chapter held in 1206, and also admitted to his counsels two Spaniards, Diego Acebes, bishop of Osma, and Dominic de Guzman, the celebrated founder of the Dominican order.

At this time the great feudatories of Provence and Narbonne were engaged in constant wars with each other; and hence, when the papal legates summoned them to prosecute the heretics in their states, they represented that they could not execute the orders of his holiness by reason of the wars which they were obliged to maintain against their neighbours. Innocent III. then ordered his legates to mediate between the great lords, and turn their thoughts to rooting out heresy in their domains. These orders, backed by the thunders of the church, had the desired effect, and the great

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lords consented to sign a peace. Of these seigneurs the most powerful was Raymond VI., count of Toulouse. Having been several times threatened by Pierre de Castelnau, the proud noble answered with a haughty retort; and the Albigenses, believing themselves safe under his protection, assassinated the legate. This outrage roused the wrath of Innocent, who proclaimed a crusade against the heretics, and proclaimed to all who would join it the same indulgences as if they had been called to combat against the Saracens.

The establishment of the Inquisition in France dates from the war now (1208) begun against the Albigenses, and their protector, Raymond VI., count of Toulouse. Resistance was speedily overcome at all points; and the church was soon in circumstances to work its will upon its victims. It is not easy to determine the number of the unfortunate Albigenses who perished in the flames after 1208; but it is impossible not to be strongly moved with horror as well as compassion in reading the histories of the time, which represent the destruction of many thousands of persons, in the midst of the most cruel torments, as the triumph of a religion on which its divine Founder had impressed the characters of benevolence and mercy. In 1215 Innocent III. held a tenth general council, in which a variety of new penalties were decreed against the heretics of Languedoc. In particular, it was ordained that those who were condemned by the bishops as impenitent heretics should be delivered to secular justice; that the goods of laymen condemned should be confiscated, and those of priests applied to the use of their churches; that the inhabitants suspected of heresy should be summoned to purge themselves in the canonical form, and in case of refusal excommunicated; that if they continued more than a year under the anathema, without having recourse to the pardon of the church, they should be accounted heretics, and treated as such; that all persons who favoured or received into their houses heretics, should be liable to excommunication as well as the heretics themselves,—declared infamous, and as such excluded from all public employments,—deprived of the right of electing their own magistrates,—and rendered incapable of giving evidence in a court of justice, making testamentary dispositions, or taking up any succession, if at the expiry of a year they had failed to perform their duties and satisfy the church.

Pope Innocent III. died on the 12th of July 1216, and was succeeded by Honorius III., who resolved to continue the work which his predecessor had commenced. The new pontiff approved of the institution founded by Dominic de Guzman, with the view of preaching down heretics and heresy, an institution which gave rise to the order of preaching friars, afterwards known as Dominicans. He wrote to Guzman, encouraging him to persevere in his enterprise; and through Cardinal Bertrand, whom he sent into the provinces of Languedoc and Provence, with the title of legate, carried on the war against the Albigenses with all the zeal of his predecessor. Meanwhile St Dominic had instituted an order for seculars, the members of which were to be bound to assist those who preached against heresies, and to prosecute heretics with unrelenting rigour. This order was known under the various names of the Third Order of Penitence, the Militia of Christ, or, as they belonged to the family of the inquisition, Familiars. Here, then, we have the two great elements of the Holy Office: first, the institution of St Dominic, or the order of preaching friars, called Dominicans; and, secondly, the Militia of Christ, an association which afterwards gave rise to that which was known under the name of the Congregation of St Peter Martyr; two orders which were soon confounded, and the members of which were denominated *Familiars of the Holy Office of the Inquisition.* It was not long before this tribunal commenced active operations against heretics. In 1224 the Inquisition had been established in Italy, under the direction of the religious Dominicans. But it was reserved for Gregory IX., who ascended the pontifical throne in 1227, to fix the establishment of the Inquisition in the form of a tribunal, and at the same time to give it constitutions. With this view he convened a council at Toulouse, where new measures of severity were adopted against the heretics; he also issued a bull excommunicating them, and further enjoining that the impenitent should be delivered over to the secular arm, and that all their supporters and adherents should be declared infamous. He next transmitted a brief to Esparrago, archbishop of Toledo, exhorting him to combat heresy; and at the same time addressed to the prior of the Dominicans of Lombardy a commission, confiding to that religious order the execution of his bull against heretics. Councils were also held at Melun, and at Béziers, where new regulations were adopted for preserving the purity of the faith, by multiplying the severities against those by whom it was denied. Meanwhile the heresy of the Albigenses penetrated even into the capital of the Catholic world. The extreme means of repression hitherto employed against them had failed of the desired effect. Several thousands of their number had perished at the stake in France and Italy; yet, so far from being discouraged, they had carried their doctrines into the very capital of the Pope. A new bull was immediately issued, more severe if possible in its provisions than any that had preceded it, and embittered by the terrible rigour with which it was enforced in all the States of the Church. From Rome these regulations were transmitted to the Archbishop of Milan, to be rigorously executed in the various parts of Cisalpine Gaul, where heresy had made alarming progress. Frederick II. also renewed the constitutions which he had published against heretics in 1224, particularly the law against blasphemers, which condemned all heretics indiscriminately to undergo the punishment of burning, or of having the tongue cut out, if the bishops thought proper to show them mercy, in order that in future it might be impossible for them to blaspheme the name of God.

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Such is the general form which the Inquisition had assumed in France and Italy, when Gregory IX. introduced it into Spain. This event took place about the middle of the thirteenth century. Never did plant find a more congenial soil. In France and in Italy it had required strenuous and persevering efforts to establish the terrible tribunal; but in Spain it took root at once, and in time attained a magnitude which it never reached in any other country. During the fourteenth century its progress was steady, whilst its vigour and energy were continually on the increase. Its jurisdiction was enlarged, and its ramifications multiplied; *autos-da-fe* were celebrated in various places; and its victims were counted by hundreds.

But it was not until towards the close of the fifteenth century, when Spain became a united kingdom under Ferdinand and Isabella, that the Inquisition became general in that country, and assumed the form which it retained till its abolition in 1808. The execution of the bull of Sixtus IV., which authorized Ferdinand and Isabella to establish the Inquisition in their states, was indeed for a time suspended; but this suspension must have been of short duration, for in 1480 and 1481 we find it in full activity. Severe measures were adopted against the Jews, who were accused of the most absurd and ridiculous crimes, and in consequence the new Christians, as they were called, emigrated in great numbers. The flames of persecution raged at Seville, where, in 1481, twenty-six persons perished at the stake; and already no less than two hundred and ninety-eight victims had shared a similar fate. From this period may be dated the establishment of the Inquisition as it existed till our own time. This was effected by the creation of a grand inquisitor-general; the appointment of a royal

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council of the Inquisition, afterwards denominated the Council of the Supreme; the institution of subaltern tribunals in all parts of the kingdom; and, lastly, the enactment of laws, giving stability to the tribunal, and uniformity to its procedure. By this organization there was created in Spain a jurisdiction in matters of religion, which, under the able but merciless direction of such men as Torquemada, Valdez, and their immediate successors, became the most effective engine of persecution which had ever before been known in any age. Its character will be best understood by stating the substance of its fundamental laws, which, under the name of *Instructions*, were published at Seville on the 29th of October 1484.

The first of these regulated the manner in which the institution of the tribunal should be announced in those countries or places where it might be judged necessary to establish it. The second ordained the publication, in the church of the place, of an edict accompanied with the *censures* provided against those who, having committed the crime of heresy or apostasy, should not voluntarily denounce themselves before the expiry of the term of grace which had been granted them; and also against those who should obstruct or resist the execution of the measures ordained by the Holy Office. By the third a delay of thirty days was allowed to heretics to declare themselves, and thereby to prevent the confiscation of their goods, without prejudice, however, to the pecuniary fines to which they might afterwards be condemned. By the fourth it was provided that the voluntary confessions of those who declared themselves should be made in writing in the presence of the inquisitors and a registrar, so that the self-accused might be required to answer all the questions which might be addressed to them by the inquisitors on the subject of their confessions, and also respecting their accomplices, and those whom they knew or suspected to be guilty of apostasy. The fifth prohibited giving secret absolution to any one who had made a voluntary confession, excepting in the single case where no one had had knowledge of his crime, and where there was nothing to apprehend from its publicity. By the sixth article it was provided that part of the penance enjoined on him who had been reconciled should consist in his being deprived of the exercise of every honourable employment, and of the use of gold, silver, pearls, silk, and fine linen. The seventh imposed pecuniary fines upon those who had made a voluntary confession. The eighth provided that the voluntary penitent who might present himself with his confession after the expiration of the term of grace should not be exempted from the penalty of confiscation of goods, which he would otherwise have incurred. In the ninth article it was enacted, that if persons under the age of twenty presented themselves to make confession after the expiry of the term of grace, and if it were proved that they had been led into error by their parents, it would be sufficient to impose on them a slight penance. The tenth imposed on inquisitors the obligation of declaring, in the act of reconciliation, the time in which the reconciled had fallen into heresy, in order to ascertain what portion of his goods belonged to the fisc. The eleventh article bore, that if a heretic detained in the secret prisons of the Holy Office were touched with due repentance, and demanded absolution, it might be granted him, by imposing as a penance the pain of perpetual imprisonment. By the twelfth it was provided, that if the inquisitors considered the confession of the penitent to have been simulated, in the case indicated in the preceding article, they should refuse absolution, declare him a false penitent, and condemn him as such to be *relaxed*, that is, delivered over to the secular arm. The thirteenth ordained that if a man, absolved after free confession, boasted of having concealed several crimes, or if it appeared from information afterwards obtained that he had committed more than he confessed, he should be arrested and judged as a false penitent. The fourteenth provided that if the accused when convicted persisted in denying the charge, even after the publication of the evidence, he should be condemned as impenitent. By the fifteenth, if there were only a *semi-plena probatio* against the accused who denied the crime charged against him, he might be subjected to the question; in which case, if he confessed himself guilty under the torture, and thereafter confirmed his confession, he was punished as one regularly convicted; but if he retracted, he was to undergo a second time the same probation, or to be condemned to an extraordinary punishment. The sixteenth prohibited communicating to the accused an entire copy of the declarations of the witnesses. They were only to be informed generally what had been deponed, without being made aware of any circumstances which might enable them to discover who had given evidence against them. The seventeenth article enjoined inquisitors themselves to interrogate the witnesses in every case where it was possible for them to do so. The eighteenth provided that two inquisitors should be present when the person arraigned was put to the question; but if otherwise occupied, they might appoint a commissary to receive the declarations of the sufferer. By the nineteenth article, if the accused did not appear, after having been cited according to the prescribed forms, he might be condemned as a convicted heretic. The twentieth bore that if it were proved by the books, or by the conduct whilst in life of a person deceased, that he had been a heretic, he might be judged and condemned as such, his corpse disinterred, and the whole of his property confiscated to the state, at the expense of his natural heirs. By the twenty-first article the inquisitors were ordered to extend their jurisdiction over the vassals of the great lords; and if the latter refused to recognise it, to apply to them censures and other penalties. The twenty-second provided that if the person condemned to be *relaxed* to the ordinary tribunal left children minors, a small portion of the confiscated property of their father should be granted them by the government in name of alms, and the inquisitors should be obliged to confide to proper persons the care of their education and Christian instruction. By the twenty-third, if a heretic reconciled during the term of grace, without having incurred the penalty of confiscation, should have acquired property from a person who would have been condemned to that penalty, such property was not to be included in or protected by the law of pardon. The twenty-fourth rendered it obligatory to restore to liberty the Christian slaves of the reconciled when confiscation had not taken place, provided the king had granted pardon only on that condition. The twenty-fifth article prohibited the inquisitors and other persons attached to the tribunal from receiving presents, under pain of incurring the greater excommunication, being deprived of all their employments, condemned to make restitution, and amerced in twice the value of the articles received. The twenty-sixth recommended to the officers of the Inquisition to live in peace with one another, without affectation of superiority, even on the part of him who might be invested with the powers of the ordinary of the diocese; and in case any difference should arise, it was reserved for the inquisitor-general to settle it quietly (*sans éclat*). By the twenty-seventh, inquisitors were expressly enjoined to watch carefully over their subordinates, in order that the latter might be exact in discharging their duties. Lastly, the twenty-eighth article committed to the prudence of the inquisitors the examination and discussion of all points which might not have been provided for in the foregoing constitutions.

Such is the substance of the Code of the Inquisition, as originally promulgated. From this abstract it is evident that the judgments and sentences pronounced would depend upon the manner in which the charge was prepared, and the

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personal feelings and prejudices of the individual judges. The code in question was, however, several times augmented, even in the early days of the Inquisition. In particular, there were added to it the instructions which had been prepared at Seville in the beginning of 1484, those of Valladolid in 1488, those of Toledo and Avila in 1498, and lastly those of Valladolid in 1561. But with all these modifications the forms of procedure underwent little or no change; nor was the cruel and inhuman character of the code at all mitigated. It was scarcely possible for the accused, however innocent, to establish an effectual defence. Placed between the alternative of either recognising his innocence or suspecting him of guilt, the judges constantly allowed themselves to adopt the latter course, which superseded the necessity of proof, and left the accused at their mercy.

The additional acts of the inquisitor-general Torquemada also fall under the description which has already been given. They were eleven in number, and principally intended to regulate details. They provided that in every subaltern tribunal there should be two inquisitor-jurisconsults, a fiscal, an alguazil, registrars, and other officers if required; that every functionary who received presents either from the accused or their families should be immediately dismissed; that the Inquisition should maintain at Rome an able jurisconsult, with the title of agent; that contracts signed before the year 1479 by persons whose goods happened to be seized after that period, should be valid; that proprietors who might have afforded to fugitives an asylum on their estates, should he held as having placed their whole property at the disposal of the government; that the notaries of the Inquisition should keep accounts of the effects of persons condemned; that the receivers of the Holy Office might sell that property the administration of which they found troublesome, and collect the rents of such as was immoveable; that each receiver should attend to the interests of the tribunal to which he was more immediately attached; that the goods of a person condemned could not be sequestrated without an order of the Inquisition; that the inquisitor and other officers should be paid their salaries quarterly by the receiver; and that, in regard to circumstances unprovided for in the new constitutions, the inquisitors should have a discretionary power to act as they judged best, but that, in matters of great importance, they should have recourse to the government for instructions.

The crimes of which the Inquisition took cognisance were heresy in all its different forms, apostasy, Judaism, Mohammedanism, sorcery, offences against nature, and polygamy; and the punishments consequent on conviction varied according to the presumed degree of delinquency, from temporary confinement and severe penance to the *san benito* and the *auto-da-fe*. This tribunal was not established without great opposition. The first inquisitor of Aragon was openly assassinated, and all the provinces of that kingdom offered the most strenuous resistance to a jurisdiction which trenched so much on their ancient rights and privileges. But their opposition proved unavailing, as did also an attempt made by the Cortes of Castille and Aragon to reform the Holy Office after it had been established. The Inquisition triumphed over all its adversaries, and soon became so formidable, that parents delivered up their children, husbands their wives, and masters their servants, without a murmur. Terror, in fact, constituted the great element of its power; nor was this feeling diminished by the suddenness with which it pounced on its victims, and the impenetrable secrecy in which all its proceedings were involved. Imagination lent its aid to exaggerate the fearful reality; terror froze all hearts; even kings and princes trembled before it. Nor can it be denied that, in its early days, its proceedings were marked by a bold and fearless impartiality. It scrupled not to arrest and proceed against Don Carlos of Austria, prince of the Asturias, whom death alone placed beyond the reach of its sentence. It instituted processes against Charles V., Philip II., the Duke of Alba, and other illustrious personages. Nor was it in any respect more lenient to the clergy than to the laity. Bartolomeo Carranza, archbishop of Toledo, a prelate of eminent learning, piety, and moderation, was accused of entertaining and countenancing certain opinions declared to be heretical, imprisoned for several years, and, after enduring the greatest sufferings, died before his process was brought to a close, though it ended in a sentence of absolution. With regard to the inferior clergy, a charge of heresy, or even the suspicion of having shown kindness to heretics, was almost equivalent to a capital condemnation.

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The procedure of the Inquisition consisted of several parts; namely, the denunciation, the inquest, the censure by qualificators, secret imprisonment, the primary audiences, the charges, torture, the requisitory, the defence, the proofs, the publication of the proofs, the definitive censure by qualificators, and the sentence.

The procedure of the Holy Office commenced by denunciation, or something held equivalent thereto, such as a discovery incidentally resulting from a deposition made before the tribunal in another affair; and this, when signed, assumed the form of a declaration, in which the delator, after having sworn to tell the truth, designated by their names, or in some other manner, the persons whom he believed or presumed to be able to give evidence against the denounced. Then followed the inquest, or examination of the persons named and designed in the declaration as cognisant of the facts and circumstances therein set forth, and who were made to promise upon oath that they would never reveal the interrogatories which they were to be called upon to answer. Next came the censure by the qualificators. When the tribunal had examined the preliminary *instruction*, and discovered therein sufficient grounds for further procedure, and when the registers of the other tribunals of the province had been examined, to ascertain if there existed in these any charges against the denounced, the whole was submitted by the inquisitors to certain theologians, called *qualificators of the Holy Office*, who indicated or *qualified* in writing the propositions meriting theological censure, as heretical, savouring of heresy, or calculated to lead to heresy. In case the denounced was only suspected of this crime, they decided whether the suspicion was *light*, *grave*, or *violent*. As soon as the qualification here described had been made, the procurator-fiscal demanded that the denounced should be transferred to the secret prisons of the Holy Office. The tribunal had three sorts of prisons; public, intermediary, and secret. The first were those in which the Holy Office caused to be confined persons who, without being guilty of any crime against the faith, were accused of some delict, the punishment of which belonged of right to the Inquisition. The second were destined for such servants or ministers of the Holy Office as had committed some crime or some fault in the exercise of their functions, without, however, incurring the suspicion of heresy. The third or secret prisons were those in which heretics, or persons suspected of being so, were confined, and where the prisoners could only communicate with the judges, in the cases provided and with the precautions enjoined by the constitutions.

In the three days which followed the imprisonment of the suspected, they gave him three audiences of *monition* or advice, to engage him to speak the truth and the whole truth, without concealing anything which he had himself done or said, or which he could impute to others contrary to the faith. He was also told that if he conformed faithfully to what had been prescribed to him in this particular, mercy would be shown him, but that in the contrary case he would be treated with all the rigour of law. After the formality of the three audiences of monition had

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been gone through, the procurator-fiscal prepared the indictment against the prisoner, in conformity with the heads of accusation indicated or *qualified* in the *instruction;* and although there existed only a *semi-plena probatio*, he charged the facts deponed to as if they had been fully proved, and what was worse, he did not limit the articles or counts of his indictment to the number of facts declared, and dispensed with applying to each head of accusation the proper character or notion which distinguished it. The next part of the procedure was the most horrible, namely the application of the torture. Although the prisoner, in the three audiences of monition, might have confessed as much as, or even more than, the witnesses had deponed to, the fiscal terminated his requisitory or accusation, by demanding that the accused should be subjected to the question, on the alleged ground of culpable concealment and denial of the truth. It is certain that for a long period the torture had not been applied by the inquisitors, either in Spain or in any other country, the mitigating and humanizing influence of time and improvement having virtually abolished this barbarity; but the form of procedure still remained unchanged. The *requisitory* or accusation of the fiscal was never communicated in writing to the accused, to enable him to prepare his defence. He was conducted into the hall of audience, where, in presence of the inquisitors and the fiscal, a secretary read over the charges one after another, stopping at each article, and calling upon the accused to answer at the instant, whether it was conformable to the truth or otherwise; thus laying a snare for the unhappy person who was about to be put on his trial. After the accusation had been read, the inquisitors asked the accused if he wished to be defended. If he answered in the affirmative, they ordered a copy to be taken of the accusation and answers, and, from the list of titularies of the Holy Office, appointed him an advocate. No prisoner was permitted to choose his own counsel, although there existed no law of the Holy Office which denied him this just and natural right. To the proof, and the publication of the proof, as it was called, both gross mockeries of justice, succeeded the definitive censure by the qualificators, or theologians of the Holy Office, to whom was remitted the original of the judgment they had pronounced on the summary instruction, together with an extract of the answers made by the accused in his last examination, and who were required to qualify for the second time the propositions upon which the accusation was founded, to consider the explanation given by the prisoner, and to decide whether he had, by his answers, elided in whole or in part the suspicion of heresy with which he was charged, or whether, on the contrary, he had not fortified the suspicion of his guilt. The importance of this censure must be evident, since on it depended the definitive sentence. Yet, says Llorente, in his *Hist. Crit. de l'Inquis. d'Espagne*, "les *qualificateurs* se donnent à peine le temps d'écouter une lecture rapide de ce qui s'est passé; ils se hâtent d'établir leur opinion, et c'est là le dernier acte important de la procédure," all the rest being a simple formality. Lastly came the sentence, which, as may easily be anticipated from the nature of the procedure, was generally condemnatory of the prisoner. In fact, before the reign of Philip III., sentences of absolution were so rare in the Holy Office, that in one or even two thousand judgments we scarcely find an instance where the prisoner was fully acquitted, because the slightest doubt as to the complete innocence of the accused led the qualificators to declare him suspected *de levi*, and this was sufficient to induce the inquisitors to condemn him to suffer pains more or less grave, according to circumstances, and to make a formal abjuration of all kinds of heresy, particularly of that of which he had incurred the suspicion. The reading of the judgment formed the finale of the procedure which we have been endeavouring to describe; and the execution of it always commenced in the same *auto-da-fe* where it was read and signified. It is not necessary here to dwell on the ceremony of the *auto-da-fe*, which has been already discussed under the head Act of Faith. We shall only speak here of the *san-benito*. This vestment was merely a kind of scapulary which was fitted close to the person, and descended only to the knees, in order that it might not be confounded with any form of the monastic habit. It was made of an ordinary woollen stuff dyed yellow, with crosses of a red colour. Such was the *san-benito* in 1514, when Cardinal Ximenes de Cisneros caused the ordinary cross to be replaced by that of St Andrew. Afterwards, however, the inquisitors varied the forms of the *san-benito*, adapting them to the different classes of penitents. We shall only mention here those in common use. When a person had been declared *slightly suspected* of heresy, and condemned to make abjuration, if he demanded to be relieved from the censures *ad cautelam*, he was made to assume a *san-benito* which the Spaniards of the fifteenth century called *zamarra*, and which was merely the scapulary we have already mentioned, without a cross in saltier. But if the condemned abjured as one *violently suspected*, he bore one-half of this cross; and if he made abjuration as a *formal heretic*, he bore it entire. This, however, applied only to those who, after having been reconciled, had their lives spared. But there were other kinds of *san-benito* for those who were condemned to perish in the flames. He who, after having been once absolved from the crime of formal heresy, and reconciled to the church, relapsed into his former errors, was denominated *relapsed*, and incurred the pain of death. His fate was inevitable, however sincere his repentance. If reconciled before his death he was merely strangled, or put to death in some other manner less horrible than by fire, and then his corpse was delivered to the flames. Thus, as there were three kinds of *san-benito* for the three classes of condemned who were delivered to the secular arm, so also the inquisitors contrived an equal number for those who were doomed to suffer death.

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The *first* was that of prisoners who had repented before being condemned. It was formed of a simple yellow scapulary, with an entire red cross in saltier, and a round pyramidal bonnet, called *coroza*, of the same stuff as the *san-benito*, and garnished with similar crosses, but without any representation of flames, because the repentance of the accused had saved them from death by fire. The *second* was destined for those who had been definitively condemned to be delivered to secular justice, in order to undergo the pains of fire, and who had repented after their condemnation, and before being conducted to the *auto-da-fe*. The *san-benito* and the *coroza* were made of the same stuff. On the lower part of the scapulary was represented a human bust on a brazier, whilst the rest of it was covered with the resemblance of flames pointing downwards, to indicate that the criminal was not to be burned alive, because he had not been adjudged to suffer that punishment, but only to be thrown into the flames after being strangled. The same representations were painted upon the *coroza*. The *third* was for those who were treated as guilty of final impenitence. It was made of the same stuff (serge) as the others. The lower part exhibited a human bust on a brazier, surrounded with flames; and the rest was covered with flames in their natural direction, to show that he who wore it was doomed to actual burning. On the vestment were also delineated grotesque figures of fiends, which were intended to indicate that these lying spirits had taken up their abode in the soul of the guilty. The *coroza* was marked with similar figures. Such were the principal forms of the *san-benito*. The others were intended for those adjudged to suffer milder penalties, as confinement and penance, and generally had inscribed on them the name, country, species of heresy, punishment, and date of con-

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demnation of the delinquent, accompanied with a cross in saltier or with flames, according to circumstances.

As the Inquisition was the creation of an intolerant age, when religious zeal was envenomed by bigotry, and exasperated by schisms and divisions, so it has fallen before the humanizing influence of modern civilization, and is now, even in Catholic countries, only a matter of history. In Spain and Portugal it has ceased to exist even in name; in Italy and other countries, where it has not been formally abolished, it is practically obsolete. But the time was when it acted with fearful energy and efficacy, and when, like the Vehmgericht, it struck terror into all hearts. In Spain alone, according to Llorente, upwards of three hundred and forty thousand persons were judged and punished, one way or other, by this tribunal. Of these nearly thirty-two thousand were burned alive. And if to this number be added all the unfortunates who were condemned by the tribunals in Mexico, Lima, Carthagena, Sicily, Sardinia, Oran, Malta, together with Naples, Milan, and Flanders, whilst these countries were under the dominion of Spain, it would probably be found that more than half a million of human beings had been condemned by this inexorable tribunal to undergo various punishments, a large proportion of which inferred infamy. (J. B—E.)

INSANITY. See MENTAL DISEASES.

INSECTS. See ENTOMOLOGY.

INSOLVENCY. See BANKRUPTCY.

INSPIRATION. See REVELATION.

INSTINCT (from *ἐν*, in, and *στίζειν*, to prick), the name given to that principle in the animal economy which enables all animated beings to perform certain actions for the preservation and reproduction of their species, involuntarily and independently of all experience. It may be conveniently divided into physical and mental instinct; the former, independent of will or mind altogether, although never found except where animal life and consequently mind exists, is exemplified in the action of the heart and the peristaltic motion of the bowels; the latter, independent of reason or the higher faculties of mind, may be exemplified in the formation of beaver-dams by the efforts of that animal itself. The existence of such a principle is best seen in the two instances which have been rendered classic by Lord Brougham,—the formation of hexagonal cells by the bee, and the deposition of grubs over her egg by the solitary wasp. In the former example, antecedently to all experience, the bee constructs a habitation for her brood on mathematical principles of economy and strength, not solved by the reason of man till after a lapse of eighteen centuries of his history. In the latter instance, the solitary wasp is found unerringly to provide for an unknown future, bringing a given number of small grubs, and depositing them over her egg in a hole which she has made, providing exactly grubs enough to maintain the worm that egg will produce when hatched, although all the steps in the process are unknown to her experience and transcend her reason, she having never seen an egg produce a worm, having never seen a worm produced, being herself doomed to death before the worm can be in existence, having never tasted grubs nor used the hole which she has made except for the prospective benefit of the unknown worm she is never to see. These two instances bring into striking prominence the characteristic feature of instinctive action. It is action without knowledge, and in the dark; action in which nothing is designed by the agent, and yet all his labour tends to a certain defined and important purpose; action which works to perfection in its kind, anterior to and independent of the teaching of experience. In all these particulars the instinct of animals differs from the appropriate action of man. He only works well after a course of teaching and experiment; he has a consciousness of the nature of the work which he undertakes, and intends and designs to do what he accomplishes. Perfection and uniformity are seen in the products of instinctive toil, imperfection and variety are the consequences of human labour having the process and the result always within the sphere of its cognition. Instinct.

From these and similar facts various theories have been formed in regard to the instinctive principle. By some philosophers all instinctive action has been attributed to merely an exquisite kind of mechanism, such as may be brought to explain the actions resulting from mere irritation; while, on the other hand, they have been by others referred not only to thought, but to the most sublime degree of intelligence of which we can form any conception. From the marked infallibility of instinctive labour—which though some have challenged, yet most concede—there has arisen the notion that it is produced immediately by a direct divine inspiration; and in comparing the deceitfulness of reason with the faultless operations of instinct, the maxim has become common with many writers, *Deus est anima brutorum*. Both these theories, however, are incompetent; the one degrading instinct below its proper rank to the level of machinery, and the other lifting it above its proper place to the highest mood of mind. It seems as unreasonable to claim all that is unerring for the immediate agency of God, as to claim it for the purely mechanical agency of matter. The fact of the instinctive impulse being more precise and unerring than human reason, does not demand that it should be regarded as the effect of an influence superior to it, since in this particular, although excelling human reason, it falls short of the precision secured by mere irritation, as irritation itself is transcended in perfection of result by mere chemical and mechanical attraction and repulsion.

Another theory regards instinct as the result of the animal's faculties actuated by the impressions of his senses. Here it is necessary to distinguish instinctive or natural *desires* from instinctive *operations*. The gratification of a sensual desire is something different from the execution of a work. In the one it is not necessary to suppose any moving power other than the strength of the appetency, which finds its gratification in the sensual act; but in the other, when the process is long and complex, a purely sensual cause seems utterly inadequate. Of course, such a theory cannot be disproved, and there is much to afford it countenance in those cases where the instinct has been blunted, the animal being guarded against those sensations which would have called it into play. Thus swallows have been known to lose their impulse to migrate at certain seasons, when a due supply of food was granted, and they were carefully shielded from the ungrateful sensations of cold. This, however, is of as little avail to solve the more intricate problems of the question, as is Leibnitz's doctrine of pre-established harmony to cut the knot of liberty and necessity in man, a theory which though it cannot be redargued, scarcely demands a formal rejection. That a bee should simply gratify herself by the laborious structure of a cell—which as a product occupies a place vastly superior to the motive that called it forth—is a much more inconceivable hypothesis even than an invisible power or influence acting constantly and immediately on the animal. To imagine a sensitive organism so contrived that it shall find gratification only in making a straight line of a certain size at right angles to a plane, and in executing rhomboids inclined at a certain angle, is to imagine a machine to which the analogy of our own nature forbids us to be reconciled. But the theory which would reduce all to sensual titillation demands more than this. It postulates an organism so contrived that each finds pleasure not only in her own work, narrowed as it is into a given mathematical track, but in adjusting that work to the place and direction wanted, in order that when added to the previous and subsequent labours of the rest, a given effect unknown to each may be produced. It errs also in placing on a level those acts in which instinct per-

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forms a known part only of the process, with these higher acts in which instinct not only procures a gratification which it knows, but accomplishes an end which it does not know and does not intend. The phenomena in fact are more complex than the theory allows or proposes to account for: to use Lord Brougham's comparison, it is as inapplicable to account for the working of the bee as the supposition of merely sensuous gratification would be to account for the skill of a man who in rubbing his hands not only warms himself but moulds a watch, or of a child who, in trying a pencil on a slate for its own amusement, unconsciously writes a classic.

Another theory discerns in instinct the faint glimmerings of intelligence working by the same rules which guide the operations of more developed reason; in fact, regards it as of the same kind as the rational intelligence of man. This, however, is completely at variance with the dicta of our consciousness, which clearly and decisively discriminates the simple agency of instinct from the more elaborate process of reasoning. It is at variance with the fundamental idea of unconscious tendency to a given end, which, from an induction of the phenomena, we cannot help regarding as a necessary element in every instinctive act. But although distinct from reason, with which it coexists generally in the inverse ratio, being regular and perfect in its operation in proportion as reason is dormant or inactive, the instinctive act admits of being modified by the reasoning faculty. That animals do reason, and are capable of abstraction and comparison, both of concepts and judgments, in a faint degree resembling the higher intellectual process, is clear from numerous recorded feats, and is the foundation of their training for the assistance of man. The bee, when interrupted by Huber in her operations, was seen to shorten the length of her cells, to diminish the diameter, gradually making them pass from one state to another, and adapting her building to the unusual circumstances imposed on it. The thirsty crow which threw into the pitcher pebble after pebble, till he raised the surface of the liquid to the level of his beak, showed a power of utilizing the resources of nature that is put forth in its highest degree only by him who is pre-eminently the "tool-making animal." And, to a certain extent the habits, thus originated by the judgment of individuals, become hereditary in the race. Skill acquired by dogs in hunting is found to pass to their pups; and the dogs in South America hunt in line the first time they are taken to the chase, while animals from other countries, heedless of the precaution, rush on singly and are killed. Still this modifying power is found to go only a little way, and from its transitory effects, as seen in numerous experiments, it serves only to show how certainly the operations of instinct can *not* be referred to reason.

It thus only remains for us to regard instinct as a mental faculty, *sui generis*, the gift of God to the lower animals, that man in his own person and by them might be relieved from the meanest drudgery of nature.

INSTITUTE (National), of France. After the suppression of all royal and literary societies in France during the Revolution, a decree of the Year III. of the new calendar ordained that there should be a *National Institute*. It was appointed for the pupose of perfecting the sciences, publishing discoveries, corresponding with learned foreign societies, and pursuing such literary and scientific researches as should tend to the general good and the glory of the Republic. Of this association there were 144 resident members in Paris, 144 associates in different parts of the country, and 24 foreign. It was divided into three classes;—1. Of physical and mathematical sciences, with 60 members resident in Paris, 60 associates in the departments, and 8 foreign. 2. Of moral and political science, with 36 members resident in Paris, 36 in the departments, and 8 foreign. 3. Of literature and the fine arts, with 48 resident members in Paris, 48 associates in the departments, and 8 foreign; in all 312. In addition to these, 20 citizens were to be appointed to travel in France and other countries to make scientific observations. The first public session of the institute was held 22d Germinal, Year IV. (1796). The administration of each class was vested in a president and two secretaries. In 1803 the constitution of the society was changed by Bonaparte, then first consul, who suppressed the second class, that of moral and political science. The whole number of classes was then increased to four;—1. The physical and mathematical sciences, corresponding to the Academy of Sciences which existed before the Revolution. 2. The French language and literature, which corresponded to the French Academy. 3. Ancient history and literature, which corresponded to the Academy of Inscriptions and Belles Lettres. 4. The fine arts, corresponding to the Royal Academies of Painting, Sculpture, Architecture, and Music. For the first class the number of resident members in Paris was 63, and 100 correspondents; for the second class 40 members; for the third, 40 resident members, 60 correspondents, and 8 foreign associates; and for the fourth class 28 resident members, 38 correspondents, and 8 foreign associates. In the beginning of 1804 the temporary secretaryship was made perpetual, and the five now appointed to the office retained it till the re-establishment of the academies in 1816 as before the Revolution. In 1805 an imperial decree issued a commission regarding the Dictionary of the French language. In 1806 the society changed its name to "The Institute of France." In 1808 Napoleon demanded an historic statement of all the progress that had been made in each class since 1789. In 1811 the name of the association was changed into the "Imperial Institute."

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In 1816, upon the restoration of monarchy, the four classes resumed their ancient appellation of Academies. In 1832 the class of moral and political science, which had been suppressed by Napoleon, was revived by Louis Philippe. It consisted of five sections till the present Emperor added a sixth by two decrees of the 14th April 1855. For this new section, devoted to *Politics*, *Administration*, and *Finances*, ten members were nominated. The same decrees instituted a triennial prize of the value of 10,000 francs for the work or discovery which the classes should deem of most importance to the country. Several of the appointments, such as for the management of the library, &c., are at the disposal of the minister of public instruction, who presents to the Emperor an annual account of what is done by the Institute. There are thus five classes or academies, from each of which two persons are chosen to manage the finances of the Institute. New members are appointed by ballot. Each has a salary of 1500 francs. Those neglecting to attend are liable to fine and expulsion. The institute now consists of 223 members, 31 associates, 228 correspondents, 7 secretaries, and 35 free academicians. Each academy distributes annual prizes for merit in its own department. Thus there is a prize of 2000 francs for poetry, 2000 for the best work on French history, &c. See Academy.

INSTRUMENTATION, in *Music*, signifies, in a general sense, the manner in which the different musical instruments in a piece of music are arranged and employed. The different powers and qualities of the instruments, their relative pitch, &c., must all be consulted in producing a good instrumentation, whether in a piece composed for instruments only, or in an instrumental accompaniment to vocal music. A true balance of power must be maintained among the different instruments, otherwise the clearness and brilliancy of the harmony will be destroyed, and the effect confused and unsatisfactory. The best models of judicious instrumentation are the compositions of Haydn, Mozart, Beethoven, Cherubini, Weber, and Mendelssohn. See Music, §§ *Accompaniment* and *Orchestral Music*. (G. F. G.)

INSURANCE.

Insurance. INSURANCE or ASSURANCE is a contract between two parties, one of whom, the insurer, assurer, or underwriter, undertakes, for a certain consideration, called the premium, to assure or indemnify the other, the insured or assured, against a certain amount of loss from the occurrence of a specified contingency. The deed of contract is called a policy, and the contingency assured against is termed the risk. Such contracts are either for a period, fixed at the outset of the transaction, or for a period terminable on the occurrence of an uncertain event, such as the termination of a voyage, or the falling of a life.

The terms *Insurance* and *Assurance* are used somewhat indiscriminately, but to mark the distinction between a contract involving a fixed claim on the occurrence of a specified contingency and a contract for an uncertain *indemnity*, assurance is more properly applied to contracts connected with life—insurance to those connected with fire or marine risks.

The different kinds of risk in "Life Assurance" contracts may be further arranged under the following heads:—

Contracts which are to subsist until the occurrence of an event which must happen sooner or later, such as life assurance for the whole term, the contract being limited only by the occurrence of the event, namely, death;

And contracts which are to provide against the consequences of the same event, either within a specified period, such as assurance for a fixed term of years, or dependent on survivorship, when the death of one or more parties makes the assurer responsible, or terminates the risk in his favour. The first is an assurance certain, the claim being merely deferred. The second an assurance uncertain, the claim being contingent on an event which may or may not happen.

Marine assurance, all writers allow, preceded fire and life assurance, and it is natural to suppose that such should have been the case from the fact that the mercantile adventurer had constant experience of direct loss by shipwreck or disaster, while intelligent men could scarcely avoid being impressed, through time, with the conviction that, out of a certain number of voyages, some were fortunate and others unfortunate. The idea having been once struck that the risk of loss might be shared, assurance appears a natural consequence. Devastations by fire, being at once more easily traceable to their causes, and less susceptible of being brought under the law of average, could not so readily have suggested such an expedient; while, as regards life assurance, the predominance of the selfish sentiment sufficiently explains why insurance against pecuniary loss at sea should have preceded the purely benevolent desire to mitigate to survivors the effects of an untimely death.

In all that has been handed down to us in regard to Phœnician commerce, and in what of the Rhodian code of maritime laws has been preserved in the legislation of Augustus, we find no record of a contract of insurance. The Greeks were unacquainted with the practice; and the Romans knew it only indirectly in the contract of bottomry or loan on the ship and cargo, not recoverable in the event of the ship being lost, a practice which forms the subject of a particular title in the compilations of Justinian, "Dig. de Nautico Fœnore."

From several passages in ancient literature, the invention of the principle has been claimed for the Romans. One is from Livy (*Hist.* 23, 49), where the contractors for delivering corn in Spain during the second Punic War, stipulate that the government should indemnify them against losses by enemy or tempest in the course of their voyages. Insurance. Another is from Suetonius (*Vita Claudii, c.* 18), where it is recorded that Claudius granted a similar guarantee during a time of scarcity; and in another quotation generally adduced, Cicero (*Epist. ad diversos*, ii. 17), mentions to Caninius Sallust his expectation of attaining security at Laodicea against any hazard from the carriage of the booty accruing to him after his victory in Cilicia. None of these passages, however, seem to warrant the conclusion that the practice or the principles of insurance were understood in those times, although the arrangements referred to are suggestive of the principle.

The earlier writers who hold that there are distinct traces of the practice of marine assurance in Roman History, are—Loccenius (*De Jure Maritimo*, lib. ii., cap. 1.); Puffendorff (*Droit de la nature et de gens*, lib. v., cap. 9); Malynes (*Lex Mercatoria*, 3d edition, p. 105). Grotius (*De Jure Belli et Pacis*, 1624), is also referred to as a supporter of the same views. On the other hand, Cleriac (*Les us et coutumes de la Mer*, 1661), and others deny the correctness of the inference. Among more modern writers Emerigon (*Traité des Assurances et des Contrats à la Grosse*, 1783), and more recently Dr Duer (*A Lecture on the Law of Representations in Marine Insurance, &c.*, New York, 1844), vindicate the claim of the Romans to this invention; but on the other hand, Beckmann, Judge Park, M'Culloch, and Pardessus (*Collection des Lois Maritimes*, 1828–45), regard the Roman practice as little more than an indemnification or species of bounty, and failing to exhibit any trace of a *pretium periculi* or premium given to the assurer on account of his promise to make good a loss which fortuitous events might occasion to the property of the assured.

It is after the revival of commerce in the 10th century, that we must look for authorities as to the origin of assurance.

Don Antonio de Capmany (*Memorias Historicas Sobré la Marina, &c., de Barcelona*, tom. ii., page 383), founding on an ordinance issued by the magistrates of Barcelona in 1435, was the first to challenge for that city the honour of being the birth-place of insurance; but having met with the works of Uzzano and Pegolotti he soon found reason to modify his claims. Uzzano, a Florentine merchant, whose writings are placed about 1400, quotes the rate of assurance from London to Pisa, also from Bruges; and Pegolotti, another Italian author, whose writings appeared before 1350, makes reference to the contract of assurance.

But Mr F. Hendriks, in his valuable contributions to the History of Insurance (*Assurance Magazine*) quoting from Pardessus shows that the word *sigürare* occurs with reference to assurance in an unedited document of the year 1318, the *Breve Portus Calleritani*, enacted by the Pisan republic for its then dependent port of Cagliari in Sardinia. (*Collection des Lois Maritimes*, vol. iv., p. 566.) M. Pardessus also mentions that "the contract of reciprocal insurance was known in Portugal as early as the second half of the fourteenth century, according to a chronicle of King Ferdinand, who reigned from 1367 to 1383; and that *Souza* (*Priviléges*, tom. i., p. 355) refers to King Edward (of Portugal) writing in his instructions from Lisbon, 10th September 1436, that the merchant vessels of the English, which had been chartered for the Tangiers expedition, had not been insured, owing to the fault of their proprietors, whilst those of the Portuguese, even of the royal navy, were insured."

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The earliest extant Flemish law as to assurance is dated 1537, but M. Pardessus, in his work above referred to, makes a quotation from the *Chronicle* of Flanders, from which it may be inferred that insurance was practised at Bruges as early as the end of the thirteenth century; the chronicler further stating that the court of Flanders consented, in 1310, to the establishment of a chamber of assurance in Bruges, on requisition from the inhabitants. At first, this great author inclined to regard the statement of the chronicler with very grave suspicion, no trace of the matter being found in the archives of Bruges, or in any authentic history; and even more recently, although admitting the document to be as old as the second half of the fourteenth century, and the improbability of its authenticity to be diminished in proportion as its antiquity is proved, he still inclined to look on the record with suspicion, the law in question being "unknown at the present time," and the system of premium insurance to which it alludes, being specifically different from the mutual insurance originated by King Ferdinand for Portugal.

The *Roole d' Oleron*, and the *Consolat de Mar*, have been adduced by some as furnishing the origin of assurance, but it seems clearly proved that they did not contain any reference to the premium system of assurance. The *Laws of Wisby* are equally silent on the subject, no mention being made of assurance in these laws till 1541, when the notice of it appears interpolated in a manuscript in the possession of the University of Greifswalde.

Various French writers, Cleirac being the chief promoter, hold that insurance and bills of exchange both owed their origin to the expulsion of the Jews from France about the beginning of the twelfth century, but we may accept the opinion of Judge Park, that there are no materials for deciding the question, supported as that view is by the fact, that President Montesquieu who mentions that the Jews, upon this occasion, invented bills of exchange, does not say a syllable of policies of assurance.

On the whole, the question of priority seems to lie between Flanders and Italy; but we think that the advocates for its Italian origin might fairly push the discussion a little further, and the following additional remarks will serve to indicate our leaning on the subject:—

The maritime commerce of the *Italian* States appears to have rapidly increased between the early part of the twelfth and the end of the thirteenth centuries, at which latter period it was carried to a very considerable extent. It is extremely probable, that insurance came into use in Italy about that time; and after the advantages attending it came to be understood, it is natural to suppose that it would be transplanted into most of the countries where the Lombards had established their trading companies. Indeed, according to Malynes, they introduced it into England, at an earlier date than in the neighbouring countries on the continent; as a proof of which he says that down to the time in which he wrote (1622), there was, in every policy made at Antwerp and other places in the Low Countries, a clause inserted, that it should be in all things the same as policies made in Lombard Street, in the City of London, the place where the Lombards are known to have first settled and carried on their commerce in England.

In giving the merit of the invention to the Italians, it ought not to be forgotten that in the period of which we speak they had made the greatest proficiency in trade, and in every species of mercantile improvement. In Venice was established the first public bank, and there also was first introduced a funded debt, transferable from hand to hand. Bills of exchange, if not invented by Venetian merchants, were first used by them extensively, and the principles of book-keeping by double entry were there first understood and applied in practice.

Thus, although no direct authority exists to warrant a positive assertion that the Lombards were the inventors of this kind of contract, yet, when it is admitted that in the twelfth and thirteenth centuries they were the carriers, manufacturers, and bankers of Europe, the inventors of banking, book-keeping, &c., that they originated the name of the contract, and carried the knowledge of it to the different maritime states in which they settled, and that it was by them introduced into this country in the thirteenth century, there is much to be said on the side of those who maintain, that in order to support their extensive commerce, these industrious and ingenious people originated the system.

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The first English statute as to assurance was the 43d Elizabeth, cap. 12, in 1601; but as it designates the system as "tyme out of mynde, an usage amongste merchants," the practice must therefore have been introduced into this country at a much earlier period; probably through the Lombards as already referred to.

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It is curious to observe that Life Assurance, which has so favourable a bearing on our social and moral welfare, may be said to have originated from the study of the laws of chance, as observed in the experience of the gambler. It will be remarked, however, that the one is the very antithesis of the other. In Life Assurance, the individual is freed from risk by union for mutual protection with his fellow-men. The gambler takes the single risk upon himself, and his average, if he obtain it, can only arise from the duration of his play. In fact, the man who has the opportunity of assuring his life, and does not do it, is the gambler, taking the single risk upon himself.

That the one practice took its origin, however, from the observation of the other, there can be no doubt; the earliest mathematical publication on probabilities, being a little tract of Christian Huygens, written in Dutch, but afterwards translated into Latin, and appearing under the title "De Ratiociniis in Ludo Aleæ," in the *Exercitationes Geometricæ* of Francis Schooten, printed at Leyden 1657. Two other mathematicians, however, who preceded Huygens, really laid the foundation of the science, although he wrote the first systematic treatise on the subject. We refer to the famous Pascal, and Fermat his friend, a magistrate of the parliament of Toulouse. But as the history of the general doctrines of probabilities is given under that head, we must confine our remarks to the history of that doctrine as applied to the duration of life, and the progress of life computations.

It has been usual to commence the history of life contingencies with the little volume of "John Graunt, citizen of London," who published observations on the bills of mortality in 1662; but Mr Hendriks has given the means of more remote speculation on the subject.

The practice in the days of Herodotus was to reckon three generations equivalent to a century, and the census of Vespasian, as noticed in Pliny, distinguished cases of extreme longevity. But we do not find anything like an observation on the subject until we come to the calculations of the Prætorian præfect, Ulpianus, one of the most eminent commentators on the Justinian Code, who gave a table of the estimated present worth of Life Annuities, with reference to the requirements of the Falcidian law, which rendered it necessary to put a value on liferents and other similar provisions. Ulpianus, however, took no account of interest, so that his calculations are more expectations of life than life annuities, and in that view Mr Hendriks says, "The old Roman jurisprudence gave far more correct views of the comparative value of life at different ages than the moderns possessed, in a popular way, until nearly the close of the seventeenth century." Ulpianus' calculations (*Pandect*,

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35–2·68), compared with certain Swedish observations given by Dr Price, are as follows:—

Ages.	Stockholm Life. Dr Price. Expectation of Males.	Females.	Ages.	Expectations Male and Female Roman Life. Ulpianus.
Birth.	14·25	18·10	Birth to 20	30
5	31·05	37·12	20 „ 25	28
10	30·00	36·89	25 „ 30	25
15	26·74	33·43	30 „ 35	22
20	23·85	30·01	35 „ 40	20
25	21·40	26·80	40 „ 41	19
30	19·42	23·98	41 „ 42	18
35	17·58	21·62	42 „ 43	17
40	15·61	19·25	43 „ 44	16
45	13·78	17·17	44 „ 45	15
50	11·95	15·12	45 „ 46	14
55	10·30	12·89	46 „ 47	13
60	8·69	10·45	47 „ 48	12
65	7·39	8·39	48 „ 49	11
70	5·81	6·16	49 „ 50	10
75	4·09	4·39	50 „ 55	9
			55 „ 60	7
			60 and upwards.	5

It seems abundantly evident that Ulpianus' estimate must have been based on actual observations in some form, but the Romans must have had a miserable chance of life in old age.

From that period we have nothing to attract attention till the sixteenth century, when Dr (or Sir) Thomas Wilson, who died in 1581, published his *Discourse upon Usurie*, which contains illustrations of endowment transactions on the lives of children, but the life contingency portion seems merely incidentally introduced with reference to questions as to usury.

In 1661, M. Cleirac, the author of *Les us et Coutumes de la Mer*, notices the *Guidon*, "a French production, formerly compiled for the benefit of the merchants trading in the noble city of Rouen." This work is nearly 300 years old, its author's name is unknown, but it is a most curious document, in consequence of the reference it makes to assurance matters. From Mr Hendriks we give the following translation, omitting Cleirac's notes:—

"1. In other countries, where the bodies of people may be captured and reduced to bondage, there are various usages for the insurance of the body and life of men, whether they be of free condition, or slaves, which customs will not be mentioned here, because in France, men of whatsoever nation are of frank and free condition.

"2. Notice only will be taken of what is practised in this country by those who undertake distant voyages, as to the coast of Italy, Constantinople, Alexandria, or other like voyages in the Mediterranean and Atlantic Seas, on account of the fear which they have of the galleys, *fustes*, and frigates of the army of the Turk, or Corsairs, who make a traffic of the sale of Christians, whom they capture as well on sea as on land; which creates occasion for the masters and captains of this country, when they undertake such voyages, to stipulate with their merchant freighters, or others, for the restitution of their persons, in case they are captured; and this they can do even for the people of their crew.

"3. In such a case, the master must, in the policy, estimate his ransom, and that of his companions, at so much per head; declare the name of the ship, the stay or touchings which it will make, the duration of each stay, and to whom the ransom is payable. The insurer is bound to pay the sum insured for the ransom 15 days after verification and certification of the captivity, without waiting for the usual two months' delay; and without other formality of seeing freightage, bill of lading, or charter party, it will suffice to produce the attestation of capture and the policy.

"4. Pilgrims going to the Holy Sepulchre of Jerusalem, or on other distant voyages, may effect insurance for their redemption, valued at a given amount. Description shall besides be made of their persons, names, surnames, country, abode, age, and rank; and, moreover, limit shall be made as to within what time they undertake to make and accomplish the voyage: the longest period shall be of three years inclusive, without admitting excuse of illness, or other detention whatsoever. In imitation of the preceding, those who undertake journeys or vows for a lengthened period, or a passage from one country to another, may insure for their ransom.

"5. Another kind of insurance is made by other nations upon *the life of men, in case of their decease upon their voyage*, to pay certain sums to their heirs or creditors. Creditors even may insure their debts, if their debtor *remove from one country to another*; the same can be done by those having rents or pensions, so as in case of *their decease, to continue to their heirs such pension or rent as may be due to them*. Which are all stipulations forbidden, as against good morals and customs, from which endless abuses and deceptions arose, whence they have been constrained to abolish and prohibit the said usages; which is also to be prohibited and forbidden in this country."

The most remarkable feature of these times was the condemnation of, and legislation against, the practice of assurance in many countries. Not only in France was it assumed unrecognizable by law, but in the Netherlands' Ordinance of Philip II., and in the Civil Statutes of Genoa (1588), in which last it is declared that "securities, bonds, or wagers may not be made, without the license of the senate, upon the life of the pope, nor upon the life of the emperor, nor upon the life of kings, cardinals, dukes, princes, bishops, nor upon the life of other lords or persons, in constituted dignities, ecclesiastical or secular. Neither may they be made upon the acquisition, loss, or change of lordships, governments, kingdoms, provinces, duchies, cities, lands, or places" .... nor upon any other transaction having the species or form of a bond, security, or wager (*vadimonii securitatis, seu partiti*); but all are understood and are forbidden. The 24th article of the Amsterdam Ordinance of 1598 prohibits insurance of the life of any person, and likewise wagers upon any voyage or frivolous purpose; and the Rotterdam Ordinances of 1604 and 1635 repeat the latter injunctions. The 10th article (*Titre* 6) of the great French Marine Ordinance of Louis XIV., dated 1681, says, "We forbid the making of any insurance on the life of men;" but the 11th article excepts those who redeem captives, and guarantees the price of the redemption assured upon the persons, if the redeemed on his way back perish *by other means than natural death*. "Even later than the 17th century," adds Hendriks, "life insurance was regarded in France as obnoxious. In 1783, there remained a spirit of opposition to it. Emerigon, whose work on assurance comprises more than 1300 quarto pages, devotes *one page* to the subject of life assurance, and that short space to the purpose of attacking the system."

But we must now pass on to a more interesting period, when we are called on to consider the conflicting claims of great names, with reference to the origination and practical application of the doctrine of annuities, as derived from the study of the laws of chance or probability.

John de Wit, the Grand Pensionary of Holland, submitted to the States-General of Holland, in 1671, a treatise on the valuation of life annuities, and, on the basis of that document, it was resolved to grant life annuities for the purpose of raising funds. This treatise Mr Hendriks characterizes as "the first known production of any age treating in a formal manner of the valuation of life annuities," and the scientific world are much indebted to him for the restoration of this document, which was inserted in the Resolutions of the States of Holland and West Friesland of the year 1671, and which had remained as good as lost for 180 years.

In the preparation of this document De Wit was no doubt aided by the preceding labours of Pascal, Fermat, and Huygens, and he had no doubt the advantage of observations on the duration of life among persons to whom the States of Holland had previously granted annuities; but, independently of the originality of the design, we must give him the entire credit of having discovered a correct principle on which the value of a life annuity might be calculated.

De Wit's Treatise is headed "Value of Life Annuities

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in proportion to Redeemable Annuities." He commences with pointing out the difference between a "redeemable annuity," as he terms it, at 4 per cent., that is a perpetuity at 25 years' purchase, or perpetual investment at 4 per cent., and a life annuity; estimating the value of the latter in the most favourable circumstances as "really not below, but certainly above 16 years' purchase." He then gives some preliminary observations on the doctrine of chances, and afterwards applies the principle to the calculation of an annuity value at a particular age. His calculations are simplified and explained as follows by Mr Hendriks:—

"*First*, Out of 128 lives, aged say 3 years, 1 is supposed to die in every half-year of the first 100 half-years, or 2 per annum for 50 years, leaving 28 alive, aged 53 years, at the end of the term; out of whom 1 dies in every 9 months, being 0·66 per half-year during the next 20 half-years, or 1·33 per annum for 10 years, leaving 15·66 alive, aged 63 years, at end of second term; of whom 1 dies in every year for 10 years, being 0·5 per half-year during the next 20 half-years, leaving 5·66 alive, aged 73 years, at the end of the third term; of whom 1 dies in every year and a half for 7 years, being 0·33 per half-year during the next 14 half-years, leaving 1 alive, aged 80, at the end of the fourth term; which survivor does not live over another half-year. *Secondly*, Out of the 128 lives, those who die in the respective half-years between the ages of 3 and 80, will receive an annuity certain in half-yearly instalments, for a term equal in continuance to the number of completed half-years elapsed between age 3 and the date of their death; therefore, the sum of the present values of half-yearly annuities certain, for the corresponding terms multiplied in the numbers *dying* within such respective terms, gives the present worth of all the annuities which will be enjoyed by the 128 lives, $1\frac{1}{2}\frac{1}{8}$ of which represents the present value of the single life annuity at age of, say 3 years."

We have dwelt at some length on the discovery of De Wit, as it has not been available previously in any account given of the progress of life calculations, our best writers in this country, from the absence of any precise knowledge in regard to it, having passed it over with a slight notice. On the continent, however, the labours of De Wit have been more highly appreciated. The Marquis of Condorcet, in his *Discours Preliminaire*, gave him the credit of being "the first mathematician who thought of applying calculation to political questions." "*It was he who first essayed to fix the rate of life annuities according to the probabilities of life given by the tables of mortality.* Upon politics, upon the true interests of nations, upon the freedom of trade, he had very superior ideas to those of his age; and we may say that his premature death was a misfortune to Europe as well as to his country."

We cannot conclude our notice of De Wit without mentioning the name of his fellow-labourer, if we may so term him, the Burgomaster Hudde. We had at one time rather a painful impression left on our mind, arising out of the terms of Hudde's certificate to the report of De Wit to the States-General, and other observations by Mr Hendriks, but we are glad to find, from the correspondence subsequently brought forward, that they were fellow-labourers in the same field, and that Hudde himself was a man of science.

We have now to mention the first published work in which an attempt is made to form Tables of Mortality. We allude to the work of John Graunt, whose name has been already mentioned. It was published in 1662, and is the first book on the subject of life observations, as a distinct treatise. It is entitled, *Natural and Political Observations, mentioned in a following index, and made upon the Bills of Mortality, by John Graunt, citizen of London*, (afterwards described in the fifth edition as "Captain John Graunt, F.R.S.") A century previous to the publication of this little volume, viz., on 1st January 1562, the first register of burials was commenced in London, the necessity for the inquiry arising from the great mortality occasioned by the plague at that time. From that time the bills of mortality were kept at irregular intervals, according to the appearance and disappearance of the plague, but from 1603 the records were continued uninterruptedly. Graunt paid particular attention to these weekly returns, and, with a sagacious appreciation of their value, reduced the results into tables, "in order to the more ready comparing of one year, season, parish, or other division of the city." He analyses the bills themselves, and draws certain conclusions with great adroitness, giving the first semblance of a table of mortality in the arrangement of deaths in decads. The work passed through five editions, the last under the superintendence of his relative Sir William Petty, who himself paid some attention to the subject, having published *Essays on Political Arithmetic concerning the People, Housings, &c., of London and Paris. Essay concerning the Multiplication of Mankind, and the Growth of the city of London. Observations on the Dublin Bills of Mortality*, &c.; and *Discourse on Duplicate Proportion*, read before the Royal Society 1674.

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From this time till 1693, when the celebrated Dr Halley's investigations and calculations appeared, there is little to attract attention. A set of tables were published during this interval, entitled, *Tables for Renewing and Purchasing of the Leases of Cathedral Churches and Colleges*, &c.; also *Tables for Renewing and Purchasing of Lives*, &c., bearing the imposing title of "*Sir Isaac Newton's Tables;*" but we learn from Mr Edwin James Farren's historical *Essay on the Rise and Early Progress of the Doctrine of Life Contingencies in England*, that Sir Isaac Newton being then at Cambridge (Lucasian Professor *vice* Barrow), it appears to have been thought politic to obtain his sanction or *imprimatur* as to the correctness of the tables, and "his original cognizance of the work appears to have been to merely confirm the (Q.E.D) correctness of a single table relative to the established usage of renewing college leases."

In No. 196 of the *Philosophical Transactions*, 1693, Dr Halley published the result of his investigations under the following title:—"An Estimate of the Degrees of the Mortality of Mankind, drawn from curious Tables of the Births and Funerals at the city of Breslau, with an attempt to ascertain the Price of Annuities upon Lives, by E. Halley, R.S.S."

The Table of Dr Halley is arranged exactly in the same form as the mortality tables of the present day, and shows the numbers living at each age, being the first table of the kind. He proceeded to form annuity values from his mortality table; but as he computed at one rate of interest only, 6 per cent., and the values were given for every fifth year merely, his results were very limited in their application. His mode of construction was not consecutive, he having failed to obtain a general formula for the value of annuities; but if he had made separate calculations for each year of age, he would, no doubt, have discovered the general solution. Dr Halley's formula for annuity values in modern notation (Milne's) is as follows:—

$$A = a^{-1}\{^1a\,(1+r\}^{-1} + {}^2a\,(1+r)^{-2}, \text{ \&c. \&c.}$$

In specifying the uses to which his table may be put, he thus indicates the calculations of assurances. "Use IV.—By what has been said the price of insurance upon lives ought to be regulated, and the difference is discovered between the price of insuring the life of a man of 20 and 50. For example—it being 100 to 1 that a man of 20 dies not in a year, and but 38 to 1 for a man of 50 years of age," &c. It will be perceived that the reference made is to short period assurances, which, as will be shown afterwards, was the practice of the day.

Dr Halley may be designed, then, the discoverer and scientific arranger of what are called Life Tables, but there is no doubt that De Wit preceded him by some years in the elimination of a method by which the true value of a

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life annuity could be obtained. Halley was more scientific than De Wit, but there is no occasion to place the one above the other, they both made important discoveries and valuable additions to our knowledge, and, without clashing, they may be referred to as the originators of the application of the doctrine of probabilities of life and death to practical uses.

Notwithstanding the progress thus made in ascertaining the values of life annuities at particular ages, the Government continued to disregard such knowledge in their enactments, and in 1694 made the following estimate in a money act, which was passed in that year:—

Single life	7	years' purchase.
Two lives	8½	...
Three lives	10	...

Which rates, under another act passed in 1703, were raised, on

A single life, to	9	years' purchase.
Two lives to	11	...
Three lives to	12	...

Abraham de Moivre comes next. The first edition of his tract, entitled *Annuities upon Lives*, &c., by Abraham De Moivre, F.R.S., was published in 1724, and passed through several editions, viz., in 1738, in 1750, in 1752, and, finally, in 1756. This distinguished analyst improved what Halley had begun, and Mr Farren points out very distinctly, that the formula, generally attributed to Thomas Simpson, by which the value of an annuity at any age may be derived from that at the next higher age, must now be attributed to De Moivre, he having generalized the formula given by Halley. We have not been able to find the passage on which Mr Farren founds his claim in the 4th edition 1752, or in the edition of 1756; but as Mr Farren quotes from the edition of 1724, that is sufficient authority.

The formula may be given as follows, in modern notation (Milne's), and it may be afterwards compared with that of Simpson and of Euler, to whom the discovery has also been attributed:—

$$A = {}^{1}a\,a^{-1}(1+r)^{-1}(1+{}^{1}A)$$

But the labours of De Moivre are best known from his hypothesis, that the decrements of life are equally and uniformly progressive. He took Dr Halley's observations from the Breslau mortality, and finding that the decrements of life, for considerable intervals of time, were nearly in arithmetical progression, he assumed, that out of a given number of persons born, a certain number of deaths would take place annually, fixing the limit of life at 86 years; thus out of 86 lives, assuming that 1 would die annually, the mortality the first year would be one out of 86; the second year 1 out of 85; and when the lives were reduced to 50, the mortality became 2 per cent., that is, 1 out of 50, and so on. Upon this basis he worked out a system, which, from the uniformity of its series, was easily made applicable to all single life calculations. The results agreed closely with the true values according to Halley, from 30 to 70, and this mode of calculation was so far useful at the time; but the talented author did not succeed in applying the theorem satisfactorily to joint lives. It is quite possible, we think, that an extension or modification of De Moivre's hypothesis, at some future day, may be found practicable, and we are rather inclined to think that the discussion proved favourable to the more complete investigation of the laws and doctrines involved. At any rate we agree with Bailey, that his hypothesis will ever remain a proof of his genius and abilities.

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We have only further to direct attention to the fact of De Moivre having proposed questions as to assurance values. See Problems 14th and 15th in his 4th edition.

He also published a paper in the *Philosophical Transactions*, 1754, to determine the value of life annuities when a proportion is required from the date of last payment to the date of death.

After De Moivre, we pass on to Thomas Simpson,[1] who, in 1742, published *The Doctrine of Annuities and Reversions, deduced from General and Evident Principles, with useful Tables, showing the Values of Single and Joint Lives*, &c. Simpson did not think the Breslau Tables of Halley at all applicable to London, and considered Smart's *Tables on London Observations* required correction with reference to the afflux of people from all parts up to town. The whole subject is treated by Mr Simpson in a much more perspicuous manner than by any previous writer. His formulæ are general, and adapted to any table of mortality, and although De Moivre portrayed the method of obtaining the annuities on lives at a younger age, from the values at the immediately preceding age, still we must allow that the advancement of the science is more attributable to Simpson than to De Moivre. Simpson's formula is contained in the seventh corollary to the first problem, in his *Doctrine of Annuities*, which declares—"If the value (P) of the joint lives A, B, C, be given, or once computed, the value (K) of the next younger lives $\overset{1}{A}, \overset{1}{B}, \overset{1}{C}$, &c., whose ages are each, respectively, one year less than those of ABC, &c., may be easily derived. And the result shown is

$$K = \overline{1+P} \times \frac{QRS, \text{ \&c.}}{r\,\overset{1\ 1\ 1}{QRS}, \text{ \&c.}}$$

$\overset{1\ 1\ 1}{QRS}$, &c., being the numbers found in the table of observations against the next younger ages, and r the amount of L.1 in a year." In modern notation this becomes

$$ABC, \text{ \&c.} = {}^{1}(abc)\,(abc)^{-1}(1+r)^{-1}\{1+{}^{1}(ABC)\}, \text{ \&c.},$$

which is evidently the same as De Moivre's process.

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[1] The most important works in the interval are the following:—John Smart—*Interest Table, with an Appendix as to Annuities on Lives*, 1726. In consequence of a suggestion made by Mr Smart in this publication, the *ages* appear to have been added to the London bills of mortality in 1727-28; and in 1738, after ten years' results had been obtained, he published the first table composed from English data. Richard Hayes—*A New Method of Valuing Annuities on Lives*, 1727. The only novelty this work contains is a table of life annuities at yearly ages. The data on which he compiled his tables are not given, and he appears to have formed a table of probability for himself. From an example given of the sale of an annuity, one would almost be inclined to attribute to Mr Hayes some portion of the credit for the origination of the whole term assurance principle, but as he deals with it entirely as an annuity question, we must merely record the step as tending towards the more complete process. An assurance company certainly buys an annuity from the policy holder when an assurance is granted, and in that view the cases are almost identical. This work was reprinted in 1746. In 1728 Mr Hayes, the same author, published *An Estimate of Places for Life, showing how many years' Purchase a Place for Life is worth.* Neither of these works are of much value, but they tend to show that the interest in the subject was increasing. John Richards of Exon.—*The Gentleman's Steward and Tenants of Manors Instructed*, &c., 1730. The Tables for valuing estates on lives are founded on Dr Halley's hypothesis, and calculated by the method laid down by M. Ab. de Moivre, to 4, 5, 6, 7, and 8 per cent, &c. Edward Lawrence, land surveyor, 1730—*A Dissertation upon Estates, upon Lives*, &c. Gael Morris, 1735—*Tables for Renewing and Purchasing of Leases, and also for Renewing and Purchasing of Lives*, &c. Weyman Lee, 1737—*An Essay to Ascertain the Value of Leases, of Annuities for Years and Lives, and to Estimate the Chances of the Duration of Lives.* Mr Lee endeavoured to show that an annuity certain for the number of years equal to the probable lifetime of a person was the true value of a life annuity. He of course failed. In 1751 Mr Lee published *A Valuation of Annuities and Leases certain for a Single Life*, in which he endeavoured to defend himself. John Richards, 1739—*Annuities for Lives and for Limited Terms of Years considered*, &c. This was an answer to Weyman Lee, who had attacked his work of 1730. From 1725 to 1740 a number of other works were published as to the value of leasehold estates, church and college leases, &c., but those mentioned above are the most important, and it is quite unnecessary to record the others here.

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"Subsequent investigations," says Farren, "have indeed revealed to us that Simpson's formulæ were capable of improvement, but the principle of relying solely upon the doctrine of mathematical 'probability' in demonstrating life-contingency problems, without being restricted to any particular set of numerical results, is still happily recognised by calculators, and undoubtedly owes its prevalence to the pre-eminent example thus afforded by this celebrated mathematician." It should, however, be mentioned that Simpson's rules being partly deduced from De Moivre's hypothesis, and partly from real observations, are thus rendered of diminished value.

It is perhaps scarcely fair to record the foibles of men of learning, but historical notes such as these would be wanting in completeness if we did not refer to the controversy between Simpson and De Moivre. It is characteristic of the times in which they lived, and if not instructive, is certainly amusing. Mr Simpson appears at a subsequent date to have got into controversy also with Deparcieux, and he complains with some bitterness of Deparcieux having criticized with more *severity than judgment* the alterations he had made in Smart's table of mortality for London; but Simpson appears to have taken his information at second-hand, and that the views of M. Deparcieux were erroneously reported. Mr Milne, however, considers M. Deparcieux's remarks "to be both candid and just," and gives them at length in the introduction to his *Treatise on the Valuation of Annuities and Assurances*, vol. i., p. 8. In 1752, Mr Simpson published his *Select Exercises for Young Proficients in the Mathematics*. That part relating to annuities was separately printed in 1791, and is generally bound up with his *Doctrine of Annuities and Reversions*. In this last publication, he gives approximations to the value of reversionary sums and annuities upon lives according to assigned order of precedency.

M. Antoine Deparcieux, in 1746, published his *Essais sur les Probabilités de la Durée de la vie Humaine*. This work contains valuable tables of mortality, derived from the registers of deaths in the different religious houses in France, separating the males and females. M. Deparcieux also made use of the experience of the French Tontines, and by separating the sexes, he ascertained the greater longevity of female life. His calculations of the values of annuities on single lives are made at three rates of interest. Milne considered his tables to be some of the most useful that had then been published, and the values of annuities given by them nearer the truth for the average of England than any others of which he was aware, except in old age, when they were certainly too small. Altogether, he seems to have made a valuable addition to the information of the day. His work attracted much attention on the Continent, and it is understood to have been the foundation of the articles, "Rentes Viageres," and "Vie, Durée de la," in the *Encyclopédie*. He had a nephew of the same name, who published a quarto volume at Paris in 1781, on annuities certain, entitled *Traité des Annuités*.

Omitting the minor works of James Hodgson in 1747; George Louis le Clerc, Comte de Buffon, in 1749; Thomas Short in 1750; and Corbyn Morris in 1751, we come to the works of James Dodson, who in 1751 contributed a paper to the *Philosophical Transactions*, "On the Improvement of the Bills of Mortality;" in 1753, he published a second volume of the *Mathematical Repository*, which contained solutions of various annuity questions on De Moivre's hypothesis; in 1754, he contributed a paper to the *Philosophical Transactions*, suggesting an improvement on De Moivre's calculation connected with the payment of a proportion of annuity to the date of death; and in 1755, he published the third volume of his *Mathematical Repository*, which is entirely devoted to problems relating to annuities reversions, survivorships, insurances, and leases dependent on lives.

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These publications of Dodson are highly interesting, and we find considerable prominence given to assurance calculations as distinct from annuities. De Moivre and Simpson gave one or two problems from which assurances might be inferred, or which involved the assurance principle; but Dodson proposed the solution of distinct problems on the subject. All the solutions, however, being based on an erroneous principle, are of little practical value.

Passing over the works of William Kersseboom of the Hague, to be found in the *Phil. Trans.*, May 1753, and of S. Stonehouse (1754), whose new tables, deduced from the London Bills of Mortality, do not differ largely from those of Simpson, and the paper of the Rev. William Brakenridge, in the *Phil. Trans.* of 1755, we notice the labours of Leonard Euler, who, as Bailey expresses it, "has condescended to illustrate the first principles of this science." In 1760, in a paper inserted by him in the *Histoire de l'Acad. Roy. de Berlin*, entitled "Recherches Generales sur la Mortalité et la Multiplication du Genre Humaine," he gave a formula, similar to that of De Moivre and Simpson, for ascertaining the value of an annuity at any age, from the value at the age immediately preceding; and by it he calculated a table for single lives, on a table of mortality prepared by M. Kersseboom, founded chiefly upon the registers of the Dutch annuitants, carefully examined for a century backward. His formula is—

$$\overline{m} = \frac{1}{\lambda} \cdot \frac{(m+1)}{(m)} \left(1 + \overline{m+1}\right)$$

$\overline{m}$ and $\overline{m+1}$ being values of annuities upon lives aged m and $m+1$ years respectively (m) and (m+1) the numbers that attain to those ages, according to the table of mortality, and $\frac{1}{\lambda}$ the present value of L.1, to be received at the expiration of a year; being the same formula as given in modern notation, in the explanation of De Moivre's discovery of the process. In the second volume of his *Opuscula Analytica*, published after his death in 1785, the solution of a question relating to reversionary annuities is given—a much more arduous undertaking, be it observed, than in the present day, when so many auxiliary tables are ready to assist the actuary.

In 1759 the publications of Graunt, Petty, and Corbyn Morris, were reprinted in a work entitled *Collection of the yearly Bills of Mortality, from* 1657 *to* 1758 *inclusive, together with several other Bills of an earlier date* (anonymous); and *A Comparative View of the Diseases and Ages, and a Table of the Probabilities of Life*, by J. P., Esq., F.R.S. These were supposed to have been arranged by Dr Birch, secretary of the Royal Society, from materials furnished by Dr Heberden; and the Table of Probabilities was calculated by James Postlethwayte, Esq. Mr Farren says, "the publication is, in every respect, worthy of being consulted, especially by statisticians interested in the early history of the London bills of mortality, these being printed at full length, and a very judicious preface prefixed."

We have now to mention the works of an author, whose name is known more extensively in connection with life assurance than probably any other—we refer to Dr Price. He wrote at a time when the practice may be said to have been purely experimental, and with a disinterested desire of protecting the public from erroneous and ill-digested schemes, he did good service to the cause by hastening and guiding its reform. Had he done no more than put an end to many of the bubble schemes of the days in which he wrote, his name would have been deservedly remembered, but he did more, and much more, in the cause. Even the first three editions of his work, which mainly contained a polemic

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against the errors of the annuity plans then prevalent, was highly suggestive on many other points, especially in showing the necessity of more accurate observations on the mortality of human life, in order to determine with more correctness the value of life annuities. In 1783 a fourth edition of the work appeared, enriched with much new matter. Various tables calculated on the Northampton Observations were contained in this edition, also the Swedish tables, founded on the observations of Mr Wargentin, who was one of the commissioners appointed to take charge of the returns of the annual births and deaths in all Sweden and Finland. The number of the people, sexes distinguished, was returned to these commissioners once in three years, and Mr Wargentin furnished to the *Transactions of the Royal Academy* an abstract of the returns for nine years, 1755 to 1763, for the whole kingdom, and Stockholm separately. Wargentin died in 1783, but Mr Nicander, his successor, who afterwards continued his observations, maintains that he left similar computations for four periods—(1765-6-7), (1768-9), (1772), (1774-5 and 6)—and that an abstract deduced from these statements was sent by him to Dr Price not long before his death. Dr Price acknowledges his obligations to Mr Wargentin, as well as to Mr Oeder of Oldenburgh, and John Peter Sussmilch, the author of *Göttliche Ordnung, or The Divine Decreet in the Variations of the Human Race, with regard to Births, Deaths, &c.* (4 edits., 1742, 1761, 1765, 1775).

The chief feature of Dr Price's fourth edition, however, is the introduction of the Northampton Observations and Tables founded on them, which became the basis of the calculations in the Equitable Society, and were adopted by many assurance institutions established during the forty years which succeeded their publication. These Tables at the present day form the basis of the calculations in connection with legacy duties under the 36th Geo. III., cap. 52, and are still confided in by various of the older insurance offices. They were framed from the accounts kept at Northampton during the forty-six years 1735-1780, of the ages at death of 4689 persons who were buried in the parish of All Saints. The chief defect in the result is, that the expectation of early life is too small, and of later life too great; but the table has fulfilled its mission; and although it is now properly designated the "False Northampton Table," in contradistinction to the "True Northampton Table," published in the records of the registrar-general, we can still afford to give it its meed of praise, and we have no hesitation in pointing to it as one of those supports which has lent valuable aid in the construction of the vast fabric of life assurance. The inaccuracy of the table we can only touch upon very slightly, leaving those interested to refer to the valuable investigation of the subject by Dr Farr in the Eighth Report of the Registrar-General of England. The Northampton Table of Dr Price was constructed from the deaths alone, on the hypothesis that the population of Northampton had been stationary for nearly a century; but Dr Farr has ascertained the fact, that from the eleventh century, when the Doomsday Survey was taken, down to the present time, the population increased during the whole period; and it is certain that life tables can only be constructed from the deaths alone, if the population be stationary, if the births and deaths be equal, and if the results be not disturbed by migration.

Dr Farr, in illustrating this subject, gives a true life table for Northampton, deduced from the population returns of 1841, and the numbers living and dying at each age in All Saints parish there, which he designates "the True Northampton Table;" and a table constructed from the deaths alone during the same period, which he designates "the False Northampton Table" (being the counterpart of Dr Price's). These he compares together, and with Dr Price's own table, in the following manner. The calculations are made at 3 per cent. interest, without any allowance for expenses or profits:—

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Age.	After Lifetime at 7 Ages.		Value of Life Annuities of £1, at 7 Ages.		Annual Premiums to be paid for Life, to insure £100 at Death.		Single Premiums to Assure £100 at Death.	
	By True Northampton Table.	By False Table, which agrees with the Northampton Table in common use.	By True Northampton Table.	By False Table.	By True Northampton Table.	By False Table.	By True Northampton Table.	By False Table.
0	37·57	24·88	17·085	12·169	2·617	4·681	47·324	61·642
10	47·57	39 54	23·396	20·615	1·186	1·714	28·946	37·044
20	39·93	33·40	21·412	18·702	1·549	2·163	34·717	42·616
30	32·59	28·15	19·081	16·961	2·067	2·655	41·506	47·686
40	25·49	22·85	16·296	14·859	2·869	3·393	49 625	53·809
50	18·76	17·49	13·055	12·275	4·202	4·620	59·054	61·334
60	12·27	11·91	9·155	8·949	6·935	7·139	70·424	71·021

From these data he draws the conclusion that "the Northampton Table of Mortality by Dr Price does not express the mortality of All Saints parish in the town of Northampton, of the county of Northampton, nor any other town or county either in the past or the present century." We may add, at the same time, that if Dr Price's Table had been properly formed, we believe the results would not have differed from the values now exhibited on observations correctly made; and that it is probable these results, as compared with modern observations, would have led to the conclusion that the value of life in this country has not materially improved during the last century. Without supporting or suggesting the use of the Northampton Table, which, without doubt, is erroneous in its mode of construction, and cannot be continued in use by any society without sooner or later giving rise to a feeling of dissatisfaction; yet we almost regard it as providential that a nearer approach to the truth was not then made, and that the Equitable Society adopted the Northampton data, as it is probable that that institution, if its rates had been little more than equal to the risks, might have become involved in early difficulties; or at least would have failed to inspire that confidence, to which the vast accumulation of its funds, in consequence greatly of its high rates of premium, based on the Northampton data, gave rise. In other circumstances, it is probable that life assurance would have made but slow progress, and its blessings would not have been available to every man, as they now are.

Dr Price gives tables for single lives on the Northampton data, complete at six rates of interest, and on two joint lives at four rates, calculated on combinations of from five to seventy years' interval, which is sufficiently near to be used for all ages by interpolation. To the sixth and seventh editions of Dr Price's work, there are valuable prefaces by Mr William Morgan, actuary of the Equitable Society, whose works we shall have to notice presently, and who in his preliminary observations gives a graphic picture of the state of assurance offices in his time.

The mathematical demonstrations are generally considered the most unsatisfactory part of Dr Price's work, and it certainly is a blemish that, in the later editions, various examples, or rather calculations, proceed partly on De Moivre's Tables, and partly on the Breslau Observations, notwithstanding the publication of his own new tables. Dr Price has also the merit of having been the first to determine the true value of a given sum payable at the end of the year in which any number of lives become extinct, the investigations of Simpson and Dodson both having been erroneous. Baily also mentions De Moivre as having missed the solution, but with his formula before us, we cannot admit it.

Mr Morgan's earliest work, entitled *The doctrine of*

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Annuities and Assurances on Lives and Survivorships, was published in 1779. In his tables and examples the results on De Moivre's hypothesis were still required for illustration, and in the absence of more extensive tables they answered the purpose. On the whole, his book is highly suggestive; and from his plan of checking annuity values, it may almost be said that the first idea of the columnar system is to be found in the method employed by him. The fourth edition of Dr Price's *Observations* was published in 1783; and in the interval, and subsequently, Mr Morgan appears to have devoted himself to the study of the subject with greater ardour and success than formerly. In 1788, 1789, 1791, 1794, and 1800, he contributed several papers to the *Philosophical Transactions*, in which he gave for the first time accurate solutions of problems involving values of reversions and annuities according to assigned order of precedency, detecting the inaccuracy of his former rules, which were also the rules of Simpson and others who had gone before him. In 1821, after a lapse of 40 years, Mr Morgan again came forward with a second edition of his work, in which, not only much additional matter is contained, but he abandons entirely the hypothesis of De Moivre, and gives the solutions of his questions according to the real probabilities of life. He explains the nature of annuities and assurances on lives, together with the principles on which the calculations are based, giving the rules in words at length, and the demonstrations algebraically in an appendix. In a postscript, he gives a "Nosological Table," containing an account of all the deaths in the Equitable Society during twenty years, "among a population exceeding 150,000 persons." These were not the lives assured, but the number of years enjoyed by those lives, and the mode of expression gave rise to some mistakes—Mr Babbage and Dr Young being both misled. Mr Morgan also published in 1828, *A View of the Rise and Progress of the Equitable Society*.

Prior to the second edition of Mr Morgan's work, M. De St Cyran (capitaine en premier au corps royal du génie), published a work (in 1791), entitled *Calcul des Rentes viagères sur une et sur plusieures têtes*, containing various annuity tables, computed from Kersseboom's Tables of Mortality. He also gives values of annuities at 5 per cent., calculated from a corrected copy of the table of mortality of M. Dupré de Saint Maur; and he gives a copy of Deparcieux's Table of Annuities for Single Lives. The algebraical formulæ are not clear, and his values of two and three lives are only approximations. The annuities, as in Deparcieux's Tables, are made payable to the date of death.

In 1781 Carl Chassot de Florencourt published a work entitled *Abhandlungen aus der juristischen und politischen Rechenkunst*, in which he gives a table of single lives, calculated on Deparcieux's Table of Mortality, but making the annuity payable at the end of every year the life survived, with a table of proportional parts, for additions to be made according to the period the annuitant survived the year.

In 1783 Francis Maseres, Cursitor Baron of his Majesty's Court of Exchequer, published *The Principles of the Doctrine of Life Annuities explained in a familiar manner*. This work consists of 726 large quarto pages, but although so voluminous, the work is full of information clearly conveyed. He reviews with great acuteness the most interesting points in the advancement of the doctrine, prior to the period at which he wrote. In tabular matter the work is peculiarly rich, and Deparcieux's Tables of Annuities from the French Tontines are extended to 12 rates of interest on single lives (2 to 10 per cent.), and on joint lives to two rates ($3\frac{1}{2}$ and $4\frac{1}{2}$ per cent.) the combinations being equal ages—5 or 10 years, and multiples of 10. He also gives, in an appendix, various suggestions and tables connected with a proposed scheme for the better support of poor persons in certain circumstances, by enabling parishes to grant them annuities for life; the tables being divided "for the use of London," and "for the use of country parishes."

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Next in order of time, and in order of importance not behind any we have yet mentioned, comes Francis Baily, F.R.S. With his earlier works we have no immediate concern, but his volume on Annuities and Assurances (editions of 1810 and 1813) contains a clear demonstration of the whole theory. He adopts Simpson's notation, and gives solutions in the several cases of contingent annuities and assurances as Mr Morgan had also done. He does not spare censure in expressing his opinions of Mr Morgan's works, but although we do not admire some of the remarks made in his criticism, we cannot help being impressed with the idea that what Baily wrote he truly and honestly felt; and if he does find fault, he is no less ready to praise when he thinks it deserved. His defence of Barrett every actuary must admire. Mr Baily's work is a text-book in the study of the science, and contains extensive tables, calculated on the Northampton data, on the probabilities of living as observed by M. Deparcieux, and on the probabilities of living as observed in Sweden.

In 1806 E. E. Duvillard published his "Table of Mortality for France before the Revolution," in his work on the *Mortality of Small-pox*, "a work which," says Milne, "would have been of greater authority if he had given us satisfactory information respecting its construction and the observations it depended upon." From the time of Dr Price, however, down to the date we have now reached, there were many other writers on subjects connected, directly and indirectly, with annuities and assurances. For these, we must refer to the excellent *Bibliographical Catalogue*, appended to a work by Lewis Pocock, F.S.A., published in 1842, entitled, *A familiar Explanation of the Nature, Advantages, and Importance of Assurances upon Lives*, &c.

The next work of historical interest is that of Joshua Milne, actuary to the Sun Life Assurance Society, entitled, *A Treatise on the Valuation of Annuities and Assurances on Lives and Survivorships, on the Construction of Tables of Mortality, &c., with a variety of New Tables*, 1815. It is to him that we are indebted for the introduction of the observations of Dr Heysham, made at Carlisle from 1779 to 1787. From the data afforded by these, which he believed "to be the only data derived from a fluctuating population, which furnished the means of forming an accurate table of mortality," he calculated tables, and published annuity values at various rates of interest. These Carlisle Tables, along with those on the law of mortality in Sweden and Finland, proceeding from the observations of Mr Nicander, in continuation of the observations given by Dr Price, form his most valuable contributions to the science of life assurance. The following will afford a general idea of the difference between these two sets of Swedish Observations:—

There died annually in Sweden and Finland,	Males.	Females.
	One of	
During 21 years, ended with 1775 (Dr Price)	33·25	35·94
During 20 years ended with 1795 (Milne)	35·60	39·11

The Carlisle Table has to a great extent superseded the Northampton Table. Most of the offices established before Mr Milne's work was published proceeded on the Northampton data, and still do so, being probably deterred by the complexity of a change; but the great mass of offices now adopt the sounder data of Milne; and those which do not, proceed on tables very similar, such as the Chester, the Equitable Experience, the results of the combined expe-

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rience of various life offices published in 1841, or the Tables of the Registrar-General. The only real objection which can be taken to the Carlisle Table is, that at some ages it is very badly graduated, so that particular results are somewhat anomalous. Instance the assurance for one year, at the following ages:—

Age.	Single Premiums.	Age.	Single Premiums.
45	1·4377	49	1·3284
46	1·4385	50	1·3027
47	1·4178	51	1·3876
48	1·3529	52	1·4758

But notwithstanding this irregularity, it is very generally admitted that all subsequent observations have proved the accuracy of its results, and the best proof of this probably is, that all the auxiliary tables published for many years have been founded on the Carlisle data. We admit that it would be possible to have a more satisfactory table; but it is as near the truth as we will probably ever reach—sufficiently near for any practical purposes; and the immense mass of tabular matter which has been computed and arranged on its basis, must always keep it in the first place as the foundation of assurance calculations.

On 29th June 1820, B. Gompertz, F.R.S., read at the Royal Society a *Sketch of an Analysis and Notation Applicable to the Estimation of the Value of Life Contingencies;* and the paper was published in their *Transactions*. We will not enter on consideration of the hypothesis of this writer, as our limits do not admit of our discussing the very interesting theory which he propounds. His object is the enunciation of a law of vitality susceptible of being calculated on a certain hypothetical principle,—viz., that the vital energy or power to oppose destruction loses equal proportion of its intensity in equal times.

In 1829, John Finlaison, actuary to the Commissioners for the Reduction of the National Debt, made a report to the Lords of the Treasury, which was ordered by the House of Commons to be printed on 31st March 1829, containing a statement of the facts and arithmetical conclusions deduced, after an investigation of ten years, from the observations on the mortality of the nominees in the various tontines, and sets of life annuities which had been instituted or granted by Government. These observations proved, that at every period of life the female has a decided advantage over the male, removing all doubt on the subject of the greater value of female life.

Some have objected to the results of these observations, amongst other grounds, from the circumstance that they extend over a remote period of time, rendering the data inapplicable to present and future circumstances, if any value is to be attached to the prevailing opinions as to the improvement of life; but after many years' experience of the use of the table, and after applying such checks as were available, we have come to the conclusion that these tables represent, very correctly, the value of the lives of annuitants, and are very suitable for calculations in connection with such transactions. On the other hand, they are quite unsuitable for adoption as the basis of life assurance premiums; and we do not think any office could with safety adopt the Government Tables as their guide in that respect. We believe the National Debt Office are in possession of joint life calculations, on the basis of Mr Finlaison's computations; but as they have thought it proper to retain them for their own use, we are glad to find that Mr Henry (a Scottish actuary) has had the perseverance to compute, and the courage to commence the publication of a complete set of Joint-life Tables.

In 1808 the Government began to grant annuities on the Northampton Tables, and did so for twenty years. The tables since adopted are founded on Mr Finlaison's report. The result of the Government operations in annuities is too extended a subject to enter upon here; but we have pleasure in referring the reader to an able article, *On the Financial Statistics of British Government Life Annuities* (1808–1855), *and on the Loss sustained by Government in granting Annuities*, read before the Statistical Society, 19th May 1856, by Frederick Hendriks, Esq., whose extensive knowledge and indefatigable research are well known to all actuaries.

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In 1825, Griffith Davies, the learned actuary of the Guardian Assurance Company, published *Tables of Life Contingencies*, containing the rate of mortality among the members of the Equitable Society, and the values of life annuities, reversions, &c., computed therefrom. The rate of mortality among the members of the Equitable Society, he deduced from the accounts given by Mr Morgan in his addresses to the general courts of that institution, and in the notes added by him to the later editions of Dr Price's *Observations on Reversionary Payments*. Mr Davies' calculations were based on a period of fifty-seven years, from 1768 to 1825.

In 1834 the Equitable Assurance Society published a valuable abstract of the accumulated facts in their possession, from which Mr Morgan deduced a table of mortality. The most remarkable fact which these observations showed was the decreasing influence of selection after five, ten, fifteen, and twenty years from the period of admission; and on this important observation there are various interesting papers in the *Assurance Magazine*. We would particularize the paper of Mr J. A. Higham, *On the Value of Selection, as exercised by the Policy-holders against the Company*, 1851. We would also refer to Mr Farren's *Life Contingency Tables*, part i., published in 1850.

Passing over the ingenious speculations of T. R. Edmunds (1832), which bear a considerable resemblance to those of Gompertz already noticed; and reserving the results of the work of Thomas Galloway (1841), on the mortality among the members of the Amicable Society, for exhibition in a tabular form, we may notice the *Experience Table* compiled from data furnished by seventeen offices, according to the resolution at a public meeting held 19th May 1838. This investigation proved very interesting, and the results so far satisfactory. Should a similar comparison be made on a wider basis at the present time, we believe that the expeperience of *well-constituted offices*, in later years, will show that the power of selection has proved stronger than formerly, seeing that family history is so much more fully inquired into; that the medical power of ascertaining certain diseases is so much increased; and that the medical men of the present day are, especially in the country, a much more competent body than formerly.

The following table, extracted from the *Report of the Actuaries on the Combined Experience*, brings concisely into view the results shown by these different observations:—

Table showing the Annual Number of Deaths in Quinquennial Periods of Age, out of 10,000 *Persons living at each Age, according to various Tables of Mortality.*

Ages.	Northampton.	Carlisle.	Equitable Experience.		Government Annuities.		Amicable Experience.			Experience of the Offices.	
			Morgan.	Davies.	Males. Observation 20.	Females. Observation 13.	Table II.	Table III.	Table IV.	Town Combined Mortality.	Adjusted Mortality.
20 to 24	747	351	363	352	697	431	...	...	...	421	374
25 ... 29	814	410	386	429	638	452	244	...	245	350	401
30 ... 34	886	506	428	518	625	498	321	...	328	375	438
35 ... 39	972	547	500	595	654	554	427	...	439	488	485
40 ... 44	1113	705	574	657	678	575	530	...	587	552	548
45 ... 49	1266	718	669	769	724	595	679	833	787	666	679
50 ... 54	1521	760	871	1089	1076	653	886	1166	1050	904	902
55 ... 59	1800	1103	1240	1380	1471	846	1289	1633	1415	1248	1241
60 ... 64	2173	1847	1753	1654	1796	1149	1846	2279	2041	1768	1767
65 ... 69	2784	2285	2551	2204	2656	1732	2765	3177	3040	2627	2589
70 ... 74	3774	3469	3702	3080	3630	2785	4136	4410	4321	3913	3812
75 ... 79	5414	5382	5292	4291	4937	4378	6261	6089	5993	5655	5607

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This combination of the experience of the offices gave rise to the calculation of *A series of Tables of Annuities and Assurances calculated from a new Rate of Mortality amongst Assured Lives*, which was published by Mr Jenkin Jones in 1843, and to which reference should be made, as well as to the report on the experience of the offices.

We have now to mention, in concluding this portion of our subject, the invaluable records of the nation, which are year by year accumulating new and important facts for our guidance in estimating the value of life in this country. We refer to the tables and results published since 1839 by the Registrar-General, and deduced from the records of births, deaths, and marriages, in England. The Sixth Report is particularly important as containing a life table and various calculations, founded on the national observations applicable to the year 1841, prepared by Dr Farr. We have had occasion to use these results extensively, having adopted them as the basis of some most important calculations, and as before adopting them we made them our particular study, we refer to them with much satisfaction, as tables well suited as a basis for life assurance transactions. They are graduated so as to give them a preference over the Carlisle observations, but a careful comparison will show how they support the results shown by that table.

Attached to the Twelfth Report of the Registrar-General, Dr Farr introduced his valuable English Life Table No. 2, compiled from the returns of deaths in the seven years 1838–44, and from the census returns of 1841. The English Life Table No. 1, the result of one year's observations, and No. 2, the result of seven year's observations, agree very closely, as will be perceived from the following tables of comparison :—

After Lifetime or Expectation of Life.

	0	10	20	30	40	50	60	70
1841. English Life Table No. 1	40·17	47·08	39·88	33·13	26·57	20·03	13·59	8·52
1838-44...No. 2	40·36	47·47	39·99	33·21	26·46	19·87	13·60	8·55

*Annual Premium to assure L.*100.

	0	10	20	30	40	50	60	70
	L. s. d.	*L. s. d.*	*L. s. d.*	*L. s. d.*	*L. s. d.*	*L. s. d.*	*L. s. d.*	*L. s. d.*
1841. English Life Table No. 1	2 5 10	1 5 0	1 11 11	2 1 1	2 14 7	3 17 6	6 2 7	10 3 2
1838-44 ... No. 2	2 5 7	1 4 5	1 11 8	2 0 9	2 14 11	3 18 6	6 2 7	10 2 6

Among other important facts which have been derived from the records of the Registrar-General, we must direct attention to those contained in the Fourteenth Report relative to the comparative effects of particular occupations on health and longevity. The annexed table is extracted from that Report, the several classes being arranged in the order of mortality at the ages 45 to 55.

Mortality per cent.

Ages.						
25—	35—	Occupation.	45—	55—	65—	75—
1·015	·864	Farmer.....	1·199	2·490	5·530	14·802
·912	1·059	Shoemaker...	1·503	2·869	6·505	16·446
·797	1·056	Weaver.....	1·537	3·299	7·459	17·308
·763	1·046	Grocer	1·579	2·265	4·972	12·457
·812	1·240	Blacksmith...	1·651	3·724	7·443	16·710
·945	1·032	Carpenter...	1·667	2·966	6·586	14·286
1·163	1·415	Tailor.....	1·674	2·818	7·647	15·528
·979	1·253	Labourer....	1·730	2·920	6·790	17·394
·849	1·135	Miner	2·015	3·450	8·051	17·867
·759	1·475	Baker	2·121	3·301	6·678	15·066
1·130	1·653	Butcher.....	2·310	4·149	6·647	15·449
1·383	2·045	Innkeeper...	2·834	3·897	8·151	13·084
·948	1·236	All England	1·787	3·031	6·396	14·055

We have now, in the course of these remarks, mentioned all the most important observations which have as yet been made in connection with the records of mortality. Life Assurance.

The following are additional sources of information, though of less importance than the preceding :—

The Government Returns of the different censuses in 1801, 1811, 1821, 1831, 1841, and 1851.

The papers by Mr Edmunds in the *Lancet*, as to the method of determining the relative mortality of particular localities, both with complete and imperfect data.

Mr Chadwick's paper in the *Statistical Journal*, on the best mode of representing accurately, by statistical returns, the duration of life; and an excellent paper in the same journal, in answer to Mr Chadwick's paper, *On a Method recently proposed for conducting Inquiries into the Sanatory Condition of various Districts*, by F. G. P. Neison.

(The *Statistical Journal* may indeed be referred to generally, as containing many important papers.)

Dr Cleland's Enumeration of the City of Glasgow in 1831, as to which Mr Milne promised to publish a Table of Mortality, based on the results of ten years, 1820–1830, but did not accomplish it.

F. G. P. Neison's *Vital Statistics*.

M. Domonferrand's *Expectation of Life in France*, calculated approximately from official documents, as published in the *Journal de l'Ecole Royale Polytechnique*.

The works of Francis Corbaux should also be referred to (see Mr Pocock's list).

Likewise the writings of Dr Young (see same list).

M. Villermés' valuable papers on the *Annales d'Hygiène*, in which the mortality of the different parts of a large city were first investigated, showing that the mortality differs very sensibly in the arrondissements of Paris, will be found interesting.

Report of Irish Census Commissioners, in an article on the health of Dublin, attached to Mr Wild's paper on the Causes of Death in Ireland.

Reports to the House of Commons, compiled from the Returns of the War Office and Army Medical Department; also *Reports on the Health of the Navy*.

We have confined our observations hitherto in a great degree to the notice of the works of those earlier authors who have materially contributed to our knowledge by introducing new data, and we may now refer to those authors whose ingenuity has greatly increased the practical application of those data by the invention of new modes of calculation. In making this distinction, however, we cannot strictly adhere to it, as we must include many of the names already mentioned as contributors to our data, who have also greatly advanced our steps in calculation. We may repeat the names of De Wit, Graunt, Halley, De Moivre, Simpson, Price, Maseres, Morgan, Baily, Milne; but their works have already been noticed at as much length as our space will admit.

We do not hesitate to place at the head of our modern computers, George Barrett of Petworth, Sussex, the original inventor in this country of the columnar system of calculation. His system, when submitted to the Royal Society, unfortunately did not meet the attention it deserved. But its value was fully appreciated by Mr Francis Baily, who published it in the Appendix to his own well-known work on *Annuities*. He thus describes the method :—

"Let A be the life on which the annuity is granted; and let the number of persons living at the age of A, according to any given table of observations, and at 1, 2, 3, &c., years older be denoted respectively by $a, b, c, d, \ldots w, x, y, z$; z denoting the number of persons living at the age of the oldest life in the given table, and in general equal to unity. Moreover, let the amount of L.1 in a year, according to the given rate of interest, be denoted by r. This being premised, it is well known (by those who are conversant with the subject), that the value of an annuity on the single life A is expressed by the following series :—

$$\frac{1}{a}\left(\frac{b}{r}+\frac{c}{r^2}+\frac{d}{r^3}+\cdots\frac{x}{r^{n-2}}+\frac{y}{r^{n-1}}+\frac{z}{r^n}\right)$$

n denoting the number of years from the age of A to the age of the oldest life in the table of observations; and the sum of this series, numerically expressed according to the age of A, forms the common tables of the value of life annuities. But the above series may be expressed more conveniently for our present purpose by the following one :—

$$\frac{1}{ar^n}\left(br^{n-1}+cr^{n-2}+dr^{n-3}+\ \ldots\ ar^2+yr+z\right)$$

which is evidently the same as the former.

In the plan proposed, therefore, A is supposed to be a child just born, or one whose age is equal to 0; and each term of the series (beginning at the end) is to be numerically expressed and arranged in regular order in the same column, at the bottom of which must be placed the numerical value of the common divisor ar^n. In a collateral column are to be placed the sums of the first one, first two, first three, first four, &c., values in the former column, which I shall denote by Z, Y, X, &c., and by the help of these two columns we shall be enabled to solve every question relative to life annuities and assurances, not only with less liability to error, but frequently in a more expeditious and easy manner than by the usual method of proceeding."

The following is part of the Carlisle Table calculated on this method by Mr Babbage:—

Age.	An	Bn	Cn
104	1·000	1·000	1·000
103	3·090	4·090	5·090
102	5·304	9·394	14·484
101	7·649	17·043	31·527
100	10·130	27·173	58·700
99	12·752	39·925	98·625
98	16·717	56·642	155·267
97	22·138	78·780	234·047
&c.	&c.	&c.	&c.

Mr Babbage gives the following formulæ:—

Value of an annuity of L.1 on a life aged $v = \frac{B_{v+1}}{A_v}$.

Do. deferred for p years $= \frac{B_{v+p+1}}{A_v}$.

Do. for a temporary period q years $= \frac{B_{v+1}-B_{v+q+1}}{A_v}$.

Value of an assurance of L.1 on a life aged $v = \frac{B_v - rB_{v+1}}{rA_v}$.

The value of an assurance on a life aged v deferred for p years is

$$= \frac{B_{v+p}-rB_{v+p+1}}{rA_v}.$$

The value of a temporary assurance for p years on a life aged v is

$$= \frac{B_v - B_{v+p} - r(B_{v+1}-B_{v+p+1})}{rA_v}.$$

Various other problems in assurance and annuities can also be solved by these tables.

Before introducing Barrett, we ought probably to have mentioned John Nicholas Tetens, Professor of Philosophy and Mathematics at Kiel, who first promulgated the columnar method in a work published in 1785, under the title of *Einleitung zur Berechnung der Leibrenten und Anwartschaften die vom Leben und Tode einer oder mehrerer Personem abhangen mit Tabellen zum practischen Gebrauch.* This fact, however, detracts nothing from the merits of Barrett, whose discovery was original to himself, and quite independent.

Tetens describes his method thus—"By means of a new auxiliary table, which can be made in accordance with the table of mortality, by which it is to be reckoned, and at the rate of interest proposed for its foundation, the whole labour as well for life annuities as for the mean duration of life, may be reduced to one division. The preparation of that table requires nothing more than an easy addition, when regard is had to the duration of life only; but demands somewhat more trouble if it be extended to the calculation of life annuities. It would not be desirable, therefore, to make it for one single annuity of the kind. But then it gives simultaneously all values of life annuities, as well as all durations for every age at once. I will here annex it, as applied to Sussmilch's Table of Mortality. It is the model for others of the like description."

A Age.	B Living according to Sussmilch.	C The numbers in B discounted for the years of the age, r being $= 1{\cdot}04$.	D Sum of the numbers in B added upward from beneath.	E Sum of the numbers in C added upward from beneath.
0	1000	1000·	28·988	12437·48
1	750	721·15	27·988	11437·48
2	661	611·13	27·238	10710·33
3	618	549·40	26·577	10099·20
4	593	560·90	25·959	9549·80
5	579	475·90	25·366	9042·90
	&c.	&c.	&c.	&c.

It is quite evident that these tables are computed on the D and N system, as contained in the works of Griffith Davies. Column C is identical with column D, and column E with column N, with this exception, that the summations are placed differently, agreeing in this respect with the arrangement of Barrett, as followed by Dr Farr.

But though the credit of the actual discovery is undoubtedly due to Tetens and Barrett, there were several other eminent calculators of the last century, who came so near it that another step boldly taken would infallibly have led them to it. The most remarkable of these were Halley, William Dale, De Moivre, and Morgan. Dr Halley's method was entirely columnar, the denominator in his formula being common to all the numerators, as expressed in the following notation (Jones):—

$$\frac{l_{m+1}v}{l_m}+\frac{l_{m+2}v^2}{l_m}+\frac{l_{m+x}v^x}{l_m}=a_m$$

If he had made a calculation for each age, he would probably eventually have discovered the D and N system; as the result, however, of trial or experiment, if it may be so called, not of real investigation. Dale's work, published in 1772, may be called Arithmetical, but is one of considerable originality. His formula is similar to that of Halley, combining the enumerators, and making one common denominator; *thus*,—

$$\frac{l_{m+1}v+l_{m+2}v^2\ldots+l_{m+x}v^x}{l_m}.$$

There is no doubt that he thus produced a D and N column, but unfortunately only applicable to one age. Had he, too, made the calculation for every age till birth, he might have discovered the D and N process. De Moivre, in his *Doctrine of Chances*, second edition, 1738, p. 212, gives a formula which gives him a primary claim to the method of dealing with discounted decrements. The following is De Moivre's own formula:—

$$\frac{A-B}{A_r}+\frac{B-C}{A_{r^2}}+\frac{C-D}{A_{r^3}}+\frac{D-E}{A_{r^4}}+\frac{E-F}{A_{r^5}}\text{ \&c.}$$

A, B, C, D, E, F, represent the numbers living at any age, and the differences give the decrements. The method, as applied to reversions, is similar to that of Halley as applied to life annuities, but the general solution was wanting. Mr Morgan, in his *Doctrine of Annuities and Assurances*, 1779, may be almost said to have discovered the D and N system without knowing it. He uses the discounted values, however, merely as a method of check, and those who peruse his explanations on the subject must feel convinced that he did not know the power of the D and N columns.

The next great impulse was given to the science by Griffith Davies. Without his inventive genius, the system of Barrett might have remained long unimproved, but he remodelled it, and although the *principle* is the same in both, he has so arranged his tables that they may almost

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be said to be a new discovery. Mr Davies published his method in his *Tables of Life Contingencies*, as published in 1825, and more fully in his *Treatise on Annuities*, also written and printed in 1825, but published only in 1856, after his death, by his executors.

The following extract of a table on the Carlisle three per cent. basis will illustrate the subject:—

Ages.	No. Living.	D	N	S	C	M	R
104	1	0462	0000	0000	04488	04488	04488
103	3	1429	0462	0462	09246	13730	18220
102	5	2452	1891	2353	09524	23260	41480
101	7	3536	4343	6696	09809	33070	74550
100	9	4683	7879	1·4576	10100	43170	1·17700
	&c.	&c.	&c.	&c.	&c.	&c.	&c.

The column D is obtained by discounting the number of living at each age to the beginning of life; thus the number living at 104 is discounted 104 years, the number at 103 is discounted 103 years, and so on. The column N consists of the continuous summation of the results in column D; and the column S consists of the continuous summation of the results in column M. The column C is obtained by discounting the number of those who die in each year to the beginning of life; thus the one who dies after reaching 104 is discounted 105 years, the number who reach 103 and die before 104, is discounted 104 years, and so on. The column M consists of the continuous summation of the results in column C. The column R consists of the continuous summation of the results in column M.

The principles of the columnar system are very concisely treated in Mr David Jones' work *On the Values of Annuities and Reversionary Payments*, published under the superintendence of the Society for the Diffusion of Useful Knowledge. The following are extracts:—

I. Annuities.

If we call z the difference between the age m, and the oldest completed by any life according to the table,

$$a_m = p_{m,1}\cdot r + p_{m,2}\cdot r^2 + p_{m,3}\cdot r^3 + p_{m,4}\cdot r^4 + \ldots + p_{m,z} r^z$$

writing for $p_{m,1}$, $p_{m,2}$, &c., their values $\frac{l_{m+1}}{l_m}$, $\frac{l_{m+2}}{l_m}$, &c.

$$a_m = \frac{l_{m+1} r + l_{m+2} r^2 + l_{m+3} r^3 + l_{m+4} r^4 + \ldots + l_{m+z} r^z}{l_m}.$$

If the numerator and denominator of this fraction be multiplied by r^m (which will not affect the value of the expression) the formula becomes

$$a_m = \frac{l_{m+1} r^{m+1} + l_{m+2} r^{m+2} + l_{m+3} r^{m+3} + l_{m+4} r^{m+4}}{l_m \cdot r^m}, \text{ &c.}$$

Rule.—Multiply the number of living at each year of age by the present value of L.1, due at the end of the same number of years as the age; then the present value of the annuity at any age, is found by dividing the sum of the products at all the ages above that on which the annuity depends, by the product at that age.

The advantage of the last form of the fraction over the other may be seen by taking as examples the separate ages of 96 and 95 in the Carlisle Table of Mortality.

$$a_{96} = \frac{l_{97} r^{97} + l_{98} r^{98} + l_{99} r^{99} + l_{100} r^{100} + \ldots\ldots + l_{104} r^{104}}{l_{96} r^{96}}$$

$$a^2_5 = \frac{l_{96} r^{96} + l_{97} r^{97} + l_{98} r^{98} + l_{99} r^{99} + l_{100} r^{100} + \ldots + l_{104} r^{104}}{l_{95} r^{95}}$$

On comparing the expressions for these two values, we observe that in finding the value at the age of 95, every term is introduced which was employed in finding the value at the age of 96; so that it costs very little more trouble to find the value at both the ages, than to find the value at one of them only; but had the first expression for a_m been used, the operation employed in finding the value at the age of 96 would not have afforded direct assistance in finding the value at the age of 95. The method which has been adopted has also other important advantages, the preparatory operations being of great use in abridging the labour of finding the values of temporary deferred annuities and assurance.

The following example in numbers, of the value of annuities at 4 per cent. at the Carlisle rate of mortality, will show the process of forming a table of the values of annuities on single lives.

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Value of Annuities.

$l_{104}\, r^{104} = 1 \times \cdot01692512 = \cdot01692512$ $\quad N_{103} = \cdot01692512$ $\quad a_{103} = \frac{\cdot01692512}{\cdot05280636} = \cdot32051$

$l_{103}\, r^{103} = 3 \times \cdot01760212 = \cdot05280636$

$N_{102} = \cdot06973148$ $\quad a_{102} = \frac{\cdot06973148}{\cdot09153125} = \cdot76183$

$l_{102}\, r^{102} = 5 \times \cdot01830625 = \cdot09153125$

$N_{101} = \cdot16126273$ $\quad a_{101} = \frac{\cdot16126273}{\cdot13326950} = 1\cdot21005$

$l_{101}\, r^{101} = 7 \times \cdot01903850 = \cdot13326950$

$N_{100} = \cdot29453225$ $\quad a_{100} = \frac{\cdot29453223}{\cdot17820036} = 1\cdot65282$

$l_{100}\, r^{100} = 9 \times \cdot01980004 = \cdot17820036$

$N_{99} = \cdot47273259$ $\quad a_{99} = \frac{\cdot47273259}{\cdot2265124} = 2\cdot08700$

II. Assurances.

The present value of the nth year's payment is found by multiplying the present value of L.1, due at the end of n years, by the fraction which has for its numerator the number who die in the nth year from this time, and for the denominator, the number living at the present age. Let us call d_m the number who, according to the tables, die in the nth year of their age; then

$$A_m = \frac{r d_{m+1} + r^2 \cdot d_{m+2} + r^3 \cdot d_{m+3} + r^4 \cdot d_{m+4} + \text{&c., &c.}}{l_m}$$

Multiplying numerator and denominator by r^m,

$$A_m = \frac{r^{m+1} \cdot d_{m+1} + r^{m+2} \cdot d_{m+2} + r^{m+3} \cdot d_{m+3} + \text{&c.} + \text{&c.}}{l_m\, r^m}$$

which may be practically applied in the same manner as the annuity formulæ.

The following works should be consulted in regard to the systems of Barrett and Davies, and their application:—

Appendix to the Doctrine of Life Annuities and Assurances, by Francis Baily, 1813.

A Comparative View of the Various Institutions for the Assurance of Lives, by Charles Babbage, 1826—(Appendix, No. III.)

On the Calculation of Single Life Contingencies, No. I., by Professor De Morgan—*Companion to the Almanac*, 1840.

On Life Contingencies, No. II., by Professor De Morgan—*Companion to the Almanac*, 1842.

Account of a Correspondence between Mr George Barrett and Mr Francis Baily, by Professor De Morgan—*Assurance Magazine*, vol. iv., page 185.

We consider that the columnar, or D and N system, has entirely superseded the old mode of calculation, we have not considered it necessary, therefore, to illustrate the older method; but every student should of course make himself acquainted with it, more especially with reference to calculations proceeding on more than two lives, by the study of Baily, Milne, and Jones.

Additional information as to the columnar system will also be found in the *Actuarial Tables* of W. T. Thomson, F.R.S.E., 1853, and in the very valuable *Tables and Formulæ for the Computation of Life Contingencies*, of Mr Peter Gray, published in 1849. In conclusion, the names of Edward Sang, Peter Hardy, Samuel Brown, Charles Jellicoe, William Wood, William Orchard, and B. H. Todd, may be selected for special notice from the long list of calculators who have advanced various departments of the science. Much valuable information on the subject will also be found in the *Assurance Magazine*; the *Reports of the Registrar-General*; and in the *Evidence* given *before the House of Commons* in 1843 on Joint-stock Companies, and in 1853 on Assurance Associations. The evidence on Friendly Societies will also be found interesting.

Life Assurance Offices.

Before the establishment of assurance offices, it was the practice for individuals to underwrite life risks, in the same way as marine assurance; and looking to the *Guidon* and the *Laws of Wisby*, it seems possible to connect the original suggestion of life assurance, or life indemnity, with the risks of the sea. It is to be assumed that during the period when life assurance was transacted by means of underwriters,

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probably during the greater part of the seventeenth century, the contracts were all for short periods. A case in point is that of Sir Robert Howard, on whose life an assurance was effected for one year, from 3d September 1697. On the 3d September 1698, about one in the morning, he died, and a question arose as to the expiry of the risk. Lord Holt ruled that "from the day of the date" excluded the day itself, and the underwriter was made liable. It is quite reasonable to suppose that persons would hesitate to accept the security of private individuals for whole term policies, which could not be acted on till the death of the assured, at, in all probability, a remote period of time.

It is generally supposed that the Mercers' Company were the first to institute a "Widows' Fund," having done so in 1699, on the suggestion of Dr Assheton. Another society was established in 1700, entitled "The Society of Assurance of Widows and Orphans." But it was not till the establishment, in 1706, of "The Amicable Society for a perpetual Assurance Office," that assurance of lives, as a scheme or business, may be said to have commenced. The charge for admission and the annual contribution were L.7, 10s. entrance-money, and 10s. monthly, or an equivalent sum quarterly, with 1s. additional quarterly in either case for expenses. These payments entitled the nomince to a dividend, dependent on the amount of the claims during the year, which, of course, was entirely a lottery. Before the division at the end of the year, there was a fixed dividend of L.1 or L.1, 4s. per share allowed to each partner. The numbers were limited to 2000 members on single lives, and no one was allowed to hold more than three shares; nor were any admitted to be partners whose ages were below twelve or above forty-five, and all between these ages were admitted on the same terms.

The original charter was soon found to hamper the operations of the society, and others were obtained from time to time, which modified its original constitution, and enabled it to enlarge the sphere of its usefulness.

The society was reorganized in 1807. This new charter empowered it to raise the number of its members to 8000; and the supplementary charters of 1823 and 1836 enabled it to increase these numbers, first to 16,000, and then to 32,000. The charter of 1836 contains some important changes of system as regards valuation and dividends, *inter alia*, the actual dividend for every share which should become a claim was increased from L.150 to L.200, and the society was empowered to effect assurances for specified sums on joint lives, or on the life of the last survivor of two or more persons, or on contingencies depending on life, or any life assurances for limited periods for specified sums.

In 1845 the society obtained an act of parliament "to enable the corporation to lend money upon mortgage for the purpose of investment, and also to confer other powers upon the said society." These other powers were connected for the most part with the mode of transacting business,—valuations, and the divisions of profits,—and had the effect of making the society an assurance office on very nearly the usual plan.

In 1854 a second act was obtained conferring extended powers as to investment.

The "Hand-in-Hand, or Amicable Contribution Society," was founded in 1636, but was then exclusively a fire office.—It now transacts life business. The Sun Office was founded by deed of settlement on 15th June 1810. The Union Office in 1714.

In 1712 the joint-stock mania *of that day* was at its height. The time of the South Sea bubble succeeded, and of course, in the prevailing mania, assurance schemes were extensively projected—few indeed were carried out, and still fewer were constituted to stand the test of time; but we find two offiees of high character and standing in the present day, which trace back their existence to that period,—The Royal Exchange Assurance Company established by royal charter on 22d June 1720; and the London Assurance Corporation by similar charter of the same date. The business of these offices did not originally extend to life assurance; but on 29th April 1721, the Royal Exchange received a charter for the assurance of lives, and similar powers were obtained by the London Assurance Corporation. The history of the proceedings of those days, connected more particularly with the establishment of these two societies, is recorded by Mr Hendriks in his interesting account of the *First Parliamentary Committee of Insurance, &c.*, and by Mr Francis in his entertaining *Annals and Anecdotes of Life Assurance.*

Life Assurance.

After the institution of the offices just named, life assurance, for nearly half a century, seems to have remained stationary, for, "in the year 1779, the business of assurances on lives (we quote from Mr Morgan) was but little understood and little practised, excepting the society in Sergeant's Inn (the Amicable), which assured lives at all ages under 45 at the same annual premium, and never exceeded L.300 on the same life, and the Royal Exchange Office, which made a few assurances for a single year at the general premium, I believe, of L.5 per cent."

We now come to the "Society for Equitable Assurances," the well-known London Equitable, which was established in 1762. Thomas Simpson, whose works have been already noticed, Dodson the editor of the *Mathematical Repository*, and Edward Rowe Moris, an accomplished antiquarian of these days, were the originators and promoters of this the most successful institution of the kind which ever existed. For some years it made little progress; but, in 1769, Dr Price published his *Observations on Reversionary Payments, &c.*, in which he recommended the society to public notice, and from that year, or rather from 1775, when Mr Morgan, Dr Price's nephew, was appointed actuary, we may date the prosperity of this great institution. A detailed history of the society is given in Mr Morgan's *View of the Rise and Progress of the Equitable Society*, published in 1828. One event, however, in connection with its early history calls for special record, viz., the fact that in 1760 the crown, on the recommendation of the Attorney and Solicitor General of the day, refused a charter to the society. The formal grounds of refusal were three:—1*st*, Doubts as to the probable success of the undertaking, which, it was argued, would be ruinously injurious to the public interest in the event of failure; 2*d*, Disbelief in the principle of the scheme, which was described as depending "on the truth of certain calculations taken upon tables of life and death, whereby the chance of mortality is attempted to be reduced to a certain standard;" this attempt being itself denounced as a mere speculation, never yet tried in practice, and consequently subject, like all other experiments, to various chances, in the execution; 3*d*, The fear of doing injustice to the London and Royal Exchange Assurance Companies, which had paid very large sums for their charters.

The following is the present position of the Equitable Society, as shown in its latest published accounts:—

ABSTRACT *of General Cash Account of the Equitable Society for the year ending* 31*st December* 1855.

CHARGE.

Received for new assurances and an annuity	L.3,789	13	6
Annual premiums on old assurances	196,462	12	0
Dividends on stock	112,050	0	0
Interest on mortgages	131,950	5	3
Interest on exchequer bills and bonds	5,623	18	4
Entrance money, policy money, extra premiums commuted premiums, and forfeits	5,226	0	10
Cash lent on mortgage, repaid	198,512	2	6
Exchequer bills sold	60,887	14	2
Stock sold	62,350	0	0
Balance from account to 31st December 1854	24,605	12	4
	L.801,517	18	11

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DISCHARGE.

Claims paid on policies within the number of the first 5000	L.300,870	0	0
Claims paid on policies not included in the number	6,700	0	0
	L.307,570	0	0
Additions to claims paid	305.110	16	0
Annuities	1,982	14	0
Income tax	15,502	18	9
Returns of premiums and forfeits	157	12	0
Expenses of management	6,762	12	8
Paid for surrender of policies	19,449	18	0
Paid for additions surrendered	15,895	9	0
Interest on mortgage	108,000	0	0
Balance 31st December 1855	21,085	18	6
	L.801,517	18	11

FUNDS, 31*st December* 1855.

Stock in the Funds—
L.1,705,000 in 3 per cent consols.
1,960,000 in 3 per cent. reduced } L.3,665,000 3 per cents.
Exchequer bonds, L.100,000.
Cash in mortgage, L.3,647,796, 13s. 5d.

Soon after the establishment of the Equitable Society, in 1762, a great number of assurance societies sprung up, but these institutions were, according to report, "for the most part, gross impositions on the public, proceeding from ignorance or knavery, and encouraged by credulity and fallacy." The abatement of most of these nuisances was due in no small measure to the appearance of Dr Price's *Observations on Reversionary Payments*.

We might follow up this account of the earlier life offices by giving information as to the rise and progress of a few more of the most prominent, established during the 50 years which followed the advent of the Equitable, and still in being, but we must confine ourselves to narrower limits, and merely give the names of all offices since established, and which are still in existence, with the date of their establishments, as nearly as we can ascertain; divided into periods to show the rapid increase of such institutions in later years.

The following English offices, now in existence, were established between 1762 and 1810:—

Westminster Society	1792	Provident	1807
Pelican	1797	Rock	1807
Globe	1803	West of England	1807
Albion	1805	Atlas	1808
London Life Association	1806	Norwich Union	1808
Eagle	1807		

The following English offices, now in existence, were established between 1810 and 1825:—

Alliance	1824	Law Life	1823
Asylum	1824	Leeds and Yorkshire	1824
British Commercial	1820	Palladium	1824
Clerical, Medical, and General	1824	United Kent	1824
		Yorkshire	1824
Economic	1823	Also	
European	1819	National Assurance (Ireland)	1822
Guardian	1821	Patriotic (Ireland)	1824
Imperial	1820		

The following English offices, now in existence, were established between 1825 and 1835:—

Argus	1833	National Life Society	1830
Clergy Mutual	1829	Promoter	1826
Crown	1825	United Kingdom	1834
Friends' Provident Instit.	1832	Universal	1834
Mutual	1834	Western Annuity	1831

The following English offices, now in existence, were established between 1835 and 1845:—

Albert	1838	Monarch	1835
Alfred	1839	National Assurance Investment	1844
Anchor	1842	National Mercantile	1837
Britannia	1837	National Provident	1835
British Mutual	1844	North of England	1844
Church of England	1840	Nottinghamshire and Derbyshire	1835
English and Scottish Law	1839	Preserver	1843
Equity and Law	1844		
Family Endowment	1844		
General	1837	Provident Clerks'	1840
Great Britain	1844	Reliance	1840
International, formerly National Loan Fund	1837	Royal Farmers'	1840
Legal and General	1836	Royal Naval, Military, East India, and General	1837
Liverpool and London	1836	Star	1843
Medical, Invalid, & General	1841	Victoria	1838
Merchants and Tradesmen	1844	Wesleyan Provident	1841
Metropolitan	1835	Western	1842
Minerva	1836	Westminster and General	1836

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The following English offices, now in existence, were established between 1845 and 1850:—

Accidental Death	1849	London Mutual	1848
Agriculturist	1845	London & Provincial Law	1845
British Empire Mutual	1846	Medical, Legal, & General	1846
Cambrian and Universal	1846	Metropolitan, Countics, & General	1848
Catholic	1846	Mitre	1845
City of London,	1845	Phœnix	1848
Consolidated	1846	Professional	1847
Defender	1846	Prudential Mutual	1848
East of England	1849	Railway Passengers'	1849
Engineers, Masonic, and Universal	1848	Royal	1845
English Widows' Fund	1847	Solicitors' and General	1846
Gresham	1848	Sovereign	1845
India and London	1846	Times	1840
Indisputable	1848	United Mutual	1849
Kent Mutual	1849	United Kingdom Temperance	1849
Legal and Commercial	1845		

The following English offices, now in existence, were established between 1850 and 1855:—

Achilles	1853	London Equitable Mutual	1855
Age	1851	Lond. & Provl. Provident	1854
Anglo-Australian	1853	Magnet	1854
Ark	1852	Manchester and London	1853
Athenæum	1851	Marine Causualty	1852
Beacon	1852	Marine and General Travellers'	1854
Birkbeck	1852	Maritime Passengers	1852
British Equitable	1854	Monetary	1851
British Nation	1854	National Alliance	1855
British Protection	1850	National Guardian	1850
British Provident	1850	National Industrial	1854
British Industry	1852	National Provincial	1851
Briton	1853	New Alliance	1855
Brunswick	1854	New National	1853
Caxton	1854	New Equitable	1850
Deposit and General	1851	Observer	1855
Diadem	1854	Peoples' Provident	1853
Eclipse	1853	Prince of Wales	1851
Emperor	1853	Protector	1853
Empire	1854	Protestant	1852
English and Cumbrian	1850	Provincial	1852
English and Foreign	1852	Safety	1854
English and Irish Church	1853	Saxon	1854
Era	1852	Security	1854
Falcon	1854	St George	1854
Female Provident	1855	Travellers' and Marine	1854
General Accident	1855	United Homœopathic	1855
General Indemnity	1853	United Kingdom Annuity	1850
Home Counties	1853	United Orders Provident	1855
Householders	1852	United Service & General	1851
Hull and London	1855	United Trades'	1855
Justice	1855	Unity Friendly Brothers'	1855
Lancashire	1852	Unity General	1854
Law Property	1850	University	1854
Law Union	1854	Waterloo	1851
Life Assurance Treasury	1855	Wellington Reversionary Annuity	1852
Lombard	1853	Whittington	1855
London and Continental	1851		
London Exchange	1853		

Abstract showing the existing English Offices, and the date of their Establishment.

Before 1762	7
From 1763 to 1810 (47 years)	11
... 1810 ... 1822 (15 years) [2 Irish]	15
... 1825 ... 1835 (10 years)	20
... 1835 ... 1845 (10 years)	34
... 1845 ... 1850 (5 years)	31
... 1850 ... 1855 (5 years)	77
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The following are the Scotch life assurance offices, and the dates of their establishment:—

Caledonian (Life 1833).....	1805	Scottish Equitable.....	1831
North British (Life 1823)	1809	Northern	1836
Scottish Widows' Fund ...	1815	Scottish Provident	1837
Edinburgh	1823	Life Association	1838
Scottish Union.....	1824	City of Glasgow...,..	1838
Standard	1825	National	1841
Scottish Provincial.....	1825	Colonial.....	1846
Scottish Amicable	1826	(15 in all.)	

It follows as a very natural question, upon consideration of these lists,—are all these offices properly constituted, and are they worthy of confidence? But such a question is one which it is very difficult to answer. There is one test which, to a certain extent, is a sound one, viz., the period of time during which an office has existed; but even that may fail if an institution has been managed by an unprincipled actuary, or by reckless directors. Indeed the character and ability of the actuary and directors is the surest safeguard, although a test difficult and often invidious to apply. Most of the long established companies are undoubtedly conducted on right principles; and although some of them be less prosperous than others, one may with perfect safety assure in almost any of them. As to those more recently established, many of them are no doubt well conducted, and cannot fail of success; but when we regard the utter recklessness with which offices have been formed of late years, it is impossible to recommend caution too strongly to intending insurers. The fact that within the last twelve years 513 offices have been projected, and 228 founded, of which more than one-half have ceased to exist, does not give us much primary confidence in the soundness, speaking generally, of anything new in the way of assurance. Most of the failures seem to have been caused entirely by reckless extravagance in the management.

In 1844 an act was passed for the regulation of joint-stock companies, which required assurance companies to go through certain forms before commencing business, and to comply with certain regulations after their establishment, such as registering their annual balance-sheet, with an account of assets and liabilities; but the act has been found practically useless for the purpose it was intended to fulfil, as it neither places a check on the formation of bubble companies, nor can it enforce its own requirements, if these companies choose to set it at defiance. For some time after the act came into force in 1846, balance-sheets were recorded with fair regularity, but they were for the most part in an unintelligible shape, and where they were understood they showed generally such extravagance and mismanagement, that it created, in 1852–3, a most uneasy feeling as to the future prospects of such institutions, and of life assurance in general. A committee of the House of Commons was appointed in 1853, and voluminous evidence was taken; but, though the danger was recognized, and the worthlessness of the act of 1844 fully acknowledged and explained, government has in the meantime done nothing to mitigate the evil.

The wholesale manufacture of offices still continues, life assurance is scandalized, and one of the greatest institutions of the age is in danger of being brought into disrepute. Special legislation will be required to check the evil, and this seems to be admitted by the government itself, which, in the Joint-Stock Companies Bill of 1856, left the question of assurance societies altogether out of account. The evidence taken in 1853 points out the proper remedies, but, in the meantime, until legislation in some form is proposed, no further suggestions can be of any avail.

In conclusion, we would refer to the immense amount of assurance transactions in this country, as showing the extent of the interests involved in that branch of business. We have no precise means of making an estimate of the existing amount of such contracts at the present date; but it was computed that in 1849 the sums assured in English offices amounted to 150 millions, while those assured in Scotch offices in 1852 amounted to 34 millions. We have no doubt that at the present date the amount of life assurance in existence in the United Kingdom is upwards of two hundred millions. A considerable number of the life assurance offices have been constituted by special acts of parliament, and a very full list of these acts will be found in Mr Bunyon's *Law of Life Assurance*, afterwards referred to.

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THE CONTRACT OF ASSURANCE.

It is quite superfluous at the present day to occupy much space in attempting to prove the benefits of life assurance, which may be said to be universally admitted. But it is not equally superfluous to explain the principle on which an assurance office is conducted, which we shall accordingly proceed to do.

Let us suppose that a number of persons having relations relying on them for support, wish to make some provision for such dependants in case of death; but, having only an annual sum to dispose of, without capital, can save but little, and that by slow degrees. We will suppose 1000 persons in this situation have discovered that, according to the laws of nature, a certain number of them will die annually, and that these persons enter into agreement with each other to the effect that those who survive shall burden themselves with a certain payment to the representatives of those who may die within the year, the subscription of each to be greater in proportion as his age is more advanced. This would be the very simplest form of an assurance contract; but, for obvious reasons, it is plain that such is not the mode in which the agreement could be practically carried out. The first difficulty, then, that arises, is in fixing the proper payment for the risk of the year to be made by each individual. This part of the transaction requires a calculation to be made by some persons skilled in such matters, proceeding on a table of the probability of life and death, generally known as a table of mortality. We will suppose that L.20 is considered a sufficient contribution for each person to secure L.1000 to the heirs of those who may die within the year, assuming all to be the same age. This subscription of L.20 each for 1000 persons would amount to L.20,000; and if 20 persons, the number calculated on, were to die, the sum of L.20,000 divided among their representatives would give exactly L.1000 for each. It will be observed that L.20 only was paid by each of the deceased members, as well as the survivors; now the benefit to the former is evident; while the latter have had the advantage, by union, of protection during the year. Of course, all required to be in good health and of good habits at the commencement of the contract.

This would be an assurance association formed for one year. For the sake of simplicity, we have not taken into account interest of money or expenses of management, neither have we assumed or provided for any probable variation in the exact number of deaths. If at the end of the year it was wished to renew the contract, an examination would require to be made as to the health of the parties, and a new premium struck with reference to the increased age of each for the next year's assurance. Now, in practice, the renewal of such a scheme from year to year would be attended with great difficulty and hardship in particular cases, as the lives in deteriorated health would require to be rejected periodically, thus virtually counteracting to a great extent the benefit of the scheme; and the premiums of the rest would go on increasing year by year, till, at an advanced period of life, the annual payment would probably be too heavy a burden to be borne. To avoid these difficulties, it would soon become evident that the body of persons referred to could attain their object better by entering into an agreement

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with each other for the whole term of life. To accomplish this, they would require to pay such an equalized annual rate (beginning higher, of course, than under the annual scheme) as might be equivalent to the annual ascending rates—in short, paying more while young, to prevent the rate increasing when older.

The following table will explain the principle more fully:

	For first year.	For a second year, assuring at 1 year older.	For a third year, assuring at 2 years older.	And so on, increasing for the fourth, fifth, and every additional year till death—	For example, after 20 years, the premium would have become
Persons of 20 years of age would be charged, on the ascending plan for an assurance of L.1000, a premium of	L. s. d. 7 10 0	L. s. d. 7 15 0	L. s. d. 8 0 0		L. s. d. 29 18 4
Persons of 30 do.	11 0 0	11 10 0	12 0 0		41 13 4
„ of 40 do.	14 10 4	15 7 8	16 0 10		66 11 8
„ of 50 do.	15 0 0	15 19 2	16 19 5		108 1 8
„ of 60 do.	37 7 9	39 19 1	41 15 4		180 16 8

But instead of this method of assuring for a year only and renewing the contract each year at the premium corresponding to a higher age, it would be found better to pay an equalized, unvarying, annual sum, as shown in the following example:—

At 20 years of age the equalized rate would be	L.17 3 4	These rates remaining always the same.
30.....	22 9 2	
40.....	29 17 6	
50.....	41 13 4	
60.....	66 11 8	

Now, it is evident, on a comparison of the annual progressive rate with these for the whole term, that under the equalized system persons assured pay more for some years than is necessary to meet the risk; while in after years, when the lives become advanced in age, they pay less—the office accumulating the difference between the premium for the risk of each year, in the earlier years, and the annual payment made on the equalized system, to meet the deferred risk, when the equalized premium, in consequence of advanced age, is less than the year requires.

The income of an assurance office, in its earlier years, consists of—

1. The premiums necessary for the risks of the year.
2. The addition to the premiums for expenses of management.
3. The difference between the premiums for the risk of the year and the whole-term rate.
4. The interest on the fund reserved for the increased risk of future years.

The first and second are legitimate expenditure; the third and fourth form the accumulated fund; but in later years the tide will turn, and this accumulated fund will be required to make the income sufficient to meet the claims.

The profit on assurance business arises from different sources—such as, from fewer deaths occurring than were calculated on; from a higher rate of interest being obtained than that on which the calculations are based; and from the expenses of management being less than the sum provided to defray them; and if a percentage for profit has been added to the rates, that will form another source.

To insurers it is of the utmost consequence to know that an assurance office is carefully accumulating the fund requisite for the risk of distant years. If that fund be squandered or lost, ruin must arrive sooner or latter; and this is the great danger of the assurance system; for a person who joins an office not only assures for one year, but makes annually, in the earlier years, a deposit with the office to meet his payments later in life.

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An agreement among a body of persons to form a union for assurance in the manner before described, is called mutual assurance; and some of the largest societies of the day are constituted upon that plan; but as assurance business is also transacted by institutions differently constituted, it will be well, before going farther, to explain the difference in the constitutions of these bodies.

Mutual Societies are bodies of individuals associated in the manner before described, for the purpose of providing capital sums, payable at death, and other cognate provisions, to the representatives of members. The affairs are managed by directors elected periodically from among the assured, and the funds are held to be common property, subject to such reserves and guarantees as may be considered necessary for the future safety of the institution. A higher rate of premium than the risk demands is generally charged, to defray expenses of management and at the same time increase the basis of security.

In consequence of the contributors paying a higher rate of premium than is absolutely required, a surplus fund should arise. From the division of the fund so created the bonus system of the assurance offices has taken its origin. In the earlier years of assurance business, the bonus system was not contemplated, there being great uncertainty as to the value of life and as to the sufficiency of premiums; but as knowledge increased, it was found that, from time to time, a portion of the funds not required to provide for the responsibilities of the office might be fairly and safely divided; and the different modes of dividing that surplus have become at the present day the marked and distinguishing feature in the constitution of each office.

Guarantee or Proprietary Companies are formed of parties who have subscribed a capital, on the security of which the business of assurance is transacted. Formerly this class of offices used only to grant policies for fixed sums, payable at death, guaranteeing the security of the parties by large capitals, but giving them no benefit or advantage from the profits of the business. This was in the earlier days of life assurance; but the guarantee class of offices do now, we believe, without exception, allow the policy-holders to participate more or less in the profits of the business; and some of them, constituted in the best manner, affirm that they are enabled to give even larger benefits than the mutual institutions; while their security is greater, not only from the capital of the partners, but from the more responsible management, the directors being partners and policy-holders. There is much difference of opinion, however, as to the merits of the two classes of offices, and each has numerous supporters. A well-constituted mutual institution properly managed does not, if the premiums are sufficient and the funds are properly accumulated, require a capital, as the premiums should meet all claims; but as in guarantee or proprietary companies the assured are relieved from all anxiety, and the responsible management is in the hands of those who are the obligants under all the transactions of the office, while the assured are allowed to participate largely in the whole profits of the business, there is much to be said in favour of that class of offices; everything, however, depends on the regulations and constitution of the offices themselves. Guarantee as well as mutual offices are widely different in their modes of doing business and in the principles of their constitution. Having, therefore merely indicated that there is a difference, the choice between the two classes, and the selection of a particular office, must be the subject of inquiry and selection by each individual himself.

Before an office agrees to assure a life, there are certain forms to be filled up and regulations to be complied with, so as to ascertain the state of health of the proposer; for unless he is in good health, the office could not undertake the risk with any prospect of advantage, or in fairness to

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the other persons who have entered as assurers. These forms, which are furnished by the offices, having been completed satisfactorily, and evidence of age furnished, the policy is made out, the validity of that deed depending upon the truth and accuracy of the answers given in making the proposal. If the insurer conceals anything which he knows to be material, it is a fraud; but besides this, in strict law, if he conceals anything which may influence the rate of premium, which the underwriters may require, although he does not know that it would have that effect, such concealment entirely vitiates the policy. Having gone through all the necessary forms, the assurance will be accepted, or declined, by the company. If accepted, a deed will be issued by the assurance office, called a policy, which expresses the nature of the contract and its limitations.

Stamps.

The following are the stamp-duties upon policies of assurance on lives (16th and 17th Vict., cap. 59):—

	s.	d.
Where the sum insured shall not exceed L.500, then for every L.50, and any fractional part of L.50.....	0	6
And where it shall exceed L.500, and shall not exceed L.1000, then for every L.100, and any fractional part of L.100	1	0
And where it shall exceed L.100, and any fractional part of L.1000.....	10	0

The stamp may be either impressed on the paper, or denoted by an adhesive stamp affixed thereto.

The expense of the stamp is generally defrayed by the offices.

The Premium.

Premiums can be paid in one sum, compensating all ordinary payments, or by a limited number of payments, or by annual payments during life; also in some offices by half-yearly, quarterly, and even monthly instalments. The date at which the premium annually falls due should be carefully noted, as an error in payment, should the office omit to give notice (they are not legally bound to do so), would forfeit the policy in most instances; thirty days, called days of grace, are generally allowed for payment after the regular date of renewal; but a policy forfeited may generally be revived within three months, by producing medical evidence of good health, and payment of a fine. The forfeiture of policies in this way is a point which engages at present the anxious attention of the assurance companies, and we are glad to find that one office has shown a good example, by systematizing its practice in that respect. The following are the resolutions lately adopted by that office (the Standard Life Assurance Company of Edinburgh,) and they appear very liberal:—

1. That policies *of five years' duration*, effected for the whole term of life at a uniform rate of premium, shall not be forfeited in consequence of non-payment of any ordinary premium, notwithstanding the expiry of the thirty days of grace; provided payment shall be tendered before the expiry of thirteen months from the date of such premium falling into arrear, reckoning, not from the end of the days of grace, but from the regular date when the premium fell due; and no evidence of health shall be required; but the directors shall not receive payment of any such arrear except with a fine of five per cent. per month on the premiums in arrear. At the expiry of such period of thirteen months, the policy shall be entirely forfeited, and the directors shall calculate the value of such assurance according to their usual practice, and carry the same to a "forfeited policy account," to the credit of the persons who were interested in the assurance so forfeited, to remain there till the end of five years from the regular date when the premium fell due which was not paid. But if no claim shall be made and substantiated for such calculated value within the said period of five years, the same shall be carried into the general funds of the company, for their own use.

2. That *all other policies*, on which the ordinary premium may not be paid within the thirty days of grace allowed for payment, shall be forfeited, but may be revived by the board of directors within three months from the regular date of such premium falling due, if the directors are satisfied with the explanation given as to the cause of non-payment—the parties proving it to have been an oversight;—and if the directors are thus satisfied, medical evidence as to the health of the party whose life is assured shall be dispensed with; but the directors shall impose a fine not exceeding ten per cent. on the premium in arrear. If the directors are not satisfied, from the circumstances stated, that the forfeiture of the policy was through oversight, or if the period of arrear exceed three months, the policy may still be revived on evidence of health and habits satisfactory to the directors, provided application be made within thirteen months from the date of the premium falling into arrear, reckoning, not from the end of the days of grace, but from the regular date when the premium fell due; but the directors shall impose a revival fine not exceeding five per cent. per month on the premiums in arrear. The directors to be the sole judges of the evidence relating to health and habits, and entitled to decide accordingly."

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It is quite proper that a precise understanding as to the forfeiture of policies should be come to; for it is surely unfair that a person who has been paying premiums for ten, twenty, it may be fifty years, should stand in the position of forfeiting the savings of a lifetime, by omission to pay a sum at a particular period. A forfeiture in such circumstances becomes also a greater hardship, when we know that the office has in its hands probably a large sum, which they would have given the policy-holder to surrender his contract immediately before the forfeiture, or would have lent him on his note of hand, at interest, did he require it.

At the end of this article, the premiums for different kinds of risks on lives of persons of different ages within certain limits are given, which will be found useful for reference. They are net rates, or pure rates, as they are sometimes termed, being the bare result of calculations at Carlisle three per cent., without any additions for expenses or profit. Offices would probably add from fifteen to twenty per cent. in calculating premiums without profits, and twenty-five to thirty per cent. in calculating premiums with profits.

Some mutual offices still charge an entry-money in addition to the premiums, but that practice has now been very generally given up.

The regulation of these annual payments in the earlier stages of assurance business was a matter of some difficulty; and, as previously stated, the earliest offices charged the same premium at all ages, in ignorance of the certainty of the risk increasing with age. The Equitable was the first, it is understood, to adopt a graduated scale.

To afford increased facilities to assurers, some offices are now in the practice of allowing one-half of the premiums for a limited number of years to remain unpaid, as a debt on the policy, bearing interest. Referring to what has already been said as to that portion of the premiums which exceeds the risk of the year, it is evident, on consideration, that the offices are safe in this practice, so long as the sum lent, or allowed to remain unpaid, is only a portion of the premium applicable to future years. The system, within limits, is quite sound, although some persons, ignorant of the principle, have condemned it; and it suits the circumstances of some parties not to pay at first more than is necessary, having the prospect at the same time of bonus benefits, which may reduce the debt allowed to accumulate.

In consequence of the heavy pressure of the income-tax, more especially on persons deriving their income from their own personal exertions, and liferenters, the government, by the act 16th and 17th Vict., cap. 34, made provision for a reduction in favour of any person "who should have made an assurance on his life, or on the life of his wife, or should have contracted for any deferred annuity on his own life, or on the life of his wife." This provision was temporary, but has been renewed from year to year.

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Limits of Policy as to Residence.

Persons assured are generally allowed to travel and reside within the limits of Europe, and to pass from one part of Europe to another, by sea or land, in decked or steam vessels. Before steam-navigation was so extended, and so safely conducted as at present, persons were only allowed to cross the channel and land within certain limits, such as between the Elbe and Brest. No office now keeps up such restrictions; yet when any person holding a life assurance has occasion to leave the country, he should refer to the particular clause embodied in his policy, and get the necessary license if required.

Some offices, in the praiseworthy desire to extend their liberality, make no charge for voyages to any part of the world, limiting any extra charge to residence in particular countries. This, however, has a good deal of the show of liberality without the substance, as very few persons undertake voyages without intending to settle or reside abroad at least for a temporary period.

Residence in North America, within certain limits, including all British North America; the Cape of Good Hope, as also Australia and New Zealand, are generally considered nearly as healthy as Great Britain, and moderate rates of extra premium, if any, are usually charged for these climates. The East Indies, West Indies, and southern part of the United States, require higher rates of additional premium.

One office, the Colonial, established in 1846, has published rates for most climates, and by systematizing foreign rates, has done a great deal of good by the introduction of more liberal terms and conditions for foreign residence or occasional travel.

But the most important change made in assurance practice for many years was introduced in 1850 by the Scotch office already referred to, resolutions having been adopted under which policies after five years may be relieved of all conditions as to foreign residence, the person assured proving that he has no intention of residing abroad. This change was suggested from the observation of the very small amounts paid for foreign residence, compared with the whole business of the various companies, and the evident conclusion, that it was absurd to maintain a rule reducing the value of a policy, in a large degree, for the purpose of keeping in check a few persons who might have occasion to leave the limits of Europe. The plan has been quite successful, and has added a large percentage to the value of policies.

It would have been probably more correct in principle, if some small extra payment—1s. or 6d. per cent. per annum—had been demanded on account of this whole-world license; but there is sometimes an error in trammelling a large movement, such as that referred to, by some trifling restrictions for the sake of strict adherence to rule, and the office did wisely in giving the extended license as a free gift. It of course excludes those whose professions or occupations are likely to lead them abroad.

The Interest of one person in effecting a Policy on the life of another.

If an assurance be effected by one person on the life of another, the assurer is generally required to declare and prove that he has a sufficient interest in the life to warrant his taking out a policy to the extent proposed. The object of requiring such evidence is to prevent merely speculative assurances, but the offices generally are satisfied as to the *bona fide* nature of the transaction on the representations of respectable parties, without requiring what in legal phraseology would be termed proof.

By the act 14th Geo. III., cap. 48, it was enacted "That in all cases where the assured hath an interest in such life or lives, event or events, no greater sum shall be recovered or received from the insurer or insurers than the amount or value of the interest of the insured in such life or lives, or other event or events." Life Assurance.

This clause in the statute was brought to bear in an action raised in 1805 by Messrs Godsall and Company against the executors of the Right Hon. William Pitt. They had effected an assurance on Mr Pitt's life to cover a debt, but after his death his debts were paid by the nation, and the assurance office declined to pay the assurance, on the plea that the interest of the assurers had ceased.

The assurance office received a verdict in their favour, to which the law was considered to entitle them, but both the act and decision were based on an erroneous view of life assurance, which not being a contract of indemnity, is not a contract into which the element of damage, dependent on the payment or non-payment of a debt, enters. It is quite right, in order to prevent merely speculative assurances, that an interest should exist, and it is the duty of the offices to satisfy themselves on the point before issuing a policy; but when an office has accepted an assurance, the question of interest should never afterwards be raised, unless the policy has been obtained by fraudulent means otherwise.

This case of Godsall *v.* Boldero (Pitt's executor), was the leading case as to interest under a life assurance policy for half a century; but the offices seldom availed themselves of the precedent which it formed. It has now been overruled, on the ground that the decision was "founded on a mistaken analogy, and wrong," by the unanimous decision of six judges sitting in the Exchequer Chamber, in the case of Dalby *v.* The India and London Life Assurance Company (see Smith's *Leading Cases*, vol. ii., p. 213), delivered 2d December 1854. By this decision the continuance of any portion of the interest required by the statute, when the policy is effected, is no longer necessary; but an interest in the life of the assured at the date of contract is still necessary.

See also the case of Law *v.* The London Indisputable Life Policy Company, 15th January 1855.

Surrender of a Policy.

It is the practice of the offices to return to the policy-holder who wishes to abandon his assurance a portion of the premiums paid; and the justice of such a return is evident from what has been stated under the previous head as to the composition of an annual premium under an equalized rate. Persons assured ought to be allowed to surrender their policies at any time after joining the society, where a policy is with a mutual office, or "with profits" in a guarantee or proprietary company; but in the case of a policy without profits, which is a fixed contract, the office may make any conditions they choose. We have said that in mutual offices surrender value should be allowed from the first, and we have assumed the profit scheme of guarantee or proprietary offices to be in the same position as a mutual fund. But while we are of opinion that surrender value should be allowed from the first, we do not think that the difference between the short-period rate of premium and the whole-term rate should be exactly the measure of it. We think it quite right that a large percentage should be deducted from the pure value of the policy, not only on account of expenses, but on account of the withdrawal of the party from the scheme. The office has no power to *turn out* the lives that have deteriorated, and it is but just that the lives retiring, which may be assumed to be good, should pay a fine for the permission to retire.

A table of the values of policies from various ages and periods, is given in the appendix, Table III., p. 415, but these are pure values, and a considerable deduction from them would be made by an office in accepting a surrender.

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They will serve so far as a guide as to the value of a policy, but application must be made to the office for the real terms of surrender, if required. The values given do not embrace the values of bonus additions.

Most offices generally lend the value of a policy, at a moderate rate of interest on its security, which often prevents the necessity of surrender, and in many instances, when a policy is of some standing, it becomes a valuable fund of credit.

Death of the Assured and Claim upon the Office.

Evidence of death, when that event occurs, is required by the company, and each has its particular forms. The cause of death is required to be certified as well as the event, and it is of general importance that in that respect the return should be as accurate as possible, as it enables offices to keep full records of their casualties, which will become, and has already proved to a certain extent, a most valuable source of statistical information. The primary object, however, in requiring the cause of death to be stated is,—In order to ascertain that the particular disease of which the person died did not exist when the assurance was effected,—that is, within the knowledge of the party; and that the party did not die by his own hand or the hand of justice.

It is certainly due to assurance offices to state that the number of cases in which they have disputed claims is very limited, and that in almost every instance there was good ground for their refusal to settle. We must admit, however, that some of the recent changes in the practice of offices, by which they bind themselves not to dispute, are highly important, and are a movement in the right direction which cannot fail to extend the practice of life assurance. We think it unfortunate that those who originated the practice of declaring all policies to be indisputable contracts from the commencement, should have carried the principle so far. It is surely wrong, both on principle and with a due regard to public morals, that the office should be bound to pay a claim which had palpably arisen from fraud. Probably the originator of the idea considered the popularity of the measure more than its true effect—its business-creating power more than its justice. We do not withhold our commendation of the principle, but we cannot admit that there should be no limitations. It is quite proper, however, that all questions as to the basis of the contract, should be closed after a certain period, and that it should not be in the option of an office to raise questions at any time; indeed, it is probably more to the advantage of the offices themselves than to the public that such should be the case, as it will infallibly tend to the extension of the system. The appearance of an office binding itself not to dispute policies, was followed by the adoption of a similar resolution on the part of various other institutions subsequently founded, but we are not aware that any of the older and substantial offices have adopted the principle in the form in which it originated, that is, indisputability from the commencement of the assurance. Some offices declare that policies are indisputable except in case of fraud, meaning thereby, that no error or unintentional mis-statement will be taken advantage of, but this still leaves the door of dispute open for the whole term of the contract. On the whole, we are disposed to approve the principle now acted on by most of the Scotch offices, and originated by the Standard Life Assurance Company, that after five years all policies shall be admissible to a select class in which they shall be indefeasible, the whole clauses of the policy as the basis of the contract being deleted, and the company binding themselves to pay the sum assured, if the annual premiums be paid—all which is expressed in a certificate or supplementary policy. Under this system a probationary period of five years is held to be sufficient to answer the purpose in view, and it is surely reasonable that such a period should be allowed.

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These are all highly important changes in the contract of assurance, and if the legislature would only do their part to prevent the waste and extravagance which abounds under the present excess of competition, the life assurance system of this country would form one of its proudest attributes of greatness.

It has been the practice among some offices to require proof of age at death, if not previously afforded. This we conceive to be most unjust; it ought to be given or required at the commencement of the contract and ought never to be delayed till a claim arises. One case has come under our notice lately, where proof of age was required thirty-two years after the policy was effected. The gentleman had been in the service of the Hon. East India Company, and it was discovered that in some official declaration to them he had made himself out four years older than stated to the office. The representatives of the deceased could procure no evidence to show that this was wrong, though they felt morally convinced it was so, and were obliged to submit to a large deduction from the sum assured. Still the case, although hard enough on the representatives, might have been worse, as the policy could have been reduced altogether, on the ground of misstatement in the original proposal.

The only other points under this head which we think it necessary to notice, are the assignment of policies and the clause as to suicide, which we take together, because they have some bearing on each other.

In England the offices bind themselves to pay to the executors, administrators, and assigns of persons assured, while in Scotland the expression is, heirs, executors, and assignees, now although both contemplate payment to assignees, it is no less true, that, according to the law of England, policies are incapable of assignment, as *choses in action*, that is, things of which the assured has not the possession, but only the right to recover. The claim, however, can be made good in a court of equity.

In Scotland, a policy is legally assignable, but to convey it effectually, formal words of assignment and conveyance must be made use of, and due notice given to the office. An unintimated assignment would not stand good against the competing interest of creditors, or of a later assignment intimated before an earlier one, and its particular date is of great importance.

"In order to render an assignment indefeasible in England," Mr Bunyon (from whose works much accurate and valuable information on this subject may be obtained) says, "notice of the assignment to the insurers is requisite, and it is in all cases proper that the policy should be delivered to the purchaser. In this manner, although he cannot have the legal interest or right to one transferred to him, he will perfect his security or purchase, so far as the nature of the case will permit, and will obtain, at least as against all subsequent purchasers, a right, as it has been expressed, *in rem*. Until notice has been given, the vendor, moreover, has it in his power to defeat the assignment by surrendering the policy, or the bonuses which have accrued therein to the office." "But when notice has been given, the insurers will become *quasi* trustees for the assignee; and that, although there may have been no acknowledgment of the notice in any other act equivalent to the acceptance of a trust by them."

We are almost afraid to venture any remarks on the suicide clause in policies. In the case of policies of five years' standing, admitted to a select class of assurance, as already referred to, it is taken out of the contract. When a policy is held by third parties, by assignment or otherwise, it is also delete, according to the practice of most offices; but when policies are held in the name of the individual himself, the clause of forfeiture is held to apply. Some

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offices modify its effect by agreeing to return all the premiums paid; others, by allowing the value of the policy to the representatives of the deceased, but all this is not satisfactory. If a man destroys himself, knowing what he is doing, and more particularly if he were to effect the assurance in contemplation of suicide, it is quite right that the claim should not be paid; but if he does not know what he does when he murders himself, it is clear, we think, that the claim should be paid, even if it stands in the party's own name; but we would draw this further distinction, that if a person be evidently insane, and be not properly watched by his friends, or put under proper superintendence, the claim should not be admitted, even although the party did not know what he was doing when he committed suicide. In the policies of some offices there is generally a clause of arbitration, which is a great advantage to the assured, the company binding themselves to submit all disputes to the decision of two neutral persons and an umpire.

The Bonus System.

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We have said very little hitherto on this head, and we do not intend to enlarge upon it; each office will be found to display its own system, with all the attractions which characterize it, and we are not called on to offer any opinion as to the practice of the different institutions. As the systems are widely different, they cannot all be based on justice; but they may, at the same time, be just in the view that each office generally sets forth distinctly what it purposes to do in its prospectus, so that the party proposing to assure knows the system he is connecting himself with.

The practice of giving bonus arose, as already explained, from the Equitable Society finding that its funds were more than adequate to meet the demands upon them. The following bonus table of that society, the only one we will particularize, shows the extent of the benefit which assurers have derived.

TABLE showing the addition to be made to each sum of £100 assured by the Equitable Society prior to the 1st of January 1817, when it shall become a claim, agreeably to orders of general courts, holden in the years 1791, 1792, 1795, 1800, 1809, 1819, 1829, 1839, and 1849.

Date of Assurance.	Addition made in 1791.	Addition made in 1792.	Addition made in 1795.	Addition made in 1800.	Addition made in 1809.	Addition made in 1819.	Addition made in 1829.	Addition made in 1839.	Addition made in 1849.	Whole Addition.	Date.
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	
* Before May 1st in the year 1790	2 0	6 0	6 0	22 0	50 0	75 0	120 0	125 0	120 0	526 0	1790
1791	1 0	4 0	5 0	20 0	47 10	72 10	117 0	122 10	118 0	507 10	1791
1792	...	2 0	4 0	18 0	45 0	70 0	114 0	120 0	116 0	489 0	1792
1793	...	...	3 0	16 0	42 10	67 10	111 0	117 10	114 0	471 10	1793
1794	...	...	2 0	14 0	40 0	65 0	108 0	115 0	112 0	456 0	1794
1795	...	...	1 0	12 0	37 10	62 10	105 0	112 10	110 0	440 10	1795
1796	...	...	...	10 0	35 0	60 0	102 0	110 0	108 0	425 0	1796
1797	...	...	...	8 0	32 10	57 10	99 0	107 10	106 0	410 10	1797
1798	...	...	...	6 0	30 0	55 0	96 0	105 0	104 0	396 0	1798
1799	...	...	...	4 0	27 10	52 10	93 0	102 10	102 0	381 10	1799
1800	...	...	...	2 0	25 0	50 0	90 0	100 0	100 0	367 0	1800
1801	...	...	...	...	22 10	47 10	87 0	97 10	98 0	352 10	1801
1802	...	...	...	...	20 0	45 0	84 0	95 0	96 0	340 0	1802
1803	...	...	...	...	17 10	42 10	81 0	92 10	94 0	327 10	1803
1804	...	...	...	...	15 0	40 0	78 0	90 0	92 0	315 0	1804
1805	...	...	...	...	12 10	37 10	75 0	87 10	90 0	302 10	1805
1806	...	...	...	...	10 0	35 0	72 0	85 0	88 0	290 0	1806
1807	...	...	...	...	7 10	32 10	69 0	82 10	86 0	277 10	1807
1808	...	...	...	...	5 0	30 0	66 0	80 0	84 0	265 0	1808
Before the 8th of December 1809	...	...	...	...	2 10	27 10	63 0	77 10	82 0	252 10	1809
On or after the 8th of December 1809	...	...	...	...	...	27 10	63 0	77 10	82 0	250 0	1809
1810	...	...	...	...	...	25 0	60 0	75 0	80 0	240 0	1810
1811	...	...	...	...	...	22 10	57 0	72 10	78 0	230 0	1811
1812	...	...	...	...	...	20 0	54 0	70 0	76 0	220 0	1812
1813	...	...	...	...	...	17 10	51 0	67 10	74 0	210 0	1813
1814	...	...	...	...	...	15 0	48 0	65 0	72 0	200 0	1814
1815	...	...	...	...	...	12 10	45 0	62 10	70 0	190 0	1815
1816	...	...	...	...	...	10 0	42 0	60 0	68 0	180 0	1816

* If the Policy is dated *on* or *after* the 1st of May, the whole addition prior to 1801 will be £2 less than it is stated to be in the last column.

† A prospective addition of £2 per cent to be computed on the sums assured will be made for every year's premium paid and become due after the 31st December 1849, upon policies entitled to additions, but in the event only of their becoming claims before the next investigation.

Following the example of the Equitable, it is now the practice of all mutual assurance offices to divide profits among their members, and all proprietary offices have a bonus scheme. The reason, however, for such accumulations and divisions has somewhat altered since the Equitable promulgated the system; high rates of premium were originally demanded by the early societies, from want of information as to the value of the risk undertaken; and higher premiums than are requisite for the risk are now required, in order to give confidence, and to provide against any incidental occurrence which might derange the calculations. The result, under good management, is of course a surplus fund, divisible as profits.

We have already mentioned the sources from which profits arise, and we have indicated the necessity of accumulating a reserve fund for the deferred risks of an office, he amount of that fund compared with the value of the obligations, being the only proper test of the condition of the institution; we are also of opinion that the mode of ascertaining the position of an assurance office—that is, the investigation of its affairs with reference to profits—is a much more important matter than the mode of dividing the fund when ascertained; but beyond these general indications of our views, we cannot enter on the subject of Investigation. For similar reasons we must decline to enter on a discussion of the various plans or schemes in accordance with which the profits of life offices are divided. They are very various. Some make reversionary additions to the sum assured; others pay in cash, or reduce the premium; while others offer a choice among these benefits. Some again give those who have been longest assured the greatest advantage; while others divide according to the amount of premiums paid, or assume the value of the policy as the basis of the bonus. Each office, of course,

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lauds its own scheme as the best; some divide according to the "strictest principles of justice;" others have temptations for old lives; while another class attracts the younger members. In fact, the "greatest possible advantages" are offered in many quarters, and the study of the prospectuses of the offices is recommended as the only way to get a proper idea of the real advantages, and questionable allurements, which are held out.

These divisions generally take place annually, quinquennially, or septennially. The Equitable period of division is at intervals of ten years; but no office could now expect to do business which started on the basis of such a long period.

There is no department of the onerous duties of the manager of a life office which calls for greater skill and judgment than the investigation of affairs and division of profits, more especially the former; and I cannot do better than close these observations with the following quotation from Dr Farr's opinion in the Report of the Registrar-General:—"There is so much of peculiarity in every society, and such skill required in determining what charge should be laid on the net premium, what reserve should be laid up, what constitutes the safety of a particular office, what should be sacrificed to extend the transactions, what should be strenuously resisted to save a society from imminent danger or insolvency, and what should be adopted to give families the greatest benefits, the public the greatest confidence in insurance societies—as demand from the actuary great technical and mathematical skill, besides integrity, consummate judgment, courage, and prudence."

LIFE ASSURANCE IN THE COLONIES, AND IN FOREIGN COUNTRIES.

"We cannot do more than refer very generally to the practice of life assurance in the colonies of Great Britain and in foreign countries, as our information on the subject is necessarily limited; but we think it desirable that the opportunity should not be lost, of commencing a record, which may be enlarged by further particulars at some other time.

Various British offices transact life business abroad, and some of them derive the greater part of their business from that source through branch offices or agencies. It is not necessary to particularize these offices, but it is right to mention that such exist.

The principal native offices established in the colonies, as far as we have been able to ascertain, are:—

	Founded
1. *Cape of Good Hope*—	
The Cape of Good Hope Mutual	1845
The South African Assurance Company	1831
The Cape of Good Hope Trust and Assurance Company	1840
Protecteur Fire and Life Assurance Company	1838
South African Private Widows' Fund	
2. *West Indies*—	
The Barbadoes Mutual Life Assurance Society	1840
The Jamaica Mutual Life Assurance Society	1844
3. *British North America*—	
The Canada Life Assurance Company	1847
4. *Australia*—	
The Australian Mutual Provident Society	
5. *India*—	
The Indian Laudable and Mutual Assurance Society	1815
The Madras Equitable Assurance Society	1842

The offices established at the Cape of Good Hope, and in British North America, charge rates very much the same as those of British offices in Great Britain. The rates for the West Indies and East Indies are, of course, higher, in consequence of the greater mortality which obtains in those countries.

Life assurance has been more extensively cultivated in Great Britain than in other countries; but we also find a large number of institutions for the purpose of assurance in foreign countries, more particularly in Germany and America.

We have it not in our power to give a full list of these offices, but the following are some of the more important institutions:—

AUSTRIA.

	Established
The General Annuity Fund for Widows and Orphans in Vienna	
The General Provident Fund in Vienna	1823
The Assurance Company of Milan	1824
The General Assurance Company in Trieste, established 1836; adopted life assurance	1826
The Mutual Assurance Company, for Life Assurances and Annuities, in Vienna	1834
Azienda Assecuratrice in Trieste	1839
	1822

GERMANY.

The Life Assurance Bank for Germany, in Gotha	1829
The German Life Assurance Company in Lubeck	1828
The Hanoverian Life Assurance Company	1831
The Berlin Life Assurance Company	1831
The Munich Life Assurance Company	1836
The Brunswick General Assurance Company	1836
The Frankfort Life Assurance Company	1842
The Hammonia Life Assurance Society, established at Hamburgh	1845
The Life and Annuity Assurance Company Janus in Hamburgh	1845
	1847

FRANCE.

L'Union	1829
La Compagnie d'Assurances Generales sur la vie	1819
La Nationale	1830
La France	1843
Le Phœnix	1843
Caisse des Ecoles et des Familles	1841
Caisse Paternelle (Tontine Association)	1842
La Concorde	1841
L'Economie	1841
L'Equitable (Mutual)	1841
La Minerve (Tontine Association)	1842
La Prévoyance	1842
Société Civile des Nu-propriétaires	

DENMARK.

The Life Insurance and Annuity Society at Copenhagen	1842

The American life assurance companies are numerous, and we are afraid some, especially of recent date, are omitted in the list which follows:—

AMERICA.

	Established
New York Life Insurance and Trust Company	1830
The Mutual Life Insurance Company of New York	1843
New England Mutual Life Insurance Company, Boston	1843
New York Life Insurance Company	1845
The Mutual Benefit Life Insurance Company, New Jersey	1845
State Mutual, Worcester, Massachusetts	1845
Connecticut Mutual Life Insurance Company, Hartford County	1846
Eagle Life and Health Insurance Company, New Jersey	1847
American Mutual Life Insurance Company of Newhaven County	1848
Union Mutual Life Insurance Company of Maine	1848
Trenton Mutual Life Insurance Company, New Jersey	1848
Penn Mutual Life Insurance Company, Philadelphia	1848
Natural Life Insurance Company, Montpelier, Vermont	1848
Hartford Life and Health Insurance Company, Connecticut	1849
United States Life Insurance Company, New York	1850
United States Life Insurance, Annuity, and Trust Company, Philadelphia	1850
Manhattan Life, New York	1850
Charter Oak, Hartford, Connecticut	1850
Mutual Life Insurance Company of Baltimore	1845
Howard Life Insurance Company of New York	1852
United States Mutual, Laudable, and Provident Association, Philadelphia	1853
Knickerbocker Life Insurance Company, New York	1853

Life Insurance.

The following shows in abstract the amount of business transacted by the offices established in the state of New York during the year 1854, being the latest returns at present available. Some British offices do business in the United States, but as it is necessary to invest 100,000 dollars in the state of New York, there is a wholesome check upon foreign companies. In Canada and New Brunswick similar laws are about to be introduced :—

LIFE INSURANCE RETURNS.

The aggregate assets of eleven Company's amount to	$6,727,273 72
... income from 1854 from all sources ...	2,592,982 10
Gross amount at risk on whole-life and short-term policies	72,431,797 32
Number of policies issued in U. S. in 1854, 5583	
Amount insured thereby	15,023,647 00
... Cash premiums received in 1854	1,796,378 37
... Notes taken for premiums	306,310 52
... Expenses—as far as returned, 1854	300,141 13
... Losses paid	886,932 34
... ... accrued and unpaid, 1854	257,100 00
... Premium notes and loans on policies estimated as assets	1,596,284 82

OTHER KINDS OF ASSURANCE.

Life, fire, and marine assurance were, till within a few years, the only assurance systems adopted in this country; but there has been of late an anxiety to extend the application of the principle; and we now have companies formed to afford protection against many various kinds of risk. Some will no doubt succeed, but as they are all still in their infancy, and almost altogether experimental, little information, in the shape of data, being available on which to found calculations, they will require much cautious management. The following are the most prominent of the schemes which have appeared:—

Insurance against railway accidents.

Insurance of passengers by sea and land; also against general accidents; with compensation in cases of non-fatal injury: likewise assurance of the baggage and effects of passengers.

Insurance on emigrants, covering the risk of voyages, localities, gold diggings, &c.

Insurance of health, against total disablement from any cause.

Insurance against specific diseases, such as blindness, insanity, paralysis.

Insurance of the lives of persons afflicted with disease.

Insurance, or guarantee of fidelity in situations of trust; such transactions being sometimes combined with life assurance.

Insurance of plate-glass windows.

Insurance against losses by hail storms.

Insurance against defective titles, where the title, though good for holding, is unmarketable by reason only of such defects.

Insurance of the value of mortgaged property.

Insurance or guarantee of debts.

Insurance of dividends, and compensation from embarrassed estates.

Insurance or guarantee of rents, securing punctual payment whether the property be or be not occupied.

Insurance against loss by theft; for the efficient prosecution of the offenders; and for the detection and prevention of crime.

Insurance of live-stock, for the purpose of securing the farmer against the diseases and casualties to which live-stock is exposed.

Matrimonial insurance, providing portions to persons who may marry, and making provision for them at certain age if they do not marry.

Insurance on infants, to take effect after a particular age.

(W. T. T.)

EXPLANATION OF THE TABLES.

Life Insurance.

The Tables subjoined have as their basis the Carlisle table of mortality, and three per cent. compound interest without any additions whatever. They are constructed in a manner scarcely requiring explanation, and may be used readily by inspection, according to the cases required; yet, for the sake of those who may not be acquainted with the subject here treated, a few examples as to the application of the Tables will not be out of place.

TABLE I. contains the single and annual premiums required to secure an assurance of £100, payable at death or any other period.

Example.—To effect an assurance of £100, payable at death of a party, age 25 next birth-day, the single premium required is £36 : 17 : 11 (36.8945, in the table), or the annual premium for the same is £1 : 14 : 1 (1.7029, in the table).

To effect an assurance of £100, payable at the death of a party, age 25 next birth-day, provided he dies within 5 years after the commencement of risk? Answer: single premium = £3 : 13 : 7 (=3.678); annual premium during the 5 years, = 15s. 10d. (=.791).

TABLE II. contains annual premiums required to secure an assurance of £100 at death, in case they are to cease on the party attaining a certain age. The first column shews the number of annual payments to be made by the assured, the next column specifies the age of the assured, and in the third column are to be found the respective premiums. The first column is mutual to the whole breadth of the table.

Example.—To effect an assurance of £100, payable at the death of a life, age 25 next birth-day, the annual premium to cease on his attaining the age of 65? Answer: £1 : 16 : 9 (=1.835), as found in the column headed: [*To cease at age* 65] opposite age 25.

TABLE III. shews the value of a policy of £100, after its having been in force for some number of years—for instance, a policy of £100, opened in the year 1840, on a life aged 25, is worth £1 : 0 : 8 (=1.0301) in the year 1841, or £2 : 1 : 10 (=2.0935) in the year 1842, or £16 : 11 : 6 (=16.5726) in 1855 and so on, as is to be found in the line corresponding with age 25, under their respective headings.

TABLE IV. contains the annual premiums required to secure an assurance of £100, payable at the death of the first of two lives.

Example.—The annual premium for an assurance of £100, payable at the death of the first of two lives, A and B, aged respectively 30 and 45, is £3 : 18 : 3 (=3.913), as found in the line corresponding with [*age of A* 30], and the column headed [A + 15 = B]—*i.e.*, the difference of the two given ages being 15 years. In like manner the annual premium for an assurance of £100, payable at the first death of two lives, ages respectively 25 and 30, is £2 : 17 : 4 (=2.864), as observed in column headed [A + 5 = B], and the line answering to [*Age of A*] 25.

TABLE V. is precisely analogous with Table IV., except that the former is for an insuranee of £100, payable at the death of the second party, and the premiums are to continue up to the year in which that event takes place.

TABLES VI. and VII. contain the single and annual premiums for an assurance of £100, payable at the death of a life B, provided he be survived by another life A.

Example.—The single premium to affect an assurance of £100 payable, provided B aged 35 be survived by A aged 25, is £31 : 7 : 1 (=31.352), as found in Table VI., column B 35, opposite A 25, and the annual premium for the same assurance—continuous to B's death—is £1 : 17 : 8 (=1.882), as observed in the same column and line of Table VII.

Life Insurance.

TABLE I.—Shewing the Single and Annual Premiums for Assuring £100 for Life or for a limited Period. Carlisle 3 per Cent.

Age	SINGLE PREMIUM. For Life.	For 1 Year.	5 Years.	7 Years.	10 Years	ANNUAL PREMIUM. For Life.	5 Years	7 Years	10 Years	Age
15	31.3146	.601	3.050	4 163	5 697	1 3279	655	.661	.667	15
16	31.8321	.651	3.130	4 237	5 792	1.3601	672	674	.679	16
17	32 3331	.671	3.153	4.267	5 845	1 3917	.677	.678	.685	17
18	32.8387	676	3.160	4.283	5 908	1 4241	.679	.681	.693	18
19	33.3599	.681	3.168	4.311	6 084	1.4581	.681	.686	.708	19
20	33 8973	686	3 174	4.340	6 236	1.4936	.682	.690	.732	20
21	34.4514	.674	3 195	4.395	6.459	1 5308	.687	.699	758	21
22	35 0337	.679	3 233	4 537	6 707	1.5707	.695	.722	.788	22
23	35.6345	.684	3.300	4 766	6.952	1.6125	709	.758	.818	23
24	36.2545	.689	3 442	5 017	7.193	1 6565	.740	.799	.847	24
25	36.8945	.710	3 678	5.278	7.443	1.7029	.791	.842	.878	25
26	37.5446	.715	3 922	5 520	7 687	1.7509	.844	.881	908	26
27	38 2157	.754	4.176	5 757	7.954	1 8016	.900	.921	.942	27
28	38 8874	845	4.391	5.971	8.211	1.8534	.948	.957	.974	28
29	39.5280	954	4.518	6 112	8.412	1.9039	.977	.980	.999	29
30	40.1254	.981	4.548	6.172	8.561	1.9519	.983	.990	1.018	30
31	40 7304	.991	4.561	6.231	8.767	2.0016	.986	1.000	1.042	31
32	41.3538	.984	4.590	6.307	9.021	2.0588	.992	1.012	1 073	32
33	42 0069	976	4 651	6.445	9.329	2.1097	1.006	1.035	1.111	33
34	42 6911	.986	4.747	6 681	9 666	2.1697	1 027	1.073	1.153	34
35	43.3971	.906	4 895	6 973	10.018	2.2331	1.059	1.121	1.197	35
36	44.1259	1.025	5 131	7.308	10.371	2.3002	1.111	1.176	1.241	36
37	44 8679	1 054	5.408	7 640	10 707	2.3704	1.172	1.232	1.285	37
38	45 6237	1 084	5.714	7.970	11.012	2.4438	1.240	1 287	1.324	38
39	46 3938	1.153	6 015	8.281	11 254	2.5207	1.307	1.340	1.357	39
40	47.1580	1.263	6 274	8.535	11.423	2.5993	1.366	1.384	1.380	40
41	47.8952	1.337	6.435	8 677	11.479	2.6773	1.402	1.409	1 389	41
42	48 6243	1.395	6 529	8 702	11 526	2 7566	1 424	1.414	1.395	42
43	49 3551	1.416	6 552	8 654	11.580	2.8385	1.429	1.407	1.402	43
44	50 1083	1.437	6 501	8 566	11.679	2.9253	1.418	1.392	1.413	44
45	50 8847	1.438	6.408	8.520	11.810	3 0176	1.398	1 384	1.429	45
46	51.6959	1.439	6.289	7.539	12.010	3.1171	1.371	1.386	1.453	46
47	52 5437	1 418	6 237	8 629	12.285	3.2248	1.359	1.400	1.486	47
48	53 4401	1 353	6.278	8.796	12 709	3.3430	1.367	1.427	1.539	48
49	54.4079	1.328	6.460	9.106	13.414	3 4738	1.407	1.479	1 627	49
50	55 4303	1.303	6.732	9 527	14.415	3 6224	1.467	1.550	1.754	50
51	56.5097	1 388	7.120	10.124	15 782	3.7845	1.554	1.651	1.929	51
52	57.5989	1.476	7.523	10.897	17.234	3.9566	1 645	1.782	2.119	52
53	58.6991	1.568	8.004	11.901	18 725	4.1396	1 754	1.952	2 318	53
54	59.8111	1.640	8.675	13.212	20.207	4 3347	1.904	2.176	2 521	54
55	60 9455	1 740	9.615	14.639	21.737	4 5452	2.117	2 424	2 737	55
56	62.0945	1 845	10 891	16.110	23 279	4.7713	2.407	2.687	2.963	56
57	63.2593	2 029	12.267	17.567	24.836	5 0149	2.727	2.957	3.198	57
58	64.4134	2.350	13.622	18 992	26.375	5.2720	3.051	3.228	3.439	58
59	65.5110	2.745	14 774	20.256	27.802	5.5324	3 334	3.475	3.667	59
60	66 5299	3.251	15.710	21.306	29.092	5.7896	3.567	3.684	3 875	60

TABLE II.—An Assurance of £100, by limited Annual Payments.—Carlisle 3 per Cent.

Number of Payments.	To Cease at Age 70. Age.	Annual Prem.	To Cease at Age 65. Age.	Annual Prem.	To Cease at Age 60 Age.	Annual Prem.	To Cease at Age 55 Age.	Annual Prem.	To Cease at Age 50. Age.	Annual Prem.	Number of Premiums.
60	10	1 192									60
59	11	1.225									59
58	12	1.258									58
57	13	1.292	8	1.159							57
56	14	1.328	9	1.182							56
55	15	1.363	10	1.212							55
54	16	1.398	11	1.246							54
53	17	1.432	12	1 281							53
52	18	1.467	13	1.317	8	1.185					52
51	19	1.504	14	1.354	9	1.210					51
50	20	1.543	15	1.392	10	1.242					50
49	21	1.584	16	1.429	11	1.279					49
48	22	1.628	17	1.465	12	1.316					48
47	23	1.674	18	1.503	13	1.354	8	1.222			47
46	24	1.723	19	1.543	14	1.394	9	1.249			46
45	25	1.775	20	1.584	15	1.435	10	1.284			45
44	26	1.829	21	1.628	16	1.475	11	1.324			44
43	27	1.886	22	1.676	17	1.515	12	1.365			43
42	28	1.944	23	1.726	18	1.556	13	1.407	8	1.272	42
41	29	2.002	24	1.779	19	1.600	14	1.451	9	1.303	41
40	30	2.058	25	1.835	20	1 647	15	1.497	10	1.342	40
39	31	2.116	26	1.894	21	1.696	16	1.542	11	1.386	39
38	32	2.178	27	1.957	22	1.748	17	1.587	12	1.433	38
37	33	2.244	28	2.021	23	1.805	18	1.634	13	1.480	37
36	34	2.316	29	2.086	24	1.864	19	1 684	14	1.531	36
35	35	2.392	30	2 149	25	1.928	20	1.738	15	1 583	35
34	36	2.474	31	2.215	26	1.995	21	1.794	16	1 635	34
33	37	2.560	32	2.286	27	2.067	22	1.856	17	1.688	33
32	38	2.651	33	2.362	28	2.142	23	1 922	18	1.744	32
31	39	2.748	34	2 444	29	2.218	24	1.992	19	1.804	31
30	40	2.848	35	2.533	30	2.298	25	2.068	20	1.868	30
29	41	2.950	36	2.628	31	2.372	26	2.149	21	1.937	29
28	42	3.056	37	2.730	32	2.458	27	2.236	22	2.013	28
27	43	3.167	38	2 838	33	2.551	28	2.328	23	2.094	27
26	44	3.287	39	2.955	34	2.653	29	2.422	24	2 182	26
25	45	3.417	40	3.077	35	2.763	30	2.518	25	2.277	25
24	46	3.559	41	3.204	36	2.884	31	2.621	26	2 381	24
23	47	3.716	42	3.338	37	3.014	32	2.733	27	2.493	23
22	48	3 891	43	3.481	38	3.155	33	2.857	28	2 615	22
21	49	4.090	44	3.637	39	3.308	34	2.994	29	2.742	21
20	50	4.315	45	3.810	40	3 474	35	3.146	30	2.876	20
19	51	4.569	46	4.002	41	3.650	36	3 314	31	3.022	19
18	52	4 849	47	4.217	42	3.840	37	3.500	32	3 185	18
17	53	5.159	48	4.461	43	4.050	38	3.707	33	3.368	17
16	54	5 509	49	4.744	44	4.286	39	3 939	34	3 577	16

Life Insurance.

TABLE III.—Value of a Policy of £100, according to the number of years elapsed from the commencement of Risk.—Carlisle 3 per Cent.

Age at Entering the Assurance.	After 1 Year.	After 2 Years	After 3 Years	After 4 Years.	After 5 Years	After 10 Years.	After 15 Years.	After 20 Years.	Age at Entering the Assurance
16	.7350	1.4767	2 2413	3.0296	3.8424	8 3799	13 0536	18.0347	16
17	7472	1 5174	2 3115	3 1304	3 9009	8.6931	13.3309	18 5242	17
18	.7769	1.5761	2 4011	3 2681	4.1627	9 0062	13 8569	19 0362	18
19	.8063	1 6378	2 5116	3 4132	4 3436	9.2557	14 0023	19 5587	19
20	.8382	1.7192	2.6281	3 5661	4 5343	9 4219	14.3714	20 0609	20
21	.8884	1 8050	2 7509	3 7273	4.7189	9 5792	14 7594	20 5097	21
22	.9248	1.8792	2 8644	3.8649	4.8979	9.7281	15.1374	20 9194	22
23	.9633	1 9577	2.9676	4 0102	5.0538	9 9603	15 5196	21 3107	23
24	1.0040	2.0237	3.0765	4 1303	5 1352	10 0972	15 8060	21 7830	24
25	1 0301	2.0935	3.1580	4.1781	5.1198	10.3043	16 2641	22 1692	25
26	1.0746	2.1501	3.1758	4.1323	5.1009	10 5376	16 5726	22 6384	26
27	1.0872	2.1240	3 0909	4 0701	5 0790	10 7669	16.8465	23.1905	27
28	1.0482	2.0257	3.0157	4.0357	5 1045	11.0228	17.1285	23 8128	28
29	0 9879	1.9883	3.0191	4 0992	5 2306	11 3538	17.4961	24 6059	29
30	1.0104	2.0515	3.1423	4.2851	5.4642	11 7455	17.9697	25.5617	30
31	1.0517	2.1537	3 3081	4 4992	5.7289	12 0884	18 5012	26 6226	31
32	1.1137	2.2803	3.4842	4.7269	5 9921	12 3971	19.0865	27 7000	32
33	1.1798	2.3972	3 6539	4.9334	6.2366	12 6710	19.7147	28 7833	33
34	1.2320	2 5037	3.7985	5.1172	6.4610	12.9426	20.4451	29 8731	34
35	1 2875	2.5985	3.9337	5 2942	6 6443	13.2282	21.2589	31.0027	35
36	1.3280	2.6806	4.0589	5 4266	6.7459	13.5485	22.1636	32 1588	36
37	1.3709	2.7677	4.1538	5.4909	6.8133	13.9223	23.0919	33.3588	37
38	1.4163	2.8216	4.1772	5.5181	6.8621	14.3744	24 0458	34.5549	38
39	1.4256	2.8007	4.1608	5 5242	6.9292	14.9570	25.0294	35 6624	39
40	1.3950	2.7748	4.1579	5.5832	7.0525	15.6549	26.0922	36 6508	40
41	1.3994	2.8020	4.2474	5.7376	7.2944	16.5329	27.2515	37.5016	41
42	1.4225	2.8885	4.3998	5.9787	7.6289	17.4687	28.4859	38.3460	42
43	1.4871	3.0202	4 6220	6 2959	8.0658	18.4502	29.7331	39.2302	43
44	1.5563	3.1822	4.8814	6.6781	8.6181	19.4478	30.8724	40.1874	44
45	1 6517	3 3777	5.2027	7.1733	9.2549	20.4843	31.8537	41.1879	45
46	1 7550	3.6107	5 6144	7.7309	9.9655	21.5273	32.5537	42.2445	46
47	1.8888	3 9283	6.0828	8.3572	10 6525	22.5798	33.2537	43.3631	47
48	2 0788	4.2746	6 5928	8.9324	11.2951	23.5684	33.8985	44 5226	48
49	2.2424	4.6099	6 9991	9.4122	11.8511	24.3529	34.5470	45 7025	49
50	2.4217	4.8658	7 3342	9 8290	12.3743	24.9041	35.1901	46.9138	50
51	2.5047	5 0343	7.5912	10.1998	12.8416	25.1218	35 8517	48.1881	51
52	2.5946	5.2171	7 8928	10.6025	13.3497	25 2965	36 6109	49.3571	52
53	2.6924	5.4393	8.2213	11.0413	13.8357	25.4818	37.4576	50.3280	53
54	2.8228	5.6819	8 5801	11.4517	14.1827	25.7472	38.4025	51.0646	54
55	2.9420	5.9243	8 8795	11.6899	14.2991	26.0381	39 4185	51 4352	55
56	3.0728	6.1176	9.0130	11.7012	14.0896	26 4004	40.5537	51.7690	56
57	3.1413	6.1286	8.9020	11 3661	13.7873	26 8454	41 5547	51.9661	57
58	3.0842	5 9476	8.4916	10.9913	13.5161	27.4151	42 3526	52.2180	58
	1	2	3	4	5	10	15	20	

TABLE IV.—Annual Premium for a Joint Life Assurance, payable at the first death of two lives, A and B.—Carlisle 3 per Cent.

Age of A.	A+0 = B.	A+5 = B.	A+10 = B.	A+15 = B.	A+20 = B.	A+25 = B.	A+30 = B.	A+35 = B.	A+40 = B.	Age of A.
16	2.159	2 288	2.470	2 685	2.943	3.292	3 697	4.337	5.307	16
17	2.204	2.341	2.533	2.747	3.028	3 379	3.811	4.517	5 560	17
18	2.251	2.396	2.597	2 813	3.110	3.468	3.936	4.708	5.826	18
19	2.298	2.454	2.661	2.884	3.197	3.647	4.077	4 909	6 096	19
20	2.352	2.516	2.722	2.959	3.287	3.663	4.233	5.133	6.362	20
21	2.407	2 581	2.785	3.039	3.376	3.772	4.406	5.371	6.612	21
22	2.467	2.650	2.853	3.125	3.468	3 892	4.592	5.630	6.874	22
23	2.530	2.722	2 926	3.214	3 833	4.024	4.791	5.904	7.155	23
24	2.598	2.794	3.006	3.309	3.665	4 173	5.004	6.183	7.466	24
25	2.669	2 864	3.090	3.407	3 775	4.337	5.235	6.460	7.807	25
26	2.743	2.936	3.179	3 504	3.592	4.471	5.483	6 721	8.184	26
27	2.822	3.013	3.272	3.605	3.020	4.715	5.752	6 994	8.604	27
28	2.903	3.004	3.370	3.707	4.158	4.921	6.085	7.284	9.071	28
29	2.978	3.282	3.467	3.810	4.318	5.136	6.316	7.597	9.581	29
30	3.045	3.257	3 560	3.913	4.467	5.359	6 585	7.929	10.139	30
31	3.115	3 342	3.653	4.024	4 642	5.699	6 835	8.298	10.769	31
32	3.188	3.431	3 746	4.144	4.828	5.858	7.094	8.699	11.422	32
33	3.268	3.527	3.845	4.278	5.028	6.141	7 374	9 158	12.073	33
34	3.354	3.628	3.951	4.430	5.243	6.415	7 687	9 663	12.705	34
35	3.449	3.733	4.065	4.598	5 477	6.694	8 028	10.231	13.271	35
36	3.549	3.839	4.189	4 786	5.730	6.957	8.407	10.879	13.869	36
37	3.653	3 947	4.322	4.986	6.003	7.230	8.829	11 551	14.464	37
38	3.763	4.058	4.467	5.198	6.291	7.521	9.296	12 218	15.115	38
39	3.878	4.176	4.101	5.424	6 583	7.845	9 817	12.868	15 902	39
40	3 993	4.298	4.807	5.665	6.868	8.191	10 394	13 441	16.668	40
41	4.103	4.424	4.996	5.917	7.128	8.235	11.036	14.034		41
42	4.212	4.556	5.160	6.185	7 391	8.974	11.694	14.613		42
43	4.322	4.698	5.399	6.464	7.669	9.424	12.341	15.236		43
44	4.440	4.859	5.620	6.746	7.977	7.924	12.963	15.991		44
45	4.566	5.037	5.859	7.025	8.311	10.483	13.510	16.745		45
46	4.705	5 237	6.120	7 288	8.683	11.118	14.086			46
47	4.857	5.452	6.404	7.564	9 099	11.780	14.659			47
48	5.029	5.687	6.710	7.864	9.569	12.441	15 292			48
49	5.231	5.949	7 035	8.208	10.105	13.095	16.074			49
50	5.461	6.241	7.366	8.594	10.715	13.693	16.874			50
51	5.724	6.567	7.693	9.019	11.420	14 338				51
52	6.014	6.918	8 034	9 514	12.157	14 986				52
53	6.305	7.295	8.401	10.053	12 895	15 692				53
54	6.629	7.682	8.897	10.656	13 622	16 642				54
55	6.985	8 079	9.254	11.334	14.290	17.413				55
56	7.374	8.466	9.752	12.111	15.005					56
57	7.801	8.891	10.311	12 935	15.737					57
58	8.256	9.320	10 930	13 768	16.539					58
59	8 709	8.218	11.601	14.573	17.475					59
	0	5	10	15	20	25	30	35	40	

Life Insurance.

TABLE V.—Annual Premium for an Assurance of £100, payable at the last death of two lives. Premiums to continue up to the last death.—Carlisle 3 per Cent.

Age of A.	A+0 = B.	A+5 = B.	A+10 = B.	A+15 = B.	A+20 = B.	A+25 = B.	A+30 = B.	A+35 = B.	A+40 = B	Age of A.
15	.756	.811	.868	.922	.975	1.028	1.077	1 127	1.175	15
16	.779	.836	.894	.980	1 005	1.059	1.110	1 162	1 211	16
17	.802	.861	.922	.979	1.036	1.091	1.044	1.197	1.247	17
18	.799	.846	.950	1.009	1.069	1.124	1.179	1.234	1.283	18
19	.850	.914	.979	1.040	1.101	1.126	1.215	1.456	1 321	19
20	·876	.943	1.009	1.072	1.135	1.194	1.254	1.312	1.360	20
21	·902	.972	1.040	1.106	1.171	1.232	1.294	1.353	1 401	21
22	·930	1.003	1.072	1.141	1.208	1.271	1.336	1.396	1.443	22
23	.960	1.035	1.106	1.178	1 246	1.313	1 380	1.440	1 486	23
24	.990	1.068	1.142	1.217	1.287	1.356	1 426	1 486	1.533	24
25	1.022	1.102	1.179	1.257	1.329	1.402	1.474	1.534	1.581	25
26	1.055	1.137	1.218	1.298	1 374	1 450	1.523	1.583	1.631	26
27	1 089	1.174	1.259	1 341	1.420	1.500	1.575	1.634	1.684	27
28	1.125	1.212	1.301	1.386	1.469	1.552	1.628	1.687	1.737	28
29	1.161	1 204	1.344	1.432	1.519	1.605	1.682	1.740	1.792	29
30	1.198	1.293	1.388	1.479	1.570	1.659	1.735	1.794	1.845	30
31	1.236	1.335	1.434	1.528	1.624	1.714	1.789	1.849	1.901	31
32	1.276	1 380	1.482	1.580	1.680	1.772	1.846	1.907	1 958	32
33	1.317	1 426	1.532	1.635	1.739	1.833	1.905	1.968	2.018	33
34	1.362	1.475	1.585	1.694	1.802	1.896	1.968	2.033	2.081	34
35	1.408	1.526	1.640	1 755	1 867	1.962	2.035	2.100	2.147	35
36	1.456	1 580	1 699	1 821	1.935	2.030	2.106	2.172	2.215	36
37	1.507	1.635	1 761	1.889	2 007	2 101	2.179	2.245	2.287	37
38	1.560	1.693	1 826	1.961	2.082	2.176	2.256	2.322	2.362	38
39	1.616	1.754	1 895	2.036	2.160	2.254	2.337	2.401	2.440	39
40	1.673	1.818	1.967	2.114	2.239	2 336	2.440	2.481	2.520	40
41	1 733	1.885	2.044	2.195	2 320	2.422	2.505	2.562		41
42	1.795	1.955	2.110	2.279	2.404	2.506	2.592	2 645		42
43	1.859	2.029	2.206	2 367	2.491	2 596	2.681	2 732		43
44	1.928	2.108	2.293	2 459	2.584	2.693	2.775	2.824		44
45	2.000	2 193	2 387	2 555	2.683	2.795	2.872	2.921		45
46	2 077	2.283	2 485	2 655	2 789	2 903	2.977			46
47	2.159	2 379	2.589	2 761	2 902	3.019	3.089			47
48	2.247	2.482	2.702	2 877	3.025	3.142	3.211			48
49	2.343	2.592	2 821	3 002	3.159	3.276	3.346			49
50	2.445	2.709	2.947	3.137	3.303	3.419	3.492			50
51	2.556	2.836	3.082	3 285	3.460	3.534				51
52	2.670	2.970	3.223	3.441	2 627	3.741				52
53	2.793	3 111	3.374	3.608	3 800	3.917				53
54	2.930	3.260	3 534	3.787	3.983	4.105				54
55	3.071	3.416	3 707	3 978	4 176	4.306				55
56	3.220	3.578	3.892	4.182	4 381					56
57	3.379	3 750	4.090	4 399	4 600					57
58	3.547	3.932	4.301	4.625	4.830					58
	0	5	10	15	20	25	30	35	40	

TABLE VI.—Single Premium for an Assurance of £100, payable at the death of B, provided he is survived by A.—Carlisle 3 per Cent.

Age of A.	B 10.	B 15.	B 20.	B 25.	B 30.	B 35.	B 40.	B 45.	B 50.	Age of A.
16	17.975	20.740	23.490	26.779	30.383	34 040	38.249	42.415	47.576	16
17	17.738	20.477	23.216	26.511	30.125	33.803	38.036	42.219	47.398	17
18	17.501	20.211	22.934	26.233	29.859	33 557	37.816	42.018	47.216	18
19	17.260	19.940	22.643	25.944	29.578	33.295	37.582	41 806	47.022	19
20	17.016	19 665	22.341	25.641	29.284	33.018	37.332	41.580	46.815	20
21	16.768	19.386	22 031	25.325	28.975	32.724	37.066	41.341	46.596	21
22	16.515	19.100	21.710	24 991	28.647	32.407	36.775	41.078	46.356	22
23	16.258	18.809	21.382	24.644	28.303	32.073	36.467	40.799	46.102	23
24	15.999	18.514	21.047	24.283	27.943	31.721	36 138	40.500	45.832	24
25	15.738	18.215	20.708	23.910	27.566	31.352	35.789	40.182	45.545	25
26	15.477	17.915	20.366	23 530	27.178	30.970	35.425	39.848	45.247	26
27	15.215	17.611	20.019	23.141	26.772	30 569	35.038	39.492	44.928	27
28	14.957	17.309	19 674	22.751	26.359	30.158	34 643	39.127	44 603	28
29	14.709	17.020	19.341	22.374	25.952	29.755	34.256	38.770	44 294	29
30	14.476	16 745	19.024	22.013	25.558	29.363	33.884	38.431	44.009	30
31	14.244	16.472	18.706	21.651	25.156	28.957	33.498	38.074	43 708	31
32	14.011	16 197	18.384	21 283	24.743	28.530	33.089	37.693	43.382	32
33	13.773	15.918	18.054	20.905	24.316	28.079	32.652	37.280	43.020	33
34	13.530	15.634	17.718	20.518	23.875	27.602	32.184	36.835	42.622	34
35	13.285	15.348	17 378	20.125	23.427	27.107	31.691	36.362	42.193	35
36	13.037	15.060	17.036	19.726	22.970	26.596	31.172	35.862	41.732	36
37	12.788	14.773	16.695	19·326	22.510	26.075	30.633	35.339	41.247	37
38	12.539	14.487	16.355	18.924	22.046	25.546	30.074	34.792	40.736	38
39	12.287	14.200	16.016	18.521	21.580	25.010	29.495	34.221	40.199	39
40	12.040	13.919	15.684	18 125	21.119	24.479	28.910	33.637	39.652	40
41	11.800	13.648	15 366	17.744	20.672	23.962	28.332	33.055	39.109	41
42	11.563	13.382	15.055	17.371	20.231	23.450	27.754	32.460	38.554	42
43	11.328	13.117	14.748	17.003	19.793	22.940	27.172	31.846	37.977	43
44	11.090	12.849	14.439	16.634	19.350	22.422	26.577	31.201	37.362	44
45	10.848	12.576	14.127	16.263	18.903	21.896	25.969	30.528	36.708	45
46	10.600	12.296	13.808	15.887	18.449	21.357	25.343	29.821	36.005	46
47	10.345	12.009	13.482	15.505	17.987	20.805	24.701	29.084	35.251	47
48	10.081	11.712	13.145	15.113	17.515	20.236	24.035	28.313	34.438	48
49	9.804	11.399	12.790	14.704	17 024	19.642	23.337	27.498	33.552	49
50	9.516	11.076	12.423	14.283	16.521	19.031	22.616	26.650	32.608	50
51	9.217	10.743	12.043	13.850	16.007	18.406	21.872	25.773	31.612	51
52	8.919	10.410	11.664	13.419	15.500	17.788	21.130	24.895	30.604	52
53	8.621	10.078	11.286	12.991	14.998	17.177	20.391	24.016	29.586	53
54	8.323	9.746	10.910	12.563	14.502	16.573	19.656	23.138	28.562	54
55	8.024	9.412	10.532	12.132	14.006	15·972	18.921	22.254	27.525	55
56	7.725	9.077	10.155	11.702	13.514	15.378	18.191	21.369	26.482	56
57	7.428	8.741	9.777	11.271	13.023	14.790	17.468	20.484	25.435	57
58	7 138	8.410	9.407	10.849	12.543	14.219	16.764	19.615	24.402	58
59	6.865	8.096	9.056	10.454	12.090	13.683	16.103	18.789	23.416	59
	10	15	20	25	30	35	40	45	50	

Life Insurance.

TABLE VII.—Annual Premium for an Assurance of £100, payable at the death of B, provided he is survived by A.—Carlisle 3 per Cent.

Age of A.	B 10.	B 15.	B 20.	B 25.	B 30	B 35.	B 40.	B 45.	B 50.	B 55	B 60.	B 65.	Age of B
16	.885	1.047	1.215	1.431	1.688	1.974	2.346	2.764	3.374	4.312	5.577	6.966	16
17	.878	1.038	1.206	1.422	1.679	1.966	2 339	2.757	3.367	4.306	5.571	6.960	17
18	.871	1.030	1.196	1.412	1.670	1.958	2.331	2.750	3 360	4.300	5.565	6.955	18
19	.864	1.021	1.186	1.402	1.660	1.948	2.323	2.742	3.353	4.293	5.559	6.948	19
20	.856	1.013	1.176	1.392	1.650	1.939	2.314	2.734	3 345	4.286	5.552	6.941	20
21	849	1.004	1.166	1 381	1 639	1.928	2.305	2.726	3.337	4.279	5.545	6.934	21
22	.842	995	1.156	1.370	1.628	1.918	2.295	2.717	3.329	4.271	5.538	6.927	22
23	.834	.987	1 145	1.359	1.617	1.906	2.285	2.708	3.320	4.263	5.531	6 919	23
24	.827	.978	1.135	1.347	1.605	1 894	2.274	2.698	3.311	4.255	5.524	6.911	24
25	.820	.969	1.124	1.335	1.592	1.882	2.262	2.687	3.302	4.246	5.516	6.903	25
26	.813	.961	1.114	1.322	1.579	1.869	2.249	2.676	3.292	4.237	5.508	6.895	26
27	.806	.952	1.103	1.310	1.566	1.856	2.236	2.664	3.282	4.229	5.500	6.888	27
28	.800	.944	1.093	1.297	1.552	1.841	2.223	2.651	3.271	4.220	5.493	6.880	28
29	.793	.935	1.082	1.284	1.538	1.827	2.208	2.638	3.260	4 210	5.485	6.873	29
30	.786	.927	1.072	1 272	1.523	1.812	2.193	2.624	3.248	4.201	5.476	6.866	30
31	.780	.919	1.062	1.259	1.508	1.796	2.178	2.608	3.234	4.190	5.468	6.858	31
32	.774	.911	1.051	1.246	1.492	1.779	2.161	2.592	3.220	4.179	5.459	6.849	32
33	.767	.903	1.041	1.234	1.477	1.761	2.144	2.575	3.204	4.166	5.449	6.840	33
34	.761	.895	1.031	1.221	1.461	1 743	2.125	2 556	3.187	4.152	5.438	6.831	34
35	.755	.888	1.020	1.208	1.445	1.724	2.106	2.537	3.169	4.137	5 427	6.821	35
36	.749	.880	1.010	1.195	1.430	1.705	2 086	2.517	3.150	4.121	5.414	6 810	36
37	.743	.873	1.001	1.183	1.414	1.686	2.065	2.496	3.130	4.104	5.401	6.799	37
38	.737	.865	.991	1.170	1.398	1.666	2.043	2.474	3.108	4.085	5.386	6.787	38
39	.731	.858	.981	1.158	1.383	1 646	2.020	2.450	3.085	4.064	5.370	6 774	39
40	.725	.851	.972	1.146	1.367	1.627	1.996	2.425	3.061	4.042	5.353	6.761	40
41	.719	.845	.963	1.133	1.352	1.607	1.972	2.400	3.036	4.019	5.334	6.746	41
42	.713	.838	.955	1.122	1.336	1.587	1.948	2.373	3 009	3.991	5.312	6.730	42
43	.707	.831	.946	1.110	1.321	1.567	1.923	2 344	2.980	3.967	5.289	6.712	43
44	.701	.824	.937	1 099	1.306	1 548	1.898	2 314	2.950	3.938	5.263	6.690	44
45	.695	.818	.929	1.088	1.290	1.528	1.873	2.283	2.918	3.907	5.235	6 666	45
46	.689	.811	.921	1.077	1.276	1.508	1 847	2.251	2.884	3 874	5.203	6.639	46
47	.683	.804	.912	1.066	1.261	1.488	1.822	2 219	2.848	3.838	5.169	6 608	47
48	.677	.797	.904	1.056	1.247	1.469	1.796	2.185	2.811	3.802	5.133	6.573	48
49	.671	.791	.896	1.046	1.233	1.449	1.771	2 152	2.771	3.763	5.094	6.535	49
50	.665	.784	.888	1.036	1.219	1.430	1.746	2.118	2.904	3.722	5.054	6 494	50
51	.659	.777	.880	1.026	1.206	1.411	1.721	2.085	2.862	3.678	5.012	6.449	51
52	.653	.771	.871	1.016	1.194	1.392	1.696	2.052	2.819	3.635	4.968	6.402	52
53	.646	.764	.863	1.007	1.181	1.374	1.671	2.018	2.775	3.589	4.924	6.353	53
54	.640	.758	.855	.998	1.170	1.357	1.647	1.985	2.731	3.542	4 877	6.303	54
55	.633	.751	.847	.988	1.159	1.340	1.623	1.952	2.687	3 493	4.830	6.251	55
56	.627	.745	.840	.979	1.148	1.324	1.600	1.919	2.644	3.444	4.781	6.197	56
57	.621	.738	.832	970	1.138	1.309	1.577	1.887	2.600	3.394	4.730	6.143	57
58	.615	.732	.824	.962	1.127	1.294	1.556	1 851	2.557	3.345	4.678	6.088	58
59	.609	.726	.817	.953	1.118	1.280	1.535	1.822	2.515	3.296	4.625	6.032	59
	10	15	20	25	30	3·	40	45	50	55	60	65	

FIRE INSURANCE.

Fire Insurance.

It is impossible to estimate too highly the value and importance of insurance, and the benefits conferred on mankind by the invention, whether it be considered in its original character as a protection to the merchant who adventured his property on the bosom of the treacherous deep—against its many perils—or, in its more modern applications, as a guarantee against loss by *fire*, and its further interesting adaptation to the assuring of *life*. Considering that maritime insurance was well known, and insurance on *life* understood and practised, to a certain extent, in several mercantile countries by the middle of the sixteenth century, it appears extraordinary, when we call to remembrance the devastations and distress occasioned by *fire* in this country, that some means should not have been adopted at an earlier period to render such calamities less ruinous to individuals, particularly when a plan, which appears eventually to have formed the basis of the present insurance companies, was suggested so early as 1609.

In that year, a person proposed to Count Anthony Gunther von Oldenburg, that, as a new species of finance, he should insure the houses of all his subjects against fire, on their paying so much per cent annually, according to their value; but the prospect of gain so tempting to most persons could not induce the Count to adopt the plan. He thought it good if a company was formed of individuals to insure each others' houses, but he doubted that it could by him be "honourably, justly, and irreproachfully instituted without tempting Providence—without incurring the censure of neighbours, and without disgracing one's name and dignity," adding that "God had without such means preserved and blessed, for many centuries,

Fire Insurance.

the ancient house of Oldenburgh, and He would still be present with him through His merey, and protect his subjects from destructive fires." This plan appears not to have been again thought of until the fire of 1666 had laid the city of London in ashes.

In consequence of this calamitous event, the citizens began to see the importance, and indeed necessity, of erecting their buildings of a material less susceptible of fire than hitherto; also of adopting a regular system of precaution against future accidents, as well as of devising some scheme for mutual pecuniary protection and relief. Various proposals were accordingly submitted to the Court of Common Council of the city of London, between 1669 and 1680, for the mutual relief of such as might have their houses destroyed by fire—the most notable and acceptable of which was by one of their own body, Mr Deputy Newbold. But if we may judge from the length of time that elapsed ere the worshipful committee made their report to the court, we should conclude the adopting of the proposal to have been attended with serious difficulties, and in verification of the old proverb that "delays are dangerous," during the period between the first presentation of Mr Newbold's proposals to the Lord Mayor, and the final report of the committee to whom the matter was referred by the Court of Common Council, several private individuals associated themselves together, and submitted to the good citizens of London a "design for insuring houses from fire," and on the 16th September 1681, a notice or advertisement was issued from their "*office*, on the *back side* of the *Royal Exchange*," offering to insure *brick* houses against fire for *sixpence*, and *timber* houses for *twelvepence* in the *pound*—being at the rate of £2:10s. *per cent* for brick houses, and of £5 *per cent* for timber.

Subsequently, on the 13th October 1681, the Court of Common Council did "agree and resolve to undertake ye insuring all houses wthin this city and libertyes from fire, and execute ye same with all expedicon," and thereafter "resolved forthwith to engage a sufficient fund, and undoubted security by the chamber of *London*, in lands and good ground rents, for the performance thereof." Much amusing pamphleteering and advertising in the Gazette took place between the advocates of the corporation scheme, and the "interessed" in the said insurance office on the back side of the Royal Exchange.

The journals of the Court of Common Council in 1681, 1682, and 1683, record the signing of many policies, and bear amusing evidence of the zeal and prudence of the fire insurance committees in promulgating the benefits of the corporation scheme, and combating the antagonistic pamphlets issued by their competitors.

As the fruit of this pamphleteering agitation, the subject was brought under the most serious consideration of the court on the 13th November 1682, as appears by a minute of that date; when the court evinced a much greater anxiety to relinquish than they had to undertake the design, and directed the discharge of existing contracts, with the repayment of the money which had been advanced.

Notwithstanding this resolution, however, contained in the foregoing minute, we find several policies subsequently passed the common seal, on the 6th March and 3d May 1683.

After this, the city discontinued issuing policies, and having had a *quo warranto* brought against their charter, every exertion was used to obtain a surrender of the existing policies, and thus release the city lands from the incumbrances thereon. Fire Insurance.

The last matter taken into consideration was the petition of Mr Newbold, the author of the design which turned out so unsuccessful for remuneration, for the time, trouble, and expense he had been at, which was referred to a committee who reported on the 13th October 1696, and on the 8th December following it was "resolved to give him the benefitt of making two persons free of this citie by redemp.con, paying to Mr Chamberl.in to the citie's use of fortie-six shillings eight pence a-piece, the said persons to be first presented and allowed of by this court." This was the fate of the "City's Design and Undertaking for the insuring of Houses from the evil of Fire." The "interessed" in the rival office became, of course, greatly elated, and their success led to the formation of several other companies or mutual insurance societies,[1] for protection against fire.

In 1696, the *Hand-in-Hand Fire* Office was established by about 100 persons, who afterwards formed a deed of settlement, enrolled in Chancery January 24, 1698. This office is remarkable at the present day for its *age*, and is the *only* surviving one of those of that period.

Up to the year 1706, the protection afforded by fire insurance societies was limited entirely to houses (*buildings*), but in that year the *Sun Fire Office* was projected by one Charles Povey, for insuring merchandise and household goods (as well as houses) from fire; and was the first office to extend the benefits of insurance beyond the confines of the metropolis. This office has for very many years stood proudly first on the list in amount of business. The property insured by the *Sun Fire Office* alone, in 1855 (as per the Government duty returns), amounted to nearly one hundred and twenty-seven millions sterling. The *Union Fire Office* was established in the reign of Queen Anne, 1714. The *Westminster Fire Office* in 1717. The *Royal Exchange* and *London Assurance Corporations* in 1721. These are offices of the first class; enjoying most deservedly the entire confidence of the opulent and discerning mercantile community of London and of the public at large.

Every subsequent generation has witnessed the establishment of additional fire insurance companies, hundreds of which have never reached maturity. The companies recognised by the Government at the period in which we write (1856), in England, Ireland, and Scotland, are 72 in number—insuring in the aggregate more than 894 millions of pounds sterling worth of property—besides 63 millions of agricultural produce.

In 1782, during the premiership of Lord North, the large amount of business transacted by the then offices tempted his lordship to propose the first tax upon prudence in the shape of a duty of 1s. 6d. per cent on the amount of property insured. The growing necessities of the State in times of war caused a gradual augmentation, until at the present time the duty is 3s. per cent per annum, and yields a revenue of £1,341,242, as per the following Government official return:—

There is also a stamp duty of 1s. on each policy.

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[1] The following from the London Gazette will sufficiently explain the principle on which the societies were founded:—

No. 2049.—July 6th to July 9th, 1685.

"There having happened a fire on the 24th of the last month, by which several houses of the Friendly Society were burnt, to the value of £965, these are to give notice to all persons of the said society that they are desired to pay at the office in Faulcon Court in Fleet Street their several proportions of the said loss, which comes to five shillings and one penny for every hundred pounds insured, before the 12th of August next."

Fire Insurance.

Parliamentary Return of Fire Insurance Duties, Paid to Government for the year 1855, *by the following Fire Insurance Offices*—

Sun	£190,257	Anchor	5,983
Phœnix	124,140	National (Irish)	5,609
Royal Exchange	77,694	National (Scotch)	5,341
Norwich Union	75,130	Patriotic (Irish)	4,986
County	59,555	North of England	4,938
West of England	49,928	Essex Economic	4,917
Imperial	47,951	Church of England	4,058
Alliance	43,668	Salop	3,833
Atlas	37,923	Nottinghamshire and Derbyshire	3,735
Globe	36,324	National Provincial	3,177
Manchester	36,228	Sheffield	2,955
Guardian	31,456	Law Union	2,920
London	28,014	Equitable	2,732
Westminster	27,705	Norwich Equitable	2,693
Law	27,524	Kent (Mutual)	2,610
Union	26,455	Provincial	2,583
Scottish Union	26,040	Hants, Sussex, and Dorset	2,324
Royal Insurance, Liverpool	25,037	Forfarshire and Perthshire	2,260
Liverpool and London	21,057	Midland Counties	1,869
Unity	20,265	Shropshire and North Wales	1,734
Yorkshire	19,949	Times	1,666
North British	19,583	Athenæum (3 qrs.)	909
Lancashire	18,160	Durham and Northumberland	298
Leeds and Yorkshire	18,114	Beacon	247
Birmingham	14,193	Cambrian and Universal	233
Kent	14,066	United Kingdom Provincial (3 qrs.)	226
Monarch	12,966	London and County (3 qrs.)	202
Royal Farmers'	11,414	Emperor	128
General	10,606	Era	120
Northern	10,080	British Provident (3 qrs.)	87
Caledonian	9,814	Saxon (3 qrs.)	67
Hand-in-Hand	9,450	Eclipse	31
Birmingham District	7,943	London and Continental	22
Defender	7,832	Preserver	19
Scottish Provincial	6,380	Protestant (3 qrs.) disc.	00
British Empire Mutual	6,272		
Essex and Suffolk	6,096		
Newcastle-upon-Tyne	6,008		

The duty paid by the English and Scotch offices for insurances in *Ireland*, added to the above, makes the total amount received by the Government for the year 1855, £1,341,242. The duty is collected by the offices along with their premiums, and they are allowed a drawback of 5 per cent upon it for their trouble and expense in so doing.

The following table is given as illustrative of the progressive increase of fire insurance in this country during the *last five years*:—

An Account of the Gross Amount of Receipts for Insurance (Duty) for the years 1850, 1851, 1852, 1853, 1854, and 1855.

YEARS.	ENGLAND.	SCOTLAND.	IRELAND.	Gross Amount of Receipts.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1850	1,042,396 15 1	65,875 12 7	51,258 10 0	1,159,530 17 8
1851	1,070,727 16 2	67,229 16 2	52,548 2 4	1,190,505 14 8
1852	1,098,457 13 11	68,099 1 2	53,824 14 9	1,220,381 9 10
1853	1,141,346 17 1	71,600 18 1	56,478 15 1	1,269,426 10 3
1854	1,178,016 10 1	76,782 10 4	58,424 3 9	1,313,223 4 2
1855	1,203,861 17 0	78 614 5 9	58,766 10 0	1,341,242 12 9

By the foregoing return, we find that British property to the extent of more than £894 millions sterling must be covered by our insurance offices. This, however, affords no criterion of the actual amount of risk undertaken by these offices. In the first place, because the duty on farm-stock having been repealed in 1833, that very extensive description of risk is not included in this calculation; and secondly, because some of the offices underwrite *foreign* risks to a very large amount, and these are equally, by Act of Parliament, exempt from duty. Perhaps, therefore, the enormous sum of one thousand five hundred millions sterling does not greatly exceed the amount of property insured by our British fire establishments.

Fire Insurance.

By far the greater number of the above are joint-stock companies, who insure at their own risk and for their own profit, and are represented by agents in all the principal towns of the kingdom; the remainder are joint-contribution, or mutual insurance societies, in which every insurer participates in the profit or loss of the concern.

Practice of Fire Insurance.

The advantages of *fire* insurance are too well known to require any very elaborate description. A manufacturer or private individual can, by the payment of an annual sum (premium) proportioned to the risk, secure himself against loss in the event of his manufactory or dwelling-house, or their contents, being destroyed by fire.

It is almost impossible to form a correct classification of the risks undertaken, nevertheless, the experience of many years has enabled the old offices to arrive at tolerable *data* for fixing the rates of premium for the great variety of risks they are called upon to undertake. They are generally divided into *common, hazardous, double hazardous*, and *special*—the rates varying from 1s. 6d. per cent per annum for a private first class dwelling-house, to 42s. per cent per annum for a sugar refinery or drying stove. The more fragile and costly contents of a house, such as china, glass, mirrors, and pictures, are charged a higher rate of premium than the ordinary articles of household furniture, as being more susceptible of damage in the event of fire, whilst books of accounts, written securities, bills, bonds, ready money, and gunpowder, are deemed *un*insurable.

The government duty of 3s. per cent per annum is exigible on all alike, without reference to the rate of premium—public hospitals and agricultural produce and implements excepted, which are specially exempted from this impost, although why the agriculturist should be thus favoured it is difficult to comprehend.

The conditions on which an insurance is granted are in all cases printed upon the policy, and form a part of the contract, being in general so well defined as seldom to require submission for judicial interpretation.

1. Candour is imperative on the part of all persons proposing for insurance. Any misrepresentation in describing the building, or goods, or the process of manufacture carried on, whereby the same may be charged at a lower rate of premium than they otherwise would be, invalidates the policy; and if any alteration be made in the state of the building or process of manufacture after the insurance is effected, the insured is required to give due notice thereof to the insurers, otherwise he forfeits all right of recovery under his policy.

2. The party effecting an insurance against fire must have a *bona fide* interest in the property insured, to enable him to establish a claim against the insurance company; and a trustee, mortgagee, reversioner, factor, or agent, is held to have sufficient interest to effect a policy of insurance, provided the nature of such interest be distinctly specified at the time of effecting the insurance.

An insurance on the same property in any other office, must be named in, or endorsed on, the policy, and in the event of loss, each office pays a rateable portion thereof.

It frequently occurs, however, that various parties have separate interests in the same property, in which case each may insure his own interest without communication with the others.

3. A separate sum must be insured on *each* building, and on the contents of each, unless the insurance is specially rendered subject to the conditions of average, as in mercantile policies, the operation of which is—that the assured is entitled to recover such a proportion only

Fire Insurance.

of a loss as the sum insured bears to the value of the property; so that, if a merchant insures for £5000 only, when his merchandise *collectively* in *all* the places named in the policy is worth £10,000 at the time the fire happens, he can only call on the insurance company for *half* the amount of loss.

4. Fire insurances are not in this country subject to the law of average, as in marine assurance (unless otherwise stipulated, as in the foregoing mercantile case), and the amount insured is payable to its full extent, provided the ascertained loss or damage is equal to the sum insured; but in *foreign* countries *all* policies are subject to average.

5. The offices now generally hold themselves liable for loss occasioned by lightning and gas explosions—which concessions have been forced on them by the competition of new offices; also for losses occasioned by incendiarisms, the offices having a right of recovery from the county, in the event of a conviction of the incendiary. There is a general exemption from liability in the case of *fire* occasioned by invasion, foreign enemy, civil commotion, riot, or any military or usurped power, and under this condition the Sun Fire Office was exonerated from the loss occasioned by the disgraceful proceedings of the mob in 1780 (the Gordon Riots.)

The offices are also very justly exempt from loss arising from the natural heating of hay and corn, always the result of gross carelessness.

6. Policies of insurance may be effected for any period. If for a year (which is most customary), or for a term of years, by a single payment, it is usual for the office by way of indulgence, to allow fifteen days after each year or term of years for the payment of the premium for the next period, in succession; and, provided the premium be paid within that time, the insured is considered within the protection of the office.

7. A policy of insurance is not in its nature assignable, nor can it be transferred without the express consent of the office. When, however, any person dies, his interest remains in his executors or administrators respectively, who succeed or become entitled to the property, provided such representatives respectively procure their right to be endorsed on the policy.

8. The prompt and liberal manner in which claims are met by the fire offices of this country generally, is highly creditable to the nation. There is, however, too much reason to believe that frequent frauds are perpetrated by individuals insuring to a large amount property of trifling value; and it is an undoubted fact that fraudulent and excessive claims are of constant occurrence—these have been very much increased by the competition and keenness for business which have existed among the offices for very many years. Many offices make it one of their conditions that the statement of loss shall be supported by the oath or affirmation of the claimant, declaring, at the same time, that if any false swearing, fraud, collusion, or wilful mis-statement shall take place, either by the assured or on his behalf, *the whole right of recovery shall be forfeited.*

The effect or power of this clause was tried in the court of Kings' Bench in the month of March 1832, in an action brought by a person of the name of Freidlander, a jeweller, against the London Assurance Company, where the verdict was given for the defendants, which was, in fact, declaring that, although the plaintiff could prove a loss to a certain extent, *he had forfeited all right under his policy* in consequence of the fraudulent claim he had set up.

On the oath of a suspected claimant very little reliance is to be placed, as it is borne out by the experience of all offices, that if a man will make out a fraudulent claim, he will not be very scrupulous in swearing to its correctness. Fire Insurance.

9. When a loss occurs, and there is no suspicion of any unfair practice on the part of the insured, it is the custom, as it is the duty, of the offices to be generous, liberal, and prompt in their settlements. It is beyond doubt that many fires are wilfully caused for the purpose of defrauding the insurance companies, the greatest check to which would be that the duty of coroner for each county, city, or district, should extend to a full inquiry into the cause or origin of every fire that occurs of any consequence, viz., when a house or tenement is destroyed within his jurisdiction; in fact, for an *inquest* in all respects similar to those held in cases of violent or accidental death.

This plan was suggested by the writer of this article 24 years since, and a few years ago adopted by the coroners for London and Middlesex, but as the authorities—and, strange to say, the insurance companies themselves—discouraged it, by refusing to pay the customary fee to the coroners, this most wholesome check to one of the worst of crimes was abandoned. Insurance companies much need the protection of the law in cases of fire, and none could be more effectually given than that which an inquest would afford; not, of course, to be holden in trivial cases, such as foul chimnies, &c., but whenever a fire extends to the destruction of a house or tenement.

The case of Smithers, in Oxford Street, London, in 1832, may be here mentioned as in point:—This man was executed for the double crime of arson and murder. His object was, by burning his premises, to defraud the insurance company, but in doing this he sacrificed the lives of his lodgers, and thereby caused an *inquest* to be held to inquire into the cause of the death of the parties, which led to his conviction. Now, had it not been for the loss of human life, this man would in all probability have escaped the just vengeance of the law, and the insurance company have had to pay him his iniquitous and fraudulent claim.

In the majority of cases, a fire does not involve a total loss, and the insurance company is liable for the actual amount of loss or damage sustained—not exceeding the sum insured by the policy, which is the maximum beyond which no claim can extend. The offices generally reserve to themselves the power of reinstatement—a wholesome and unobjectionable provision. (F. G. S.)

MARINE INSURANCE,

A contract by which one party, the "insurer" or "underwriter," engages for a stipulated premium to protect another party, the "assured," against loss arising from certain perils, or sea risks, to which his ship, goods, or other interest, may be exposed during a specified voyage, or period of time. Marine Insurance. Definition.

The policy of insurance, or instrument which contains the contract, is a printed form, with spaces left blank for the insertion, in writing, of the particulars of the agreement. The form in general use appears to have been originally introduced with the earliest practice of marine insurance in this country. Although worded in a confused and ambiguous manner, its meaning has been fully defined by a series of legal decisions on every debateable point; and in all cases the written conditions are held to overrule any of the printed clauses which might appear to be inconsistent with them. Of the policy.

The stamping of policies is at present regulated by the unrepealed provisions of the 35 Geo. III., c. 63, and by Stamp Acts.

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the 7 Vict., c. 21. The most important of the former are those which declare all policies not duly stamped to be void, prohibit the affixing of stamps to policies after signature, and exclude all unstamped policies, or agreements for insurance, from the evidence admissible in courts of law. The 7 Vict., c. 21, fixes the stamp duties as follows:—

1. On Voyage policies:—For every £100 insured, and for every fractional part of £100—

Where the premium does not exceed	10s.	per cent,	3d.
" " "	20s.	"	6d.
" " "	30s.	"	1s. 0d.
" " "	40s.	"	2s. 0d.
" " "	50s.	"	3s. 0d.
" " "	60s.	"	4s. 0d.

2. On Time policies—for every £100, and for every fractional part of £100—

Where the time does not exceed six months .	2s. 6d.
Where it does exceed six months . .	4s. 0d.

And no time policy is allowed to be made for a longer term than twelve calendar months.

3. On every policy of mutual insurance, not being a time policy—for every £100, and for every fractional part of £100 . . . . 2s. 6d.

If the *separate interests* of two or more distinct persons be insured in one policy, the stamp must cover each fractional part of £100 in the amount of such separate interests, as if it were a full sum of £100. The penalty on any person, broker, or underwriter, engaged in effecting or subscribing policies not duly stamped, is £100.

In practice it is usually desirable to conclude an agreement for insurance at once, lest some subsequent intelligence should induce either party to recede; and it is customary for the underwriter to sign a slip or short memorandum of the insurance, until the stamped policy can be completed. But such memorandums, however obligatory in good faith, are not legally binding.

Policies without interest.

In order to give validity to the contract, it is necessary that the assured have a right of property, or "interest," in the thing assured. A policy without interest is held to be a mere wager; and it is declared by the 19th Geo. II., c. 37, that policies bearing the words "interest or no interest," or "without further proof of interest than the policy," or "without benefit of salvage to the insurer," or any policies made by way of gambling or wagering, shall be null and void. The expected profits of a sea adventure may be included in the value of the property for insurance; but an unwarrantable or fraudulent over-valuation of the thing insured renders the policy void, even in respect to the value actually proved.

Valued policies.

A valued policy is one which contains a specific valuation of the interest insured. This valuation forms an essential element in the adjustment of all claims under the policy, and cannot be set aside except on the ground of fraud. The burden of proof, in any averment of fraudulent over-valuation, lies on the underwriter.

Open policies.

An open policy is one in which the value of the interest insured is not specified. In claims under such policies the assured must prove the value of the thing insured. The value of a ship for insurance is what she is actually worth at the commencement of the voyage, including all her stores, provisions, and outfit, money advanced for seamen's wages, and costs of insurance. The difficulty of *proving* a precise value in the case of ships is sufficiently obvious; and to avoid disputes, policies on them ought always to be valued, as it is the usual practice to do. The value to be proved under an open policy on goods is their first cost, including the expenses of shipment, with any portion of the freight that may have been prepaid, and the costs of insurance. The value to be proved in open policies on freight is the amount of the manifest, or freight list, excluding such freight as may have been paid in advance, but including the costs of insurance.

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When the value proved under an open policy falls short of the sum originally insured, the difference, which is technically termed an over-insurance, is treated as a deduction to be made from the amount of the policy. On this footing a proportionate part of the premium is returnable to the assured, who, on his part, can make no claim on the underwriter for loss or damage, beyond the value of his interest as actually proved. If, on the other hand, the value proved exceed the amount of the policy, the assured is regarded as "his own underwriter" to the extent of such excess; and the amount of loss or damage, if such has arisen, is apportioned on this footing between the parties relatively to their several proportions of the total value.

Over insurance.

Short interest.

A "short interest" arises when only a part of the interest insured has been exposed to risk; as when some portion of the goods specified in the policy have not been loaded on board of the ship. This case is treated in the same manner as that of over-insurance, from which indeed it does not essentially differ.

Double insurance.

Double insurance takes place when the same interest has been insured twice or oftener. If this be done for fraudulent purposes, the policies will be void; but it frequently occurs, either through mere inadvertence, or from the want of definite information on the part of the respective persons concerned in the transaction. In such cases, the usual practice is that all the underwriters make a return of premium, in proportion to the amounts of their respective subscriptions, for the excess of the sum insured above the actual value of the interest; the liabilities of the several underwriters under the different policies being of course proportionally diminished. To this rule, however, there are two important exceptions. One of these occurs when two or more persons insure the same thing, in order to protect the *distinct interests* which they may individually have in it; the other, when the circumstances are such that a claim for loss might have been brought against one set of underwriters before the other set had become liable at all.

Re-insurance.

Re-insurance is illegal in this country, unless the original insurer become insolvent or die.

Duration of risk.

The risk on the ship, in voyage policies, commences "at and from" the place specified in the policy, and continues till she arrive at the destination specified, and have been there moored twenty-four hours in good safety. On goods the risk begins with their loading, and ends with their discharge, at the specified ports. On freight the risk usually commences with the shipment, and terminates with the landing of the goods; but if there be a contract of affreightment, under which the goods have been provided for shipment, the risk is held to commence as soon as the ship is in readiness to take them on board.

After the risk has once commenced, the whole premium is earned, even although the voyage should not be prosecuted, and the actual risk of the insurers be thereby confined to the mere lying of the ship *at* the port where the insurance was to commence. But if the risk should not commence at all, or, in technical phrase, if the "policy should not attach," the premium must be returned to the assured.

Deviation.

If the ship should deviate from the regular and usual course of the specific voyage insured, without necessity or reasonable cause, the underwriter is thenceforth discharged from all liability under the policy. The insurance becomes void as soon as such deviation begins; and consequently, it is quite immaterial whether a subsequent loss of the ship should happen during the actual deviation, or after the ship had returned to her course, the insurer being no longer concerned. It is also immaterial

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whether the assured was or was not cognisant of the deviation. A mere *intention* to deviate will not vitiate the policy; but if the ship have sailed on a *different voyage* from that specified, the insurer is discharged, although the loss should happen before reaching the point of divergence in the two voyages. An unjustifiable delay in the prosecution of the voyage operates as a deviation. The causes which justify deviation are such as to refit the ship after she has been disabled, to avoid an enemy or an impending storm, or to save the lives of seamen in distress.

Seaworthiness in voyage policies.

In all voyage policies it is an implied condition of the contract that the ship shall be seaworthy at the commencement of the risk. By this is meant that the ship shall be in a fit state, as to repairs, equipments, crew, and all other respects, for encountering the ordinary perils of the voyage insured, at the time of sailing on it. Seaworthiness is a condition precedent to the contract; and, therefore, where the ship is originally unseaworthy, the underwriter is discharged, even although the loss should result from causes independent of the particular deficiencies constituting the unseaworthiness. It is not material whether the assured is or is not cognisant of the defects rendering the ship unseaworthy; and this rule applies indiscriminately to the owners of the ship and the proprietors of the goods on board. But there is no engagement that the vessel shall *continue* to be seaworthy after the voyage has been commenced. The burden of proof, in any averment of unseaworthiness, lies on the underwriter, unless where the ship, without adequate cause, becomes leaky soon after sailing.

Seaworthiness in time policies.

It has very recently been decided in the English courts that in *time policies* the warranty of seaworthiness is not implied. This principle has been partially affirmed by the House of Lords, in the case of Gibson *v.* Small (3d June 1853, 21 L. T. 241), where it was held that when the actual condition of the ship could not be known by the owners, in consequence of her being at the time in a distant part of the world, there was no implied engagement of her seaworthiness at the commencement of the time policy. But it was left undecided whether the seaworthiness of the ship would be implied in a time policy, taken at the commencement of an *outward* voyage. Lord St. Leonards thought it would—Lord Campbell thought otherwise. It has now been decided by the Court of Queen's Bench, in the cases of Thompson *v.* Hopper, and Fawcus *v.* Sarsfield (March 1856), that there is no implied warranty of seaworthiness in any time policies whatsoever. This view of the law, it must be confessed, is entirely new; for no distinction between voyage and time policies, in respect of the implied condition of seaworthiness, is adverted to by the writers usually recognised as authorities, such as Marshall, Park, and Arnould; nor was any such distinction made in practice previously to these legal decisions. The ground of this distinction is explained to be that "a time policy is to be construed, as an ordinary contract in writing, by the terms thereof; and not as a contract for marine insurance, subject to the rules of law relating thereto;" it being assumed that these rules were laid down for voyage policies, and were not adapted for time policies. It is further said that underwriters on time policies may protect themselves from the consequences of the law as now laid down, either by inserting an *express* warranty of the seaworthiness of the ship in their policy, or by charging a premium proportional to the additional risk. This is no doubt true; yet we venture to say that a private remedy of this nature is scarcely an adequate remedy for what certainly appears to be an anomalous state of the public law. It seems to be equally impolitic and inequitable that the owners of an unseaworthy ship should be allowed to recover their insurance, provided only they have effected it by a time instead of a voyage policy, while the shippers of the goods on board of her (who cannot insure their property otherwise than for the voyage) are not allowed to recover theirs. The circumstance, too, that it is the owners of the ship, and not the proprietors of the cargo, who have the power to regulate the ship's condition as to repairs and equipments, gives all the more force to the consideration just stated. But the principle of this distinction between voyage and time policies seems itself to be as open to objection as this particular result of it; as it may probably be found to affect various other points besides that of seaworthiness, and thus give occasion to disputes and litigations on matters hitherto regarded as conclusively settled.

Marine Insurance.

Fraud, concealment, and misrepresentation.

The contract of insurance being pre-eminently one based on the assumption of perfect good faith between the parties, it is the duty of the party wishing to effect the policy to make a true disclosure of every circumstance likely to affect the underwriter's estimate of the risk. The concealment or misrepresentation of material facts, or the representation of anything not consistent with the facts, will render the policy void. This rule holds good even where the concealment or misrepresentation may have resulted from a mistake, without the *intention* to deceive. If the underwriter has actually been deceived, whether wilfully or by mistake, the risk is different from that understood and intended to be run; and on this ground he is discharged. The materiality of a concealment or misrepresentation depends, not on its eventual influence on the result of the risk, but on its immediate influence on the judgment of the underwriter at the time of effecting the insurance. The loss may arise from causes totally unconnected with the facts concealed or misrepresented, but the policy is nevertheless void, because a true disclosure of the facts at the time of effecting it might have led the underwriter to decline the insurance altogether, or to accept it only at a higher premium. If an agent be employed to effect the insurance, he is bound to communicate to the underwriter, not only all the material facts disclosed to himself by his principal, but also any other material facts which may have come to his knowledge from other sources. If either the principal or the agent fail to communicate such facts, the policy will be void. Should any material fact come to the knowledge of the parties wishing to effect the insurance after they have sent away an order to have it effected, they are bound to intimate such fact without delay, so that the underwriter may be informed of it (if there should still be time) before he has accepted the risk. The suppression of information tending to show that the ship was overdue, or that there were rumours current as to her having met with some accident (even though it afterwards appeared that these rumours were unfounded), are instances of concealment fatal to the validity of the contract. It has also been held that a policy was void because the agents employed to effect it failed to inform the underwriters that their principal had instructed them to wait the arrival of the ship for a certain number of days before acting on the order to insure. If an agent has received orders to insure by express, or by telegraph, that circumstance ought to be mentioned to the underwriter. Misrepresentations of the terms on which other underwriters have agreed to accept the insurance, will be fatal to the validity of the contract, as well as misrepresentation of the risk itself. It may be observed generally that every circumstance represented to the underwriter ought to be at least substantially true. A mere expression of *opinion* or *expectation* does not of

course amount to a positive representation of facts; but the opinion or expectation expressed must itself be genuine, as if it appeared that it had been only a pretence, or inconsistent with anything within the actual knowledge of the assured at the time, the policy might be vitiated. When an express *warranty* is given, its terms must be *literally* complied with, otherwise the policy will be void. The chief distinction between a warranty and a representation is that the former is always inserted in the policy, while the latter is never so inserted; and the effect of this is, that while a representation affects the contract only in so far as it may be found to have been material to the risk, a warranty precludes all questions as to materiality, its express terms superseding any such inquiry.

The perils insured against.

The perils insured against are described in the printed form as the "adventures and perils of the seas, men-of-war, fire, enemies, pirates, rovers, thieves, jettisons, letters of mart and counter mart, surprisals, takings at sea, arrests, restraints, and detainments of all kings, princes, and people, of what nation, condition, or quality soever; barratry of the master and mariners, and all other perils, losses, and misfortunes that have or shall come to the hurt, detriment, or damage of the said goods, merchandizes, and ship, &c., or any part thereof." It may be observed that, as a general rule, the underwriters are liable only for such losses as are *proximately* caused by the perils insured against. For the *remote* consequences of these perils, such, for instance, as the loss of markets through delay, they are not responsible. But, on the other hand, if a loss has been proximately caused by a peril insured against, the underwriters are not relieved from liability, although such loss may have been remotely occasioned by the acts or negligence of the assured or his agents. The reason for this rule, as given by Lord Bacon, is that "it were infinite for the law to consider the causes of causes, and their impulsions one on another; therefore it contenteth itself with the *immediate* cause."

Limitations of underwriter's liability.

Losses resulting from breaches of the revenue laws, or of the law of nations, or from illegal voyages generally, are not covered by the policy. The risk of "thieves" applies only to plunder committed by open violence, and does not cover losses by theft in the ordinary acceptation of the term. The illegal acts of the master and crew, if committed without the privity of the owners, will amount to barratry, so as to render the underwriters responsible for them; but if the master be also owner of the ship, none of his acts will be held as barratrous. If the assured be the subject of a foreign State, underwriters in this country will not be liable for the acts of that State, unless it appear from the form of the policy, or from the circumstances of the case, that they meant to insure against such risk. Losses by the ordinary wear and tear of the ship, or by the natural deterioration or decay of perishable goods, are not chargeable to the underwriters.

Duty of the assured in cases of loss or damage.

The printed form of the policy declares that "in case of any loss or misfortune, it shall be lawful to the assured, their factors, servants, and assigns, to sue, labour, and travel for, in, or about the defence, safeguard, and recovery of the said goods and merchandizes, or ship, or any part thereof, without prejudice to this insurance: to the charges whereof, we, the assurers, will contribute, each one according to the rate and quantity of his sum herein insured." The object of this clause is to permit the assured to take measures for the recovery of the property without losing any right of abandonment he might have in the circumstances. Although the language of the clause is only permissive, it is a settled rule that the assured is bound so to labour for the recovery of the property. The best practical rule for the assured to follow in cases of partial loss or damage, is to act in the circumstances as a prudent man would do if uninsured.

Of the memorandum.

An important clause in the printed policy is what is called the *memorandum*, which is as follows:—"Corn, fish, salt, fruit, flower, and seed, are warranted free from average, unless general, or the ship be stranded. Sugar, tobacco, hemp, flax, hides, and skins, are warranted free from average under five per cent. And all other goods, also the ship and freight, are warranted free of average under three per cent, unless general, or the ship be stranded." The effect of this clause, as interpreted by legal decisions, is to free the underwriter from claims for particular average (or partial damage), or from such claims if under the rates specified, unless the ship be stranded. But if the ship be stranded, he is liable for such claims, *whether caused by the stranding or not*. For losses of the nature of *general average*, the underwriter is liable whether the ship be stranded or not, and whether the amount be over or under the rates mentioned in the memorandum.

What constitutes a stranding.

It is frequently a matter of some difficulty to determine whether a ship has been stranded within the meaning of the memorandum. A mere touching or striking, whether on a rock, bank, reef, or other object, will not constitute a stranding, unless the ship settles down and remains fixed for some definite time. The amount of damage sustained is not material to the question either way. Where a vessel takes the ground in the ordinary and usual course of the navigation in a tidal river or harbour, on the ebbing of the tide, or from natural deficiency of water, this is no stranding. It is essential to a stranding that the ship should take the ground by reason of some unusual or accidental occurrence. A voluntary stranding, to save the ship from sinking, is within the meaning of the memorandum, although the ship should be run into a tidal harbour for the purpose.

Of total losses and abandonment.

When an absolute total loss occurs, the assured is entitled to recover the amount of the policy without giving notice of abandonment. When the subject insured, without being wholly destroyed, is so seriously injured, through the perils insured against, that its recovery might involve greater expenses than its eventual value would cover, it forms a "constructive total loss," and the assured is entitled to give notice of abandonment to the insurers, and to claim the amount of the policy. (See Abandonment). It is only, however, when the circumstances seem to involve a virtual loss, as distinguished from a deterioration of the property, that notice of abandonment can be competently given; and unless the abandonment be accepted (which it seldom is), the *ultimate* state of the facts will alone determine the question, whether it can be insisted on. The principle upon which losses are settled when abandonment is validly made, is that the underwriter becomes the proprietor of the subjects abandoned on payment of the sum insured. The effect of an abandonment of the ship is to transfer the ownership to the underwriters, so that whatever freight she may thereafter earn belongs to them; and although such freight is thereby lost to the original owners, the insurers of the freight are not liable to them for loss in respect of it, because it is lost only by their own act of abandonment, and not by the perils insured against. When goods are so damaged by the perils insured against that they are necessarily sold at any place other than the original destination, they are constructively lost, and the underwriter is liable for their insured value, under deduction of the nett proceeds of the sale. But this rule is not applied to goods warranted "free

from average unless stranded," if there has been no stranding of the ship; it being only in that event that the underwriter is responsible for damage to such goods. A constructive loss of freight occurs when the ship is prevented by any peril insured against from completing her voyage, or when the goods on which the freight is to be earned have received such damage that they cannot be conveyed to their destination; but if the ship can proceed with other goods, the freight earned for these must be deducted from the claim for loss.

Particular average on the ship.

Partial loss or damage, arising from the perils insured against, is usually, though somewhat loosely, designated by the term "particular average." Under this head are included the damages suffered from the accidental or voluntary stranding of the ship, or by her getting into collision with another vessel, by lightning, fire, hostile attacks, or the violence of the sea under any extraordinary circumstances. Damages to the ship's upper works, sails, spars, and rigging, are included under particular average, if occasioned by the direct force of the sea; but if caused merely by the force of the wind they are treated as wear and tear, and are not chargeable to the insurers. The loss of anchors and cables parted from by the vessel riding hard, or by the anchor hooking to any object at the bottom, is regarded as wear and tear; and the same rule applies to the repairs of the ship consequent on her becoming leaky through working and straining in a heavy sea. The general principle upon which damages of the nature of particular average are distinguished from those falling under the class of wear and tear, is that the former must be caused by the immediate operation of some extraordinary accident, while the latter are only the ordinary incidents of navigation, and as such are not within the scope of the underwriter's contract. But the practical application of this principle is a matter of much nicety, and must usually be left to the judgment of a professional average stater.

In adjusting claims for particular average on ships, certain deductions are made for the difference between "new and old," unless the ship be on her first voyage, either outward or homeward, or the repairs be only temporary. On this footing one-third is deducted from the costs of the materials and labour required for the ship's repairs, excluding, however, the charges for dock dues, surveyor's fees, or similar accessories, which are allowed in full. No deduction is made for anchors (unless in so far as they may be fitted with wood), and the deduction for chain cables is only one-sixth. When a ship has to be recoppered at the expense of the underwriters, the practice is to allow in full the difference of price between old and new metal, to the extent of the weight of the old copper stript off; and if any sheets have been lost by being rubbed off, the cost of replacing these is further allowed, under deduction of one-third. If the ship has not been stranded, the underwriters are not liable for claims for particular average, amounting to less than three per cent on her insured value, independently of the accessory expenses, such as survey fees, &c., which are not taken into account in making up the three per cent. Two or more averages occurring in the course of a voyage, may, however, be taken together to make up three per cent on the value of the ship, so as to render the insurers liable.

Particular average on goods.

Particular average on goods occurs when they arrive at their port of destination damaged by sea water, or by its effects in heating or otherwise deteriorating them, although in actual contact only with other portions of the cargo. The amount of compensation recoverable from the insurers for such damage is regulated by comparing the *gross* market price which the goods would have produced, if landed in sound condition, with the actual gross price obtained for them in their damaged state, and by charging to the insurers the same rate of deterioration on the value insured, with the addition of the extra charges specially occasioned by the damage, such as surveys, &c. By this mode of adjustment the assured recovers either more or less than the actual depreciation of the goods, according as the insured value may exceed or fall below the sound market value at the port of destination; but as the latter value generally includes freights, duties, and other charges, besides profits, it is in most cases in excess of the insured value, and to the extent of such excess the indemnity of the assured is incomplete. The equity, however, of this mode of adjustment is obvious, when it is considered that the insurer receives his premium only on the value insured, and ought therefore to be liable only in respect of that value, while at the same time the *gross* market values of the goods in their sound and damaged condition furnish the only true criterion of the actual depreciation, because these are the only values with reference to which, ultimately at least, purchasers could be influenced. As already indicated, claims for particular average on goods must amount to three per cent or upwards, or in the case of the goods specified in the second clause of the memorandum, to five per cent or upwards, otherwise the underwriters will not be liable unless the ship has been stranded; and it is only when there has been a stranding of the ship that the insurers are liable for any such claims on the goods specified in the first clause of the memorandum, or on other goods specially warranted "free of particular average."

The subject of general average has been treated in a separate article, under the head of "Average," to which the reader is referred for information respecting this class of claims on insurers. On the general subject of marine insurance, the best book of reference is Arnould's Treatise, which embodies everything of essential importance in the earlier works of Marshall and Park, besides embracing the leading cases decided in the law courts up to a comparatively recent period. Amongst the minor works bearing on the subject, Steven's Essay on Average, Benecke on the Principles of Indemnity in Marine Insurance, and Baily on General Average, deserve special mention. (J. W—K.)

Integral Interest.

INTEGRAL, or INTEGRANT, in *Philosophy*, appellations given to parts of bodies which are of a similar nature with the whole. Thus filings of iron have the same nature and properties as bars of iron. The parts as making up a whole are called *integrant*; the whole as made up of its various parts is called *integrate*.

INTERAMNA, now TERNI, in *Ancient Geography*, a celebrated city of Umbria, standing on a small island in the River Nar, now the Nera, about three miles below the celebrated cascade of the Velinus. It is said to have been founded 80 years before Rome itself, and, from its position in one of the most fertile districts of Italy, early attained great wealth and prosperity. So fertile was its territory that, according to Pliny, the meadows near the town bore four crops of hay a-year. His testimony is borne out by the historian Tacitus, who is generally, though on doubtful grounds, described as a native of the place. Its importance did not diminish when it passed under the Roman yoke; and, though it suffered severely in the civil wars of Marius and Sulla, the latter of whom confiscated its territory and portioned it out among his veterans, it easily recovered its losses, and became as important as ever. Though it stood a few miles from the main trunk of the Via Flaminia, yet a branch of that highway passed through it, which, under the empire, became the principal thoroughfare. In the political history of Rome the name of Interamna is seldom met with. In the civil wars of the first century after Christ it was taken by Arrius Varus, the general of Vespasian, from the garrison that held it for Vitellius. In A.D. 253 the emperors Trebonianus Gallus and his son Volusianus, when hastening to crush the rebel Æmilian in Mœsia, were put to death by their own soldiers in this town.

Interamna was at an early age made an episcopal see. This distinction it continued to retain through the middle ages till the present day. Under the name of Terni it continues to thrive; and is interesting from the number and value of its antiquities. Its present population is about 10,000.

INTERCALARY, an appellation given to the odd day inserted in leap-year; which was so called from *calo, calare*, to proclaim, it being proclaimed with a loud voice by the priests. See CHRONOLOGY.

INTERDICT, an ecclesiastical censure often inflicted by the Church of Rome, and involving the suspension, total or partial, of the ordinances of religion. It might be inflicted on a city or province, or even upon a whole kingdom. Amongst the earliest instances of it are cases which occur in the sixth century. Prætextatus, archbishop of Rouen, had been murdered by Queen Fredegunde, in consequence of which the churches of the city were shut up, and both Dupin and Fleury consider the penalty thus incurred to have been properly an interdict. In 997 this punishment was inflicted by Gregory V. upon the whole of France, on account of the marriage of King Robert with his cousin. A procedure of this kind in those days was no idle parade of words, for we find that Robert himself was excommunicated and abandoned by almost the whole of his own court. In 1147 King Stephen of England was placed under interdict; but more famous is the case of John, who was visited with this ecclesiastical censure in 1208 by Innocent III. The papal legates came before the English king in a very suppliant manner, but the moment the fiery monarch heard of an *interdict*, he flew into a rage, exclaimed furiously against the pope and his cardinals, threatened to send off all the bishops to Rome, and to pluck out the eyes and cut off the noses of any Romans that he should find in his dominions. Notwithstanding this violence the censure was pronounced, and, in consequence, every religious ordinance ceased except confession, absolution, and baptism. The dead being denied the rites of sepulture, were cast into pits and holes like dogs. On the other hand, King John retaliated by allowing the adherents of the pope to be subjected to outrage both in person and property.

Interdiction Interest.

The effect of these interdicts was found to be bad. The suspension of the rite of marriage, for example, necessarily tended to demoralize the people. After the Reformation, political considerations of a more cogent kind, compelled the pope to resort less frequently to these modes of punishment.

INTERDICTION, a term used in the law of England; for example, a party in a suit in Chancery, to stay some waste or to stop proceedings in law, may pray for an injunction, in the nature of an *interdictum* by the civil law, commanding the defendant to cease. In Scotland, where a prosecutor sues to prevent his adversary doing something alleged to be illegal he asks for *interdict*; and if it is required, pending the suit, it is called *interim interdict*. This remedy may be granted against all alleged encroachments of almost every kind. If a neighbour be removing a mutual fence or boundary, or if any person attempts to sell property under a title alleged to be bad, or to carry off effects sequestrated or hypothecated for behoof of another, he may not only be sued for permanent interdict against doing so, but for interim interdict pending the suit. In all legal discussions regarding property the party in possession is generally entitled to have interim interdict till the question of right be decided; and it is thus quite common for a party to obtain an interim interdict who is ultimately denied a permanent one. The rule for granting the interim interdict seems to be, that provided the party applying for it sets forth both a title and an interest to obtain it, it should be given, wherever, assuming his representations to be well-founded, he would be injured if it were withheld. It is then granted at his peril, so that he is liable in damages to his opponent if he fail in the end to prove that he was in the right. When the propriety of granting interim interdict is in some degree doubtful, it is frequently granted on caution for damages to the opposite party, if it turn out to have been applied for wrongfully.

INTEREST.

Definition.

INTEREST is the annual sum or rate per cent. which the borrower of a capital agrees, or is bound, to pay to the lender for its use.[1]

Interest depends, *cæteris paribus*, on the rate of profit.

It was generally supposed, previously to the middle of last century, that, in the event of all legislative enactments regulating the rate of interest being repealed, its increase or diminution would wholly depend on the comparative scarcity or abundance of money; or, in other words, that it would rise as money became scarce, and fall as it became more plentiful. But this opinion has been successfully controverted.[2] And it has been shown that the rate of interest, in advanced communities, is not determined by the

[1] "Interêt; loyer d'un *capital* preté; ou bien, en termes plus exacts, achat des services productifs que peut rendre un capital" (*Say*, tom. ii., p. 480, ed. 4me.)

[2] First by Mr Joseph Massie in a tract published in 1750, entitled *An Essay on the Governing Causes of the Rate of Interest*; and, second, and with better effect, in Hume's *Essay on Interest*, in 1752.

Interest. abundance of the currency, but by the average rate of profit derived from the employment of capital. No doubt it most frequently happens that loans are made in currency; but this is of no consequence. There is obviously no substantial difference between A furnishing B with 100 bushels of corn, or 100 yards of cloth, to be repaid at the expiration of a specified period by the delivery of 104 or 105 bushels, or 104 or 105 yards, or with as much money, at 4 or 5 per cent., as would purchase the corn or cloth. And it is easy to perceive that, as crowds of passengers may be successively conveyed by the same carriage, so the same sum of money may serve to negotiate an infinity of loans. Suppose A lends to X, L.1000, with which the latter buys from B an equivalent amount of commodities; that B, having no use for the money, lends it to Y, who pays it away for produce to C, who again lends it to Z, and so on. It is plain that X, Y, Z have received loans of commodities or produce from A, B, C worth *three* times (and they might have been worth thirty or three hundred times) as much as the money employed in settling the transactions. According as the supply of currency, compared with the business it has to perform, is greater or less, we give a greater or less number of guineas or livres, notes or assignats, for the articles we wish to obtain. It is not, however, by the fact of the price of such articles being high or low, out by the advantage or profit which the borrowers expect to derive from their possession, that the interest or compensation to be paid to the lenders for their use is determined. It may perhaps be supposed in the case of goldsmiths and jewellers, that when the quantity of metallic money is increased, they will obtain the raw material of their business with greater facility. But this is not always the case; and, though it were, it would not, in any degree, affect the rate of interest. No coins are ever sent to the melting pot unless the currency be degraded or depreciated; that is, unless it be deficient in weight, or relatively redundant in quantity. And it is plain that the inducement to offer a high or a low rate of interest for loans of money, which it is intended to work up into plate or other articles, will not depend on the supply of such money, but on the profit to be derived from its conversion into goods, a circumstance wholly unconnected with the scarcity or abundance of coin.

It, therefore, appears that, speaking generally, the rate of interest depends on the profit that may be made by employing capital in industrious undertakings, and not on the prices paid for the articles of which it consists. The latter are affected by every change in the value of money, whereas the former is little if at all affected by these changes, and is determined by the productiveness of industry. A low or a high rate of profit is uniformly accompanied by a low or a high rate of interest. Money, as every one knows, is cheaper in the United States and in Australia, than in England; but the ordinary rate of profit being higher there than here, interest, despite the lower value of money, is also higher. Extraordinary as it may seem, it is nevertheless true, that, during the half dozen years ending with 1856, the current rate of interest in San Francisco, where bullion is so very abundant as to be almost a drug, has varied from 1½ to 2 and 3 per cent. a month, or from 18 to 24 and 36 per cent. per annum. And though it were allowed that from a third to a half of this rate should be viewed as a premium to compensate the insecurity prevalent in California, still the residue would amount to three, four, or five times the ordinary rate of interest in England. In farther corroboration of these statements, we may mention that the low rate of interest in Holland during the greater part of the 17th, and the whole of the 18th century, was not owing to any peculiar abundance or cheapness of money, but to the high rate of taxation and the difficulty of investing capital with a profit. And to this latter circumstance we owe the low rate of interest in this country towards the middle of last century and at several late periods. It is not, in short, by the amount or value of the currencies of different countries; but by the means which they respectively enjoy for the profitable employment of capital or stock, that their profits and interest are governed. Interest.

That a rise or fall in the value of money can have no direct influence over interest, is plain from the fact of the interest being itself paid in the money that has risen or fallen. But, at the same time, a sudden increase in the supply of money, may undoubtedly have a temporary effect in depressing interest. Importers of bullion may not be able to lay it out advantageously in purchases, and may, in consequence, be disposed to have it coined and lent, though at a low rate. We incline, however, to think that the influence of considerations of this sort is but inconsiderable. Lenders will not take less for loans than the borrowers are willing to offer, and the offers of the latter must be determined not merely by the amount of money seeking investments, but partly also, and in a still greater degree, by the profit that may be made by its employment. When there is a rapid influx of money, loans for short periods are usually obtainable at low rates. This, however, is not generally the case with loans for lengthened periods. The lenders are willing to accept a reduced interest for a short term, till they can look about for some more profitable means of investment. But the interest on loans on mortgage, or for lengthened periods, is always proportioned to the rate of profit at the time; and, supposing the security to be unexceptionable, is but little affected by anything else.

The profits made in industrious undertakings are, for the most part, distributed into *gross* and *nett* profits. Thus, if from the total returns, whether annual or otherwise, obtained in any business or employment, we deduct all sorts of outlays necessarily incurred in carrying it on, including the wages or remuneration due to the undertakers for their skill and trouble in superintending the business and a sum to compensate the risks provided against by insurance, the residue is the *nett* profit of, or return to, the capital employed. And it is on this latter portion that interest depends, or rather with which it is usually identical. Lenders having nothing to do with the employment of capital, are not entitled to any peculiar advantage that may arise from it. But they are entitled to all that can fairly be considered as the return to the capital they have lent, after the risks, salaries, and necessary emoluments of those who undertake its employment, are deducted; and this much, speaking generally, they will get, and no more. Whatever else may be realized by the employment of capital in industrial pursuits, belongs to the borrowers, and forms the fund out of which they are remunerated. In coming to this conclusion, we are supported by the authority of Mr Tooke. "The rate of interest," says he, "is the measure of the nett profit on capital. All returns beyond this on the employment of capital, are resolvable into compensations, under distinct heads, for risk, trouble, or skill, or for advantages of situation or connection."[1]

Whatever, therefore, may at any time occasion a sudden glut of money or capital, may lower the rate of nett profit and interest. But that very circumstance, by increasing the demand for capital, will eventually raise the rate to its proper level; and the glut having disappeared, profits and interest will depend on the productiveness of industry.

Besides such variations as are proportioned to variations in the ordinary rate of profit, and which equally affect all

[1] *Considerations on the State of the Currency*, 2d edit., p. 12.

Influence of the increase or diminution of security, &c., on interest.

loans, the rate of interest varies according to the security for the repayment of the principal, and the duration of the loan. Hence the powerful influence which the character of the borrower, the purpose for which he borrows, and the nature of the business in which he is engaged, have over interest. Careful, skilful, and intelligent parties always borrow, *cæteris paribus*, on lower terms than those of an opposite description. The spendthrift, the idle, and the unskilful, can with difficulty obtain loans on any terms; and those who deal with them and stipulate for a high rate of interest to cover their risk, frequently find that their guarantee is inadequate, and that they would have better consulted their own advantage by lending to respectable parties on the usual terms. The nature of the employment in which borrowers are engaged has also, as now stated, a powerful effect in determining the rate of interest. Wherever there is risk, it must be compensated. A sum lent on mortgage over a valuable estate is not exposed to any risk. But a sum lent to a manufacturer or merchant engaged in a hazardous business, is exposed to a high degree of risk; and the interest payable on the latter, inasmuch as it must include a premium to compensate this extra risk, may be twice or three times as much as that paid on the mortgage.

We should mistake, however, if we supposed that this circumstance places those who carry on peculiarly hazardous businesses in a comparatively disadvantageous situation. Competition will not permit, taking everything into account, a greater or a less amount of nett profit to be permanently obtained in one branch of industry than in another. The produce realized by those who engage in employments of more than ordinary hazard is generally sold at prices that yield the ordinary rate of profit, with a surplus sufficient to guarantee their stock against the extra risk to which it is exposed. Were it otherwise, everybody would decline placing their property in a state of comparative danger, and undertakings of a hazardous nature would not be entered into. But it very frequently happens, that the manager of a hazardous branch of industry, paying from 10 to 12 per cent. for loans, realizes larger nett profits than the purchaser of an estate with money borrowed at 3 or 4 per cent.

Supposing the security to be equal, capital lent for a fixed and considerable period always fetches a higher rate of interest than that which is lent for short periods, or which may be demanded at the pleasure of the lender. There are but few modes of safely employing loans of which the duration is so uncertain, so that they are frequently worth very little; and hence the rate of interest is, in the majority of cases, in part at least, determined by the length of the loan; for, when that is considerable, it may be productively employed in a variety of businesses, in which it would not otherwise be prudent to invest it, at the same time that the borrower has time to prepare for its repayment. But this principle has only a slight influence over loans for terms beyond three, or at most five, years; for a loan for either of these terms, but especially the latter, may be employed in a great variety of ways, and would bring nearly as much interest as it would do were it for ten or twelve years. It is farther to be observed, that large classes of borrowers prefer the less interest which they get for advances at short dates to the higher rate which they might get were they for longer terms. Most people wish to have the full command of their capital. Merchants and manufacturers who lent on mortgage would in so far deprive themselves of the means of extending their business, and of speculating. And though sometimes, perhaps, this might be for their advantage, yet the flattering opinion which most people entertain of their own sagacity and good fortune, would but seldom permit them to doubt that it was a very serious disadvantage. Hence the low rates at which banking companies who pay the sums deposited with them on demand,[1] and governments overwhelmed with debt, are able to borrow. A stockholder's mortgage, or claim on the revenue of a country, may be immediately converted into cash at the current prices. And, however much the majority of the creditors of a deeply indebted country may be impressed with a conviction of its inability to discharge the various claims upon it, each individual, confident in his own good fortune and foresight, flatters himself that *he*, at all events, will foresee the coming tempest, and be able to sell out before a public bankruptcy.

It is evident, from these statements, that in addition to the security for loans and their duration, the rate of interest will, to a considerable extent, depend on the facilities afforded for enforcing or carrying out the stipulations in contracts. And hence a main cause of its reduction as society is more and more improved. Generally, it may be said that a speedy, cheap, and effectual process for securing the payment of debts, has a powerful tendency to lower—and a slow, costly, and ineffectual process, to raise—the rate of interest. In most countries, extraordinary means are taken to compel payment of bills; and this is a principal cause of the low rate at which they are commonly discounted. The easy enforcement of contracts constitutes, in truth, an important portion of the security for a debt. By a good security, is not meant a guarantee that a loan will ultimately be made good, but that it will be punctually paid when due; or, if the loan be of a kind that a little delay in its payment is usually given, that that delay will not be exceeded, and that it will be paid within the customary term. A security which should insure the final payment of a debt, but which should not insure its payment when due, or shortly thereafter, is not a good, but a bad security. It is indispensable to the transacting of business safely, cheaply, and expeditiously, that there should be as little doubt as possible either in regard to the payment of loans or the term when they are to be paid. If either of these points be doubtful, the lender will insist on an indemnity for the consequent risk. And it therefore appears that the summary proceedings taken to enforce payment of bills, and such like debts, are in truth and reality more for the advantage of the borrowers than of the lenders. They reduce the rate of interest; and the hardship, such as it is, which they occasionally inflict on the borrower, does not occur in one case out of five hundred; while their powerful influence in depressing interest tells in every case.[2]

In Greece the rate of interest was not regulated by law; and it consequently varied with all the causes of variation above alluded to. Generally, however, it was what we should reckon very high, amounting, in most cases, to from 10 to 18 per cent., and upwards. This high rate of interest was not occasioned by a high rate of profit, but by the uncertainty of the laws, and the facilities which they afforded to fraudulent debtors to defeat the just claims of their creditors. The interest on money lent on *bottomry*, or on the security of the ship or cargo, or both, was rated at so much per voyage. It therefore depended on the place to which the ship was to sail, the season of the year, the chance of meeting pirates or enemies' ships, etc. Usually it was ex-

[1] This, however, is not a common practice; most companies stipulating that notice of the withdrawal of deposits shall be given some eight or ten days previously.

[2] It is not, of course, any part of our business to inquire into the methods most proper to be taken to enforce payment of debts. But, how paradoxical soever it may appear, we believe it would not be difficult to show that the putting of most descriptions of small debts, or of debts under L.30 or L.40, out of the pale of the law, would be advantageous. It would tend to prevent the abuse of credit by the lower classes, to whom it is extremely pernicious, and to make habits of economy and punctuality more valuable than at present.

Interest.

tremely great, varying from 30 to 50 or 60 per cent. The bankers and money lenders of Athens, though of low origin, being mostly freedmen or aliens, appear to have been considered as eminently trustworthy, and entitled to the public confidence. But they were, notwithstanding, quite as unpopular, and for no better reasons, as the Jews and Lombards of the Middle Ages. We are surprised that so learned a writer as Boeckh should have been so imbued with the vulgar prejudice against them as to state that they drew upon themselves the "merited hatred of all classes." He should have known that it has not been the covetousness of bankers, but that bad laws administered by interested judges, by making loans insecure, and driving parties of the highest respectability from the banking business, have been alone to blame for the exorbitant usury of ancient as well as of modern times. Had contracts been properly enforced, the probability is that interest would have been as low in Greece as in England.[1]

Attempts to limit the rate of interest have raised it.

Instead, however, of leaving the rate of interest to be adjusted by the free competition of the parties, on the principles thus briefly explained, or endeavouring to reduce it by facilitating the enforcement of contracts, most governments have interfered, either entirely to prohibit the taking of interest, or to fix certain rates which might be legally exacted, while any excess over them was declared to be *usury*, and prohibited under the severest penalties. In the ages in which these enactments had their origin, the precious metals were the only species of money, and were considered quite peculiar. Being used in a double capacity—as standards by which to ascertain the values of different articles, and as the equivalents for which they were most frequently exchanged—they acquired a factitious importance in the estimation, not merely of the vulgar, but of persons of the greatest discernment. The fact, that to buy and to sell is merely to barter one commodity for another, to exchange a quantity of corn, or cloth, or beef, for a quantity of gold or silver, and *vice versa*, was entirely overlooked. The attention was gradually transferred from the money's worth to the money itself. And the wealth of states and of individuals was not measured by the amount of their disposable produce, or by the quantity or value of the articles with which they could afford to purchase the precious metals, but by the quantity or value of these metals actually in their possession. For these and other reasons, money has been considered as a *merchandise par excellence*. And we need not, therefore, be surprised at the measures to which the prevalence of such exaggerated opinions almost necessarily led; or that vigorous efforts should have been made to protect those who were unprovided with so powerful an instrument from becoming a prey to their more fortunate neighbours. Individuals might freely dispose of their corn, cattle, land, etc. But it was supposed that the demand for money might be so great, as to enable the lenders, unless restrained in their exactions, to ruin the borrowers, and engross the whole property of the country.

Another cause of the prejudice against stipulating for interest grew out of the dislike entertained to accumulation. It is a consequence of economy, or of a saving of income; and this, in rude ages, is considered indicative of a sordid disposition, and as being positively hurtful. Prodigals and spendthrifts were long, and perhaps still continue to be, the favourites of the public. Before the nature and functions of capital were properly understood, it was believed that it could not be increased without injury to individuals, and that whatever advantage it might give to one party must occasion an equal disadvantage to others. Our ancestors did not know that those who, by their economy, accumulate stock, add to their own wealth, without diminishing that of any one else; nor did they know that, when expended, as is almost always the case, in the support of productive industry, this stock affords the means of producing an increased income. But reckoning, as they did, that the savings of individuals were so much withdrawn from income in which the public would otherwise have participated, it was natural enough that they should endeavour to limit the advantage derivable from their employment.

Interest.

Much, also, of the prejudice against bargaining for interest, prevalent in the middle ages, may be traced to the authority of certain texts of Scripture, which were understood to prohibit its exaction. It is, doubtful, however, whether they will really bear that interpretation. And supposing that they did, nothing could be more irrational than to regard the municipal regulations of a people placed in such peculiar circumstances as the Jews, as general and fixed principles, applicable in all ages and countries.[2]

But, whatever may have led to the efforts so generally made to limit or suppress interest, it is abundantly certain that, instead of succeeding in their object, they had an opposite effect. If a borrower consider it for his advantage to offer 6, 7, or 8 per cent. for a loan (and otherwise he would not make the offer), why should the legislature prohibit him from offering, and the lender from receiving, more than 3, 4, or 5 per cent.? An interference of this sort, besides being uncalled for and unnecessary, is in a high degree prejudicial. Restrictive laws, instead of reducing, uniformly raise the rate of interest. They cannot be so framed as to prevent borrowers from engaging underhand, to pay a higher rate of interest than is fixed by statute. And if the lenders had implicit confidence in the secresy and solvency of the borrowers, they might accommodate them with the sums wanted, without requiring any additional interest, because of the illegality of the transaction. But cases of this sort are extremely rare. Gratitude, and a sense of benefits received, are but slender securities for honourable conduct. Numberless unforeseen events occur to weaken and dissolve the best cemented friendships; and a transaction of this kind would afford an additional source of jealousies and divisions. In such matters, indeed, men are more than usually sharp-sighted, and are little disposed to trust to moral guarantees for the security of their property. But though neither the threatenings of the law, nor the inducements which it held out to dishonest debtors to recede from the stipulations into which they had entered, were able to prevent, or even greatly to lessen, what are termed *usurious* bargains, they rendered them more oppressive. They obliged the lenders to demand, and the bor-

[1] Boeckh's *Public Economy of Athens*, vol. i., pp. 164–191.

[2] Michaelis *On the Laws of Moses*, vol. ii., 336. English translation. It is a remarkable fact that the famous reformer Calvin was one of the first to emancipate himself from the prejudices formerly so prevalent, especially among religious people, against taking interest. He comments as follows on the statement of Aristotle, that as money did not produce money, no return could be equitably claimed by the lender:—"Pecunia non parit pecuniam. Quid mare? quid domus, ex cujus locatione pensionem percipio? An ex tectis et parietibus argentum propriè nascitur? Sed et terra producit, et mari advehitur quod pecuniam deindè producat, et habitationis commoditas cum certâ pecuniâ parari commutarive solet. Quod si igitur plus ex negotiatione lucri percipi possit, quam ex fundi cujusvis proventu: an feretur qui fundem sterilem fortassè colono locaverit ex quo mercedem vel proventum recipiat sibi, qui ex pecuniâ fructum aliquem perceperit, non feretur? et qui pecunia fundum acquirit, annon pecunia illa generat alteram annuam pecuniam? Unde vero mercatores lucrum? Ex ipsius, inquies, diligentiâ atque industriâ. Quis dubitet pecuniam vacuam inutilem omnino esse? neque qui à me mutuam rogat, vacuam apud se habere à me acceptam cogitat. Non erga ex pecuniâ illâ lucrum accedit, sed ex proventu. Illæ igitur rationes subtiles quidem sunt, et speciem quandam habent, sed ubi propius expenduntur, seipsa concidunt. Nunc igitur concludo judicandum de usuris esse, non ex particulari aliquo Scripturæ loco, sed tantum ex æquitatis regulâ." (Quoted by Dugald Stewart in his Notes to his *Preliminary Dissertation* to the *Encyclopædia Britannica*.)

Interest. rowers to undertake to pay a rate of interest sufficient to yield the current rate of nett profit at the time, with a further sum to balance the risk of entering into what the law made an illegal transaction. This latter sum being, of course, proportioned to the greater or less magnitude of the risk to be provided against, it increased or diminished according as the laws for the prevention of usury were enforced or relaxed.

Whenever, under the old system, the market rate of interest rose above the statutory rate, the free transfer of capital was obstructed. Parties could no longer look merely to their own advantage. And loans which might have been obtained for 6, 7, or 8 per cent., had there been no hazard from anti-usurious statutes, were raised, on its account, to 8, 10, and 12 per cent. It is, therefore, plain that if the means taken to put down usury were not wholly responsible for its existence, they, at all events, added largely to its amount.

These conclusions do not rest on theory only, but are supported by a wide and uniform experience. In Rome, during the republic, the ordinary rate of interest was excessively high. The debtors, or plebeians, were every now and then threatening to deprive their creditors, who were generally of the patrician order, not only of the interest, but of the principal itself. Repeated instances occurred to show that these were not mere empty threats; and the patricians indemnified themselves, by a corresponding premium, for the dangers to which they were exposed. "Des continuels changements," says Montesquieu, "soit par des loix, soit par des plebiscites, naturaliserent à Rome l'usure; car les créanciers, voyant le peuple leur débiteur, leur legislateur, et leur juge, n'eurent plus de confiance dans les contrats. Le peuple, comme un débiteur decrédité, ne tentoit à lui prêter que par des gros profits; d'autant plus que, si les loix ne venoient que de temps en temps, les plaintes du peuple êtoient continuelles, et intimidoient toujours les créanciers. Cela fit que tous les moyens honnêtes de prêter et d'emprunter furent abolis à Rome, et qu'une usure affreuse toujours foudroyée, et toujours renaissante, s'y établit. Le mal venoient de ce que les choses n'avoient pas été ménagés. Les loix extrêmes dans le bien font naitre le mal extréme: il fallut payer pour le prêt de l'argent, et pour le danger des peines de la loi." [1]

In Mohammedan countries, notwithstanding the prohibition in the Koran, the ordinary rate of interest is at least three or four times as great as its ordinary rate in Europe. "L'usure augmente dans les pays Mahometans à proportion de la sévérité de la defense: le prêteur s'indemnise du péril de la contravention." [2]

During the middle ages, when interest was excessively high, the rate of profit was probably little, if at all, higher than at present. But it should be observed that a very great majority of the loans of these ages were but little influenced by its amount. They were not made to be invested, but to be spent. The great barons and other landed proprietors were the principal borrowers. And in nineteen out of every twenty instances, the sums which they borrowed were expended in the maintenance of crowds of idle retainers, in warfare, or in prodigalities of some sort or other. And while the borrowers belonged generally to what we should now call the spendthrift class, and there were no efficient means of compelling them to abide by their engagements, the lenders were but few in number, and mostly Jews and Italians, the objects of the most unreasonable prejudices. Under such circumstances, it would be folly to suppose that the rate of interest should depend in any considerable degree on the rate of profit. The numbers, position, and character of the borrowers, compared with the fewness, position, and character of the lenders, and the risk to which the latter were exposed in entering into such transactions, occasioned the excessively high rate of interest. Of the 50 and even 100 per cent. which borrowers then frequently engaged to pay as interest, not more than 10 or 12 per cent. can properly be said to have been given for the productive services of loans. The rest must be considered as occasioned partly by the extreme scarcity of disposable capital and the carelessness of the borrowers, and partly, and principally, as a *bonus* to compensate the lenders for the imminent hazard of losing the principal. Interest.

In England, as in most other countries, Christians were, after the Conquest, absolutely prohibited, both by the civil and the ecclesiastical law, from bargaining for interest. But as Jews, according to the Mosaic law,[3] were allowed to lend at interest to a stranger, its exaction by them was first connived at, and subsequently authorized by law. And the same privilege was afterwards extended to the Italian or Lombard merchants. In consequence of this exemption, many Jews early settled in England, and engrossed a large share of the trade of the kingdom. But despite their industry and general good conduct, the prejudices against them, and against the business in which they were mostly engaged, were so very strong that they and their families were regarded as slaves of the crown, by whom they were plundered, to an extent and under pretences which would now appear incredible. To such an extreme, indeed, were these oppressive practices carried, that a particular office, called the *exchequer of the Jews*, was established, for receiving the sums extorted from them in fines, customs, tallages, forfeitures, &c. They were, in consequence, obliged to charge an enormous rate of interest, or, as Madox expresses it, "to fleece the subjects of the realm as the king fleeced them." [4] And hence, while only from 7 to 10 and 12 per cent. interest was paid in countries where sounder principles prevailed, the rate charged in England was three, four, and even five times as great.[5]

But in the end the disorders occasioned by this ruinous system became so obvious, that, notwithstanding the deeply-rooted prejudices to the contrary, a statute was passed in 1546 (37 Hen. VIII., cap. 7), legalizing interest to the extent of 10 per cent. per annum; because, as is recited in the words of the act, the statutes "prohibiting interest altogether have so little force, that little or no punishment hath ensued to the offenders." In the reign of Edward VI., the horror against interest seems to have revived in full force; for, in 1552, the taking of any was again prohibited, "as a vice most odious and detestable," and "contrary to the word of God." But, in spite of this denunciation, the rate of interest, instead of being reduced, immediately rose to 14 per cent., and continued at this rate until, in 1571, an act was passed (13th Eliz., cap. 8) repealing the act of Edward VI., and reviving the act of Henry VIII., allowing 10 per cent. interest. In the preamble to this act it is stated, "That the prohibiting act of King Edward VI. had not done so much good as was hoped for; but that

[1] *Esprit des Loix*, liv. xxii., c. 21.
[2] Ibid., liv. xxi., c. 19.
[3] Deuteronomy, cap. xxiii., v. 20.
[4] Madox's *History of the Exchequer*, vol. i., pp. 221-261, 4to, 1769.
[5] At Verona, in 1228, the interest of money was fixed by law at 12½ per cent. Towards the end of the fourteenth century, the republic of Genoa paid only from 7 to 10 per cent. to her creditors; and the average discount on good bills at Barcelona, in 1435, is stated to have been about 10 per cent. But whilst interest in Italy and Catalonia, where a considerable degree of freedom was allowed to the parties bargaining for a loan, was thus comparatively moderate, it was, despite its total prohibition, incomparably higher in France and England. Matthew Paris mentions that, in the reign of Henry III., the debtor paid 10 per cent. every two months. And this, though impossible as a general practice, may not have been very far from the average interest charged on the few loans that were then contracted for (Hallam's *Middle Ages*, vol. iii., p. 402.)

Interest. rather the vice of usury hath much more exceedingly abounded, to the utter undoing of many gentlemen, merchants, occupiers, and others, and to the importable hurt of the commonwealth." This salutary statute was opposed, even by those who should have known better, with all the violence of superstitious fanaticism. Dr John Wilson, a man famous in his day, and celebrated for the extent of his learning, informed the House of Commons, of which he was a member, that "it was not the amount of the interest taken that constituted the crime; but that all lending for any gain, be it ever so little, was wickedness before God and man, and a damnable deed in itself, and that there was no mean in this vice any more than in murder or theft." To quiet the consciences of the bishops, a clause was inserted, declaring usury to be forbidden by the law of God, and to be in its nature sin, and detestable. This statute was limited to a period of five years; but, "forasmuch as it was, by proof and experience, found to be very necessary and profitable for the commonwealth of this realm," it was, in the same reign, made perpetual (39th Eliz., cap. 18).

In the 21st of James I., the legal rate of interest was reduced to 8 per cent., by an act to continue for seven years only, but which was made perpetual in the succeeding reign (3d Car. I., cap. 4). During the commonwealth, the legal rate of interest was reduced to 6 per cent., a reduction which was afterwards confirmed by the 12th Car. II. And, finally, in the reign of Queen Anne, a statute (12th Anne, cap. 16) was framed, reducing the rate of interest to 5 per cent., at which it stood till 1839.

In the preamble to this statute, it is stated that, "whereas the reducing interest to 10, and from thence to 8, and thence to 6, in the hundred, hath from time to time, by experience, been found very beneficial to the advancement of trade and the improvement of lands, it is become absolutely necessary to reduce the high rate of interest of 6 per cent. to a nearer proportion to the interest allowed for money in foreign states." It was for these reasons enacted, that all bargains or contracts stipulating for a higher rate of interest than 5 per cent. should be utterly void. And "that all persons who should after that time receive, by means of any corrupt bargain, loan, exchange, chevizance, or interest, of any wares, merchandise, or other thing whatever, or by any deceitful way or means, or by any covin, engine, or deceitful conveyance for the forbearing or giving day of payment, for one whole year, for their money or other thing, above the sum of L.5 for L.100 for a year, should forfeit, for every such offence, the *treble* value of the moneys or other things so lent, bargained," &c.

In Scotland, previously to the Reformation, no interest could be legally charged. But that great event, by weakening the force of those religious prejudices, which had chiefly dictated the prohibition of interest, led to the adoption of more liberal opinions on the subject, and to the enactment of the statute of 1587 (11th Parl., Jac. VI., cap. 52), which legalized interest to the extent of 10 per cent.. In 1633 the legal rate was reduced to 8 per cent., and in 1661 to 6 per cent. The statute of Anne, reducing the rate of interest to 5 per cent., extended to both kingdoms.

The statutes prohibiting the taking of interest in Ireland were not repealed until 1635, when the statute 10th Car. I., cap. 22, gave liberty to stipulate for any rate not exceeding 10 per cent. In 1704 this rate was reduced to 8 per cent.; in 1722 it was reduced to 7 per cent.; and in 1732 in was further reduced to 6 per cent.

In France the rate of interest was fixed at 5 per cent. so early as 1665; and this, a few short intervals only excepted, continued to be the legal rate till the Revolution. Laverdy, in 1766, reduced it from 5 to 4 per cent. Instead, however, of the market rate being proportionally reduced, it was raised from 5 to 6 per cent. Previously to the promulgation of the edict, loans might have been obtained on good security at 5 per cent.; but an additional per cent. was afterwards required to cover the illegality. This caused the speedy abandonment of the measure.[1] Interest.

The same thing happened in Livonia in 1786, when the Empress Catherine reduced interest from 6 to 5 per cent. Hitherto, says Storch (*in loco citato*), those who had good security to offer were able to borrow at 6 per cent.; but henceforth they had to pay 7 per cent. or upwards. And such will be found to be invariably the case, when the legal is less than the market rate of interest.

It has been observed by Adam Smith, that the statutory regulations, reducing interest in England, were made with great propriety. Instead of preceding, they followed the fall which was gradually taking place in the market rate of interest, and, therefore, did not contribute, as they would otherwise have done, to raise that which they were intended to reduce. Sir Josiah Child, whose treatise, recommending a reduction of interest to 4 per cent., was originally published in 1668,[2] states, that the goldsmiths of London, who then acted as bankers, could obtain as much money as they pleased, upon their servants' notes only, at 4½ per cent. The supposed insecurity of the revolutionary establishment, and the novelty of the practice of funding, occasioned the payment of a high rate of interest for a large portion of the sums borrowed by the public in the reigns of William III. and Anne. But private persons, of undoubted credit, could then borrow at less than 5 per cent. During the reign of George II. the market rate of interest fluctuated from 3 to 4 and 4½ per cent.[3]

Smith mentions that the increased means of profitably investing capital acquired during the war, terminated by the peace of Paris in 1763, raised the market rate of interest to a level with the statutory rate, or perhaps higher. But it was not until the subsequent European war that any very material or general inconvenience was found to result from the limitation of interest to 5 per cent.

It is necessary, however, to observe, that this remark applies exclusively to loans negotiated by individuals who could offer unexceptionable security; for, since the act of 1714, persons engaged in employments of more than ordinary hazard, or whose character for prudence and punctuality did not stand high, or who could only offer inferior security, were unable to borrow at 5 per cent., and were consequently compelled to resort to a variety of schemes for defeating or evading the enactments in the statute. The most common device was the sale of an annuity. Thus, supposing an individual whose personal credit was indifferent, and who had only the liferent of an estate to give in security, wished to borrow, he sold an annuity to the lender sufficient to pay the interest stipulated for, which, because of the risks and odium attending such transactions, was always higher than the market rate, and also to pay the *premium* necessary to insure payment of the principal at the death of the borrower. It is curious to observe, that though the sale of an *irredeemable* life annuity, at a rate exceeding legal interest, was not reckoned fraudulent or usurious, yet, so late as 1743, Lord Hardwicke held that, in their less exceptionable form, or when they were *redeemable*, their sale could be looked upon in no other light than

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[1] Storch, *Traité d'Economie Politique*, tom. iii., p. 187.

[2] A second edition, very greatly enlarged, was published in 1690.

[3] On the 18th of December 1752, the three per cents. brought the highest price they have hitherto reached, namely, 106⅞ per cent. On the 20th of September 1797, the day on which the failure of Lord Malmesbury's attempt to negotiate with the French republic transpired, consols fell to 47¼, being the lowest price at which they have ever been sold.

Interest. as an evasion of the statute of usury, and a loan of money.[1] But the extreme inexpediency of this distinction soon became obvious, and the law was changed. The great extension of the traffic in annuities, and the advantage of giving as much publicity as possible to such transactions, led to various inquiries and regulations respecting them in the early part of the reign of George III. In consequence, the sale of irredeemable annuities became nearly unknown; and it was ruled, that the sale of a redeemable annuity could not be impeached, though it appeared on the face of the deeds that the lender had secured the principal by effecting an assurance of the borrower's life.

During the greater part of the French revolutionary war, the usury laws operated to the prejudice of all classes of borrowers. The great extent and high interest of the public loans, the facility of selling out of the funds, the regularity with which the dividends were paid, and the temptations to speculation arising from the fluctuations in the price of funded property, diverted so large a portion of the floating capital of the country into the coffers of the treasury, that it was next to impossible for private individuals to borrow at the legal rate of interest, except from the trustees of public companies, or through the influence of circumstances of a very peculiar nature. Hence, the proprietors of unencumbered freehold estates, of which they had the absolute disposal, were very generally obliged, when they had occasion for loans, to resort to those destructive expedients which had formerly been the resource only of spendthrifts and persons in desperate circumstances.

Committee of 1818 on usury laws. The evidence annexed to the "Report of the Committee of the House of Commons, in 1818, on the Usury Laws," sets their impolicy and pernicious influence in a clear light. Mr Sugden, now Lord St Leonards, stated, that when the market rate of interest was above the legal rate, the landed proprietor was compelled to resort to some shift to evade the usury laws. He had "known annuities granted for *three* lives, at 10 per cent., upon fee-simple estates, unencumbered, and of great annual value, in a register county. He had also known annuities granted for *four* lives; and more would have been added, but for the danger of equity setting aside the transaction on account of the inadequacy of the consideration. Latterly, many annuities were granted for a term of years certain, not depending upon lives." On being asked whether, were there no laws limiting the rate of interest, better terms could or could not have been obtained, he answered, "I am decidedly of opinion that better terms could have been obtained; for there is a stigma which attaches to men who lend money upon annuities, that drives all respectable men out of the market. Some leading men did latterly embark in such transactions, but I never knew a man of reputation in my own profession lend money in such a manner, although we have the best means of ascertaining the safest securities, and of obtaining the best terms."

"The laws against usury," said Mr Holland, of the house of Messrs Baring Brothers and Company, "drive men in distress, or in want of money, to much more disastrous modes of raising it than they would adopt if no usury laws existed. The man in trade, in want of money for an unexpected demand, or disappointed in his returns, must fulfil his engagements, or forfeit his credit. He might have borrowed money at 6 per cent., but the law allows no one to lend it to him; and he must sell some of the commodity he holds, at a reduced price, in order to meet his engagements. For example, he holds sugar which is worth 80s.; but he is compelled to sell it immediately for 70s. to the man who will give him cash for it, and thus actually borrows money at 12½ per cent., which, had the law allowed him, he might have borrowed from a money dealer at 6 per cent. It is known to every merchant that cases of this kind are common occurrences in every commercial town, and more especially in the metropolis. A man in distress for money pays more interest, owing to the usury laws, than he would if no such laws existed; because now he is obliged to go to some of the disreputable money lenders to borrow, as he knows the respectable money lender will not break the laws of his country. The disreputable money lender knows that he has the ordinary risk of his debtor to incur in lending his money, and he has further to encounter the penalty of the law, for both of which risks the borrower must pay. If no usury laws existed, in common cases, and where a person is respectable, he might obtain a loan from the respectable money lender, who would then only have to calculate his ordinary risk, and the compensation for the use of his money." Interest.

The committee admitted the force of this evidence by agreeing to the following resolutions:—"1st. That it is the opinion of this committee, that the laws regulating or restraining the rate of interest have been extensively evaded, and have failed of the effect of imposing a maximum on such rate; and that, of late years, from the constant excess of the market rate of interest above the rate limited by law, they have added to the expense incurred by borrowers on real security, and that such borrowers have been compelled to resort to the mode of granting annuities on lives; a mode which has been made a cover for obtaining a higher rate of interest than the rate limited by law, and has farther subjected the borrowers to enormous charges, or forced them to make very disadvantageous sales of their estates. 2d. That it is the opinion of this committee, that the construction of such laws, as applicable to the transactions of commerce as at present carried on, have been attended with much uncertainty as to the legality of many transactions of frequent occurrence, and consequently been productive of much embarrassment and litigation. 3d. That it is the opinion of this committee, that the present period, when the market rate of interest is below the legal rate, affords an opportunity peculiarly favourable for the repeal of the said laws."

Repeal of usury laws in 1839. In spite, however, of the recommendation of the committee, and the cogent evidence on which it was founded, the popular prejudice continued so strong, that it was not till 1839 that a statute was passed, the 2d and 3d Vict., cap. 37, which exempted all bills of exchange and promissory notes, not having more than twelve months to run, and all contracts for sums above L.10, from the operation of the usury laws.

It was supposed, or at all events argued, that the repeal of the usury laws would tempt such individuals as had money to lend, to indulge in those mean and discreditable practices which characterize the lowest class of money dealers. But it was more reasonably contended, that in the event of the rate of interest being left to be adjusted by the free competition of the parties, there would be little employment for inferior dealers. Except when the *market* rate of interest was below the *legal* rate, the usury laws prevented all persons, whose credit was not extremely good, from obtaining loans from capitalists of the highest character, and forced them to have recourse to those who were less scrupulous. Supposing the market rate of interest to be 6 or 7 per cent., an individual in ordinarily good credit may, now that the usury laws are abolished, easily obtain a loan at that rate. But when the law declared that no more than 5 per cent. should be taken, and, consequently, affixed a species of stigma to those lenders who bargained for a higher rate, the rich and more respectable capitalists being excluded from the market, borrowers were obliged to resort to those of an inferior character, who, in addition to the premium for the risk of entering into an illegal transaction, received an indemnification for the *odium* which, in such cases, always attaches to the lender. It is idle to attempt to secure individuals

[1] "Considerations on the Rate of Interest," by E. B. Sugden, Esq., *Pamphleteer*, vol. viii., p. 278.

Interest.

against the risk of imposition in pecuniary, more than in any other species of transactions. And, although the object had been desirable, it could not be obtained by such inadequate means. The usury laws generated the very mischief they were intended to suppress. Instead of diminishing, they multiplied usurious transactions, and aggravated the evils they were designed to mitigate or remove.

Nothing can be more unreasonable than the clamour against money lenders, because of their exacting a comparatively high rate of interest from prodigals and spendthrifts. This is the most proper and efficient check that can be put upon extravagance. Supposing the security of a prodigal and an industrious man to be nearly equal, and this is but seldom the case, the capitalist who lends to the latter, in preference to the former, confers a service on the community. He prevents those funds which ought to be employed in supporting useful labour, and in adding to the public wealth, from being wasted in frivolous or pernicious pursuits.

But, perhaps, it will be said, that this is mistaking the object of the usury laws; that they were not intended to force capitalists to lend to spendthrifts on the same terms as to industrious persons, but to protect the prodigal and unwary from the extortion of usurers, by making any stipulation between them for more than a given rate of interest null and void. But why all this solicitude about the least valuable class of society? Why fetter the circulation of capital amongst those who would turn it to the best account, lest any portion of it chance to fall into the hands of those who would squander it away? If the prevention of prodigality be of sufficient importance to justify the interference of the legislature, prodigals should be put under an *interdict;* for this is the only way in which it is possible to restrict them. It is not by borrowing money at high interest, but by contracting debts to dealers, on whose charge there is no check, that spendthrifts run through their fortunes. Bentham has justly observed, that so long as a man is looked upon as one who will pay, he can much more easily get the goods he wants than the money to buy them with, though he were content to give for it twice or three times the ordinary rate of interest. How contradictory, then, to permit prodigals to borrow (for it was really borrowing) the largest supplies of food, clothes, &c., at 20, 30, or even 100 per cent. interest, at the same time that we prohibited them, and every one else, from borrowing money at more than 5 per cent.? Instead of being of any service, this restriction was evidently injurious to the prodigal. It narrowed his choice, and drove him to a market where no disgrace is attached to the exaction of the most exorbitant interest, and where he could scarcely escape being ruined.

The outcry which is sometimes raised against capitalists for taking advantage of the necessities of industrious individuals, is seldom much better founded than that which is raised against them for taking advantage of the prodigal or simple. Parties borrow according to their character for sobriety and punctuality in meeting their engagements, and according to the presumed state of their affairs at the time. To say that a capitalist takes advantage of the necessities of individuals, is, in most cases, equivalent to saying that he refuses to lend to persons in suspicious or necessitous circumstances, on the same terms he would do were they in good credit, or were there no doubt of their solvency. And were he to act otherwise, would he be considered fit to be entrusted with the management of his affairs?

But, as already seen, whatever may be the extortion of lenders, the usury laws did not check it. On the contrary, they compelled the borrowers to pay, over and above the common rate of interest, a *premium* to indemnify the lenders for the risks incurred in breaking them. They attempted to remedy what was not an evil, and what, consequently, should not have been interfered with; and in doing this they necessarily created a real grievance. The wisdom of an act of parliament which should compel the underwriters to insure a gunpowder magazine and a salt warehouse on the same terms would not be very evident. Yet it would not be more absurd than to enact that the same rate of interest shall be charged on capital lent on good, on indifferent, and on bad securities. "It is in vain, therefore," to use the words of Locke, "to go about effectually to reduce the price of interest by a law; and you may as rationally hope to set a fixed rate upon the hire of houses or ships, as of money. He that wants a vessel, rather than lose his market, will not stick to have it at the market rate, and find means to do it with security to the owner, though the rate were limited by law; and he that wants money, rather than lose his voyage or his trade, will pay the natural interest for it, and submit to such ways of conveyance, as shall keep the lender out of reach of the law."[1]

Interest.

The case of Holland furnishes a striking proof of the correctness of the theory we have been endeavouring to establish. The rate of interest has been, for a very long period, lower in Holland than anywhere else in Europe; and yet it is the only country in which usury laws have been altogether unknown, where capitalists are allowed to demand, and borrowers to pay, any rate of interest.[2] Notwithstanding all the violent changes of the government, and the extraordinary disturbance of her financial concerns since 1790, the rate of interest in Holland has continued comparatively steady. During the whole of that period, persons who could offer unexceptionable security have been able to borrow at from 2 to 5½ per cent.; nor has the average rate of interest charged on capital, advanced on the worst species of security, ever exceeded 6 or 7 per cent., except when the government was negotiating a forced loan. But, in this country, where the law declared that no more than 5 per cent. should be taken, the rate of interest for money advanced on the best landed security varied, in the same period, from 5 to 16 or 17 per cent., or above *five* times as much as in Holland.

In France the usury laws were abolished at the Revolution; and it is stated that their abolition was not attended by any rise of interest.[3] According to the Code Napoleon, only 6 per cent. is allowed to be charged on commercial loans, and 5 per cent. on those made on the security of real property. There is, however, no difficulty in evading the law. This is usually done by giving a *bonus* before completing the transaction, or, which is the same thing, by framing the obligation for the debt for a larger sum than is really advanced by the lender. None of the parties particularly interested can be called to swear to the fact of such *bonus* being given; so that the transaction is unimpeachable, unless a third party, privy to the settlement of the affair, be produced as a witness.

In Hamburg, the rate of interest is quite unrestricted; or, if there be a written law restraining it, it has become obsolete. The rate, therefore, varies according to circumstances. Occasionally it has been at 7, 8, and even 10 per cent.; and in 1799, a period of great mercantile embarrassment and insecurity, it was as high as 14 per cent. Generally, however, the rate of discount on good bills does not exceed 3 or 4 per cent.[4]

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[1] "Considerations of the Lowering of Interest and Raising the Value of Money, 1691" (*Works*, vol. ii., p. 7, 4to, 1777).

[2] Strictly speaking, this applies only to the state of Holland previously to the Revolution in 1795. The enactments of the Code Napoleon were subsequently introduced; but it appears, from the Report of the Parliamentary Committee on the Usury Laws, that they have not been acted upon.

[3] Storch, *Économie Politique*, tom. iii., p. 187.

[4] *Report on Usury Laws*, p. 46.

Interest.

In Russia the legal rate of interest is 6 per cent. But as Russia is a country capable of much improvement, and where there are very great facilities for the advantageous employment of capital, the market rate of interest is invariably higher than the statute rate, and the law is constantly and easily evaded.[1]

In the United States, the legal rate of interest varies in the different states of the Union. In Alabama and Texas it is 8 per cent.; in New York, South Carolina, Georgia, Michigan, and Wisconsin, 7 per cent.; in Louisiana, 5 per cent.; and in all the other states, 6 per cent. The penalties for taking a higher rate than that allowed by law, vary in the different states, being much less in some than in others. We are not aware whether any legal rate of interest has been established in California; but, as already seen, the interest charged on bills in San Francisco has varied of late years from $1\frac{1}{2}$ to 3 per cent. per month.

The previous statements apply only to the cases of interest arising out of loans made by one party to another. But there are cases in which interest may become due without being stipulated for, by unnecessary or unjustifiable delays in the payment of debts, or by trustees, agents, or other parties coming into possession of property belonging to others, &c., and in these it is necessary, to obviate litigation, that the interest to be charged should be fixed by law. This legal rate had better be somewhat below the ordinary market rate, and may be adjusted from time to time as circumstances may require. But, except in cases of this sort, there is no more reason for interfering to regulate the rate of interest, than there is for interfering to regulate premiums of insurance, or the prices of commodities.

Simple interest.

Distinction of Simple and Compound Interest.—When a loan is made, it is usual to stipulate that the interest upon it should be regularly paid at the end of every year, half-year, &c. A loan of this sort is said to be at simple interest. It is of the essence of such loan, that no part of the interest accruing upon it should be added to the principal to form a new principal; and though payment of the interest were not made when it becomes due, the lender would not be entitled to charge interest upon such unpaid interest. Thus, suppose, L.100 were lent at simple interest at 5 per cent., payable at the end of each year; the lender would, at the end of 3 or 4 years, supposing him to have received no previous payments, be entitled to L.15 or L.20, and no more.

Compound interest.

Sometimes, however, money or capital is invested so that the interest is not paid at the periods when it becomes due, but is progressively added to the principal; so that at every term a new principal is formed, consisting of the original principal, and the successive accumulations of interest upon interest. Money invested in this way is said to be placed at *compound interest.*

It appears only reasonable, when a borrower does not pay the interest he has contracted for at the period when it is due, that he should pay interest upon such interest. This, however, is not allowed by the law of England; nor is it allowed to make a loan at compound interest. But this rule is easily evaded, by taking a new obligation for the principal with the interest included, when the latter becomes due. Investments at compound interest are also very frequent. Thus, if an individual buy into the funds, and regularly buy fresh stock with the dividends, the capital will increase at compound interest; and so in any similar case.

Calculation of interest.

Calculation of Interest.—Interest is estimated at so much per cent. per annum, or by dividing the principal into 100 equal parts, and specifying how many of these parts are paid yearly for its use. Thus 5 per cent., or 5 parts out of 100, means that L.5 are paid for the use of L.100 for a year, L.10 for the use of L.200, L.2, 10s. for the use of L.50 for the same period, and so on.

Interest.

Suppose, now, that it is required to find the interest of L.210, 13s. for $3\frac{1}{2}$ years at 4 per cent. simple interest. In this case we must first divide the principal, L.210, 13s. into 100 parts, 4 of which will be the interest for 1 year; and this being multiplied by $3\frac{1}{2}$ will give the interest for $3\frac{1}{2}$ years. But instead of first dividing by 100, and then multiplying by 4, the result will be the same, and the process more expeditious, if we first multiply by 4, and then divide by 100. Thus,—

	L.	s.
Principal,	210	13
Rate per cent.,		4
100)	8,42	12 (
	20	
	8,52	
	12	
	6,24	
	4	
	96	

L.	s.	d.	
8	8	$6\frac{1}{4}$	=1 year's interest.
		$3\frac{1}{2}$	
25	5	$6\frac{3}{4}$	=3 years' interest.
4	4	3	$=\frac{1}{2}$ year's interest.
L.29	9	$9\frac{3}{4}$	$=3\frac{1}{2}$ years' interest.

It is almost superfluous to observe, that the same result would have been obtained by multiplying the product of the principal and rate by the number of years, and then dividing by 100.

Hence, to find the interest of any sum at any rate per cent. for a year, multiply the sum by the rate per cent. and divide the product by 100.

To find the interest of any sum for a number of years, multiply its interest for one year by the number of years; or, without calculating its interest for one year, multiply the principal by the rate per cent. and that product by the number of years, and divide the last product by 100.

When the interest of any sum is required for a number of days, they must be treated as fractional parts of a year; that is, we must multiply the interest of a year by them, and divide by 365.

Suppose that it is required to find the interest of L.210 for 4 years 7 months and 25 days, at $4\frac{1}{2}$ per cent.—

Principal .	L.210	Interest for 4 years	=L.37·8000
Rate per cent.	$4\frac{1}{2}$	6 months = $\frac{1}{2}$ of 1 year	= 4·7250
		1 month = $\frac{1}{6}$ of 6 mths.	= ·7875
	840	25 days	= ·6472
	105		

Interest for 1 year, L.9·45×4=L.37·80 do. for 4 years. L.43·9597=L.43, 19s. 2d.

The interest for 25 days is $\frac{9{\cdot}45 \times 25}{365} = {\cdot}6472$; that is, it is equal to the interest for a year multiplied by the fraction $\frac{25}{365}$.

Division by 100 is performed by cutting off two figures to the right.

Many attempts have been made to contrive more expeditious processes than the above for calculating interest. The following is one of the best:—

Suppose it were required to find the interest upon L.172 for 107 days at 5 per cent.

This forms what is called in arithmetical books a double rule of three question, and would be stated as follows:—

L. Days. L. L. Days.
100×365 : 5 : : 172×107 : L.2, 10s. $4\frac{2}{3}$d., the interest required.

Hence, to find the interest of any sum for any number of days at any rate per cent., multiply the sum by the number of days, and the product by the rate, and divide by 36,500 (365 × 100); the quotient is the interest required.

When the rate is 5 per cent., or 1-20th of the principal, all that is required is to divide the product of the sum multiplied by the days by 7300 (365, the days in a year, multiplied by 20).

Five per cent. interest being found by this extremely simple process, it is usual in practice to calculate 4 per cent. interest by deducting 1-5th; 3 per cent. by deducting 2-5ths; $2\frac{1}{2}$ per cent. by dividing by 2; 2 per cent. by taking the half of 4, and so on.

[1] *Report on Usury Laws*, p. 46; and *Storch*, tom. iii., p. 207.

Interest. In calculating interest upon accounts-current, it is requisite to state the number of days between each receipt or payment, and the date (commonly the 31st of December) to which the account-current is made up. Thus, L.172 paid on the 15th of September, bearing interest to the 31st of December, 107 days. The amount of such interest may, then, be calculated as above explained, or by the aid of tables.

The 30th of June is, after the 31st of December, the most usual date to which accounts-current are made up, and interest calculated. Interest.

It is desirable, in calculating interest on accounts-current, to be able readily to find the number of days from any day in any one month to any day in any other month. This may be done with the greatest ease by means of the following Table :—

Table for ascertaining the Number of Days from any one Day in the Year to any other Day.

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	32	60	91	121	152	182	213	244	274	305	335	17	48	76	107	137	168	198	229	260	290	321	351
2	33	61	92	122	153	183	214	245	275	306	336	18	49	77	108	138	169	199	230	261	291	322	352
3	34	62	93	123	154	184	215	246	276	307	337	19	50	78	109	139	170	200	231	262	292	323	353
4	35	63	94	124	155	185	216	247	277	308	338	20	51	79	110	140	171	201	232	263	293	324	354
5	36	64	95	125	156	186	217	248	278	309	339	21	52	80	111	141	172	202	233	264	294	325	355
6	37	65	96	126	157	187	218	249	279	310	340	22	53	81	112	142	173	203	234	265	295	326	356
7	38	66	97	127	158	188	219	250	280	311	341	23	54	82	113	143	174	204	335	266	296	327	357
8	39	67	98	128	159	189	220	251	281	312	342	24	55	83	114	144	175	205	236	267	297	328	358
9	40	68	99	129	160	190	221	252	282	313	343	25	56	84	115	145	176	206	237	268	298	329	359
10	41	69	100	130	161	191	222	253	283	314	344	26	57	85	116	146	177	207	238	269	299	330	360
11	42	70	101	131	162	192	223	254	284	315	345	27	58	86	117	147	178	208	239	270	300	331	361
12	43	71	102	132	163	193	224	255	285	316	346	28	59	87	118	148	179	209	240	271	301	332	362
13	44	72	103	133	164	194	225	256	286	317	347	29		88	119	149	180	210	241	272	302	333	363
14	45	73	104	134	165	195	226	257	287	318	348	30		89	120	150	181	211	242	273	303	334	364
15	46	74	105	135	166	196	227	258	288	319	349	31		90		151		212	243		304		365
16	47	75	106	136	167	197	228	259	289	320	350												

By this Table may be readily ascertained the number of days from any given day in the year to another. For instance, from the 1st of January to the 14th of August (first and last days included), there are 226 days. To find the number, look down the column headed January, to No. 14, and then look along in a parallel line to the column headed August, you find 226, the number required.

To find the number of days between any other two given days, when they are both after the 1st of January, the number opposite the 1st day must, of course, be deducted from that opposite to the second. Thus, to find the number of days between the 13th of March and the 19th of August, deduct from 231—the number in the Table opposite to 19 and under August—72, the number opposite to 13 and under March, and the remainder, 159, is the number required, last day included.

In leap years, *one* must be added to the number after the 28th of February.

When interest, instead of being simple, is compound, the first year's or term's interest must be found, and being added to the original principal, makes the principal upon which interest is to be calculated for the second year or term; and the second year's or term's interest being added to this last principal, makes that upon which interest is to be calculated for the third year or term; and so on for any number of years.

But when the number of years is considerable, this process becomes exceedingly cumbersome and tedious, and to facilitate it tables have been constructed, which are subjoined to this article.

The first of these tables (No. 1.) represents the amount of L.1 accumulating at compound interest, at 3, 3½, 4, 4½, and 5 per cent. every year, from 1 year to 70 years, in pounds and decimals of a pound. Now, suppose that we wish to know how much L.500 will amount to in 7 years at 4 per cent. In the column marked 4 per cent., and opposite to 7 years, we find L.1·315,932, which shows that L.1 will, if invested at 4 per cent. compound interest amount to L.1·315,932 in 7 years; and consequently, L.500 will, in the same time, and at the same rate, amount to L.500 × L.1·315,932 or L.657·966; that is L.657, 19s. 4d.

For the same purpose of facilitating calculation, the present value of L.1 due any number of years hence, not exceeding 70, at 3, 3½, 4, 4½, and 5 per cent. compound interest, is given in the subjoined table, No. II. The use of this table is precisely similar to the one above. Let it, for example, be required to find the present worth of L.500 due 7 years hence, reckoning compound interest at 4 per cent.—opposite to 7 years, and under 4 per cent., we find L.75·291,781, the present worth of L.1 due at the end of 7 years; and multiplying this sum by L.500, the product being L.379·9589, or L.379, 19s. 2d., is the answer required.

N.B.—These Tables are taken from *Tables of Interest, Discount, and Annuities*, by John Smart, Gent., 4to., London, 1726. They are carried to 8 decimal places, and enjoy the highest character, both here and on the Continent, for accuracy and completeness. The original work is now become scarce. (J. R. M.)

TABLE I.—*Showing the amount of* L.1 *improved at Compound Interest, at* 2½, 3, 3½, 4, 4½, 5, *and* 6 *per Cent., at the End of every Year, from* 1 *to* 70.

Years.	2½ per Cent.	3 per Cent.	3½ per Cent.	4 per Cent.	4½ per Cent.	5 per Cent.	6 per Cent.
1	1·02500,000	1·03000,000	1·03500,000	1·04000,000	1·04500,000	1·05000.000	1·06000,000
2	1·05062,500	1·06090,000	1·07122,500	1·08160,000	1·09202,500	1·10250,000	1·12360,000
3	1·07689,062	1·09272,700	1·10871,787	1·12486,400	1·14116,612	1·15762,500	1·19101,600
4	1·10381,289	1·12550,881	1·14752,300	1·16985,856	1·19251,860	1·21550,625	1·26247,696
5	1·13140,821	1·15927,407	1·18768,631	1·21665,290	1·24618,194	1·27528,156	1·33822,558
6	1·15969,342	1·19405,230	1·22925,533	1·26531,902	1·30226,012	1·34009,564	1·41851,911
7	1·18868,575	1·22987,387	1·27227,926	1·31593,178	1·36086,183	1·40710,042	1·50363,026
8	1·21840,290	1·26677,008	1·31680,904	1·36856,905	1·42210,061	1·47745,544	1·59384,807
9	1·24886,297	1·30477,318	1·36289,735	1·42331,181	1·48609,514	1·55132,822	1·68947,896
10	1·28008,454	1·34391,638	1·41059,876	1·48024,428	1·55296,942	1·62889,463	1·79084,770
11	1·31208,666	1·38423,387	1·45996,972	1·53945,406	1·62285,305	1·71033,936	1·89829,856
12	1·34488,882	1·42576,089	1·51106,866	1·60103,222	1·69588,143	1·79585,633	2·01219,647
13	1·37851,104	1·46853,371	1·56395,606	1·66507,351	1·77219,610	1·88564,914	2·13292,826
14	1·41297,382	1·51258,972	1·61869,452	1·73167,645	1·85194,492	1·97993,160	2·26090,396
15	1·44829,817	1·55796,742	1·67534,883	1·80094,351	1·93528,244	2·07892,818	2·39655,819
16	1·48450,562	1·60470,644	1·73398,604	1·87298,125	2·02237,015	2·18287,459	2·54035,168
17	1·52161,826	1·65284,763	1·79467,555	1·94790,050	2·11337,681	2·29201,832	2·69277,279
18	1·55965,872	1·70243,306	1·85748,920	2·02581,652	2·20847,877	2·40661,923	2·85433,915
19	1·59865,019	1·75350,605	1·92250,132	2·10684,918	2·30786,031	2·52695,020	3·02559,950
20	1·63861,644	1·80611,123	1·98978,886	2·19112,314	2·41171,402	2·65329,771	3·20713,547
21	1·67958,185	1·86029,457	2·05943,147	2·27876,807	2·52024,116	2·78596,259	3·39956,360
22	1·72157,140	1·91610,341	2·13151,158	2·36991,879	2·63365,201	2·92526,072	3·60353,742
23	1·76461,068	1·97358,651	2·20611,448	2·46471,555	2·75216,635	3·07152,376	3·81974,966
24	1·80872,595	2·03279,411	2·28332,849	2·56330,417	2·87601,383	3·22509,994	4·04893,464
25	1·85394,410	2·09377,793	2·36324,498	2·66583,633	3·00543,446	3·38635,494	4·29187,072
26	1·90029,270	2·15659,127	2·44595,856	2·77246,979	3·14067,901	3·55567,269	4·54938,296
27	1·94780,002	2·22128,901	2·53166,711	2·88336,858	3·28200,956	3·73345,632	4·82234,594
28	1·99649,502	2·28792,768	2·62017,696	2·99870,332	3·42969,999	3·92012,914	5·11168,670
29	2·04640,739	2·35656,551	2·71187,798	3·11865,145	3·58403,649	4·11613,560	5·41838,790
30	2·09756,758	2·42726,247	2·80679,370	3·24339,751	3·74531,813	4·32194,238	5·74349,117
31	2·15000,677	2·50000,035	2·90503,148	3·37313,341	3·91385,745	4·53803,949	6·08810,064
32	2·20375,694	2·57508,276	3·00670,759	3·50805,875	4·08998,104	4·76494,147	6·45338,668
33	2·25885,086	2·65233,524	3·11194,235	3·64838,110	4·27403,018	5·00318,854	6·84058,988
34	2·31532,213	2·73190,530	3·22086,033	3·79431,634	4·46636,154	5·25334,797	7·25102,528
35	2·37320,519	2·81386,245	3·33359,045	3·94608,899	4·66734,781	5·51601,537	7·68608,679
36	2·43253,532	2·89827,833	3·45026,611	4·10393,255	4·87737,846	5·79181,614	8·14725,200
37	2·49334,870	2·98522,668	3·57102,543	4·26808,986	5·09686,049	6·08140,694	8·63608,712
38	2·55568,242	3·07478,348	3·69601,132	4·43881,345	5·32621,921	6·38547,729	9·15425,235
39	2·61957,448	3·16702,698	3·82537,171	4·61636,599	5·56589,908	6·70475,115	9·70350,749
40	2·68506,384	3·26203,779	3·95925,972	4·80102,063	5·81636,454	7·03998,871	10·28571,794
41	2·75219,043	3·35989,893	4·09783,381	4·99306,145	6·07810,094	7·39198,815	10·90286,101
42	2·82099,520	3·46069,589	4·24125,799	5·19278,391	6·35161,548	7·76158,755	11·55703,267
43	2·89152,008	3·56451,677	4·38970,202	5·40049,527	6·63743,818	8·14966,693	12·25045,463
44	2·96382,808	3·67145,227	4·54334,160	5·61651,508	6·93612,290	8·15715,028	12·98548,191
45	3·03790,328	3·78159,584	4·70235,855	5·84117,568	7·24824,843	8·98500,779	13·76461,083
46	3·11385,086	3·89504,372	4·86694,110	6·07482,271	7·57441,961	9·43425,818	14·59048,748
47	3·19169,713	4·01189,503	5·03728,404	6·31781,562	7·91526,849	9·90597,109	15·46591,673
48	3·27148,956	4·13225,188	5·21358,898	6·57052,824	8·27145,557	10·40126,965	16·39387,173
49	3·35327,680	4·25621,944	5·39606,459	6·83334,937	8·64367,107	10·92133,313	17·37750,403
50	3·43710,872	4·38390,602	5·58492,686	7·10668,335	9·03263,627	10·46739,978	18·42015,427
51	3·52303,644	4·51542,320	5·78039,930	7·39095,068	9·43910,490	12·04076,977	19·52536,353
52	3·61111,235	4·65088,590	5·98271,327	7·68658,871	9·86386,463	12·64280,826	20·69688,534
53	3·70139,016	4·79041,247	6·19210,524	7·99405,226	10·30773,853	13·27494,868	21·93869,846
54	3·79392,491	4·93412,485	6·40883,202	8·31381,435	10·77158,677	13·93869,611	23·25502,037
55	3·88877,303	5·08214,859	6·63314,114	8·64636,692	11·25630,817	14·63563,092	24·65032,159
56	3·98599,236	5·23461,305	6·86530,108	8·99222,160	11·76284,204	15·36741,246	26·12934,089
57	4·08564,217	5·39165,144	7·10558,662	9·35191,046	12·29216,993	16·13578,308	27·69710,134
58	4·18778,322	5·55340,098	7·35428,215	9·72598,688	12·84531,758	16·94257,224	29·35892,742
59	4·29247,780	5·72000,301	7·61168,203	10·11502,636	13·42335,687	17·78970,085	31·12046,307
60	4·39978,975	5·89160,310	7·87809,090	10·51962,741	14·02740,793	18·67918,589	32·98769,085
61	4·50978,419	6·06835,120	8·15382,408	10·94041,251	14·65864,129	19·61314,519	34·9669,5230
62	4·62252,910	6·25040,173	8·43920,793	11·37802,901	15·31828,014	20·59380,245	37·06496,944
63	4·73809,233	6·43791,379	8·73458,020	11·83315,017	16·00760,275	21·62349,257	39·28886,761
64	4·85654,464	6·63105,120	9·04029,051	12·30647,617	16·72794,487	22·70466,720	41·64619,967
65	4·97795.826	6·82998,273	9·35670,068	12·79873,522	17·48070,239	23·83990,056	44·14497,165
66	5·10240,721	7·03488,222	9·68418,520	13·31068,463	18·26733,400	25·03189,559	46·79366,994
67	5·22996,739	7·24592,868	10·02313,168	13·84311,201	19·08936,403	26·28349,036	49·60129,014
68	5·36071,658	7·46330,654	10·37394,129	14·39683,640	19·94838,541	27·59766,488	52·57736,755
69	5·49473,449	7·68720,574	10·73702,924	14·97270,995	20·84606,276	28·97754,813	55·73200,960
70	5·63210,286	7·91782,191	11·11282,526	15·57161,835	21·78413,558	30·42642,553	59·07593,018

Interest.

TABLE II.—*Showing the Present Value of* L.1 *receivable at the End of any given Year, from* 1 *to* 70, *reckoning Compound Interest at* $2\frac{1}{2}$, 3, $3\frac{1}{2}$, 4, $4\frac{1}{2}$, 5, *and* 6 *per Cent.*

Interest.

Years.	2½ per Cent.	3 per Cent.	3½ per Cent.	4 per Cent.	4½ per Cent.	5 per Cent.	6 per Cent.
1	0·97560,976	0·97087,379	0·96618,357	0·96153,846	0·95693,780	0·95238,095	0·94339,623
2	·95181,440	·94259,591	·93351,070	·92455,621	·91572,995	·90702,948	·88999,644
3	·92859,941	·91514,166	·90194,270	·88899,636	·87629,660	·86383,760	·83961,928
4	·90595,064	·88848,705	·87144,223	·85480,419	·83856,134	·82270,247	·79209,366
5	·88385,429	·86260,878	·84197,317	·82192,711	·80245,105	·78352,616	·74725,817
6	·86229,687	·83748,426	·81350,064	·79031,453	·76789,574	·74621,540	·70496,054
7	·84126,524	·81309,151	·78599,096	·75991,781	·73482,846	·71068,133	·66505,711
8	·82074,657	·78940,923	·75941,156	·73069,020	·70318,513	·67683,936	·62741,237
9	·80072,836	·76641,673	·73373,097	·70258,674	·67290,443	·64460,892	·59189,846
10	·78119,840	·74409,391	·70891,881	·67556,417	·64392,768	·61391,325	·55839,478
11	·76214,478	·72242,126	·68494,571	·64958,093	·61619,874	·58467,929	·52678,753
12	·74355,589	·70137,988	·66178,330	·62459,705	·58966,386	·55683,742	·49696,936
13	·72542,038	·68095,134	·63940,415	·60057,409	·56427,164	·53032,135	·46883,902
14	·70772,720	·66111,781	·61778,179	·57747,508	·53997,286	·50506,795	·44230,096
15	·69046,556	·64186,195	·59689,062	·55526,450	·51672,044	·48101,710	·41726,506
16	·67362,493	·62316,694	·57670,591	·53390,818	·49446,932	·45811,152	·39364,628
17	·65719,506	·60501,645	·55720,378	·51337,325	·47317,639	·43629,669	·37136,442
18	·64116,594	·58739,461	·53836,114	·49362,812	·45280,037	·41552,065	·35034,379
19	·62552,772	·57028,603	·52015,569	·47464,242	·43330,179	·39573,396	·33051,301
20	·61027,094	·55367,575	·50256,588	·45638,695	·41464,286	·37688,948	·31180,473
21	·59538,629	·53754,928	·48557,090	·43883,360	·39678,743	·35894,236	·29415,540
22	·58086,467	·52189,250	·46915,063	·42195,539	·37970,089	·34184,987	·27750,510
23	·56669,724	·50669,175	·45328,563	·40572,633	·36335,013	·32557,131	·26179,726
24	·55287,535	·49193,374	·43795,713	·39012,147	·34770,347	·31006,791	·24697,855
25	·53939,059	·47760,556	·42314,699	·37511,680	·33273,000	·29530,277	·23299,863
26	·52623,472	·46369,473	·40883,767	·36068,923	·31840,248	·28124,073	·21981,003
27	·51339,973	·45018,906	·39501,224	·34681,657	·30469,137	·26784,832	·20736,795
28	·50087,778	·43707,675	·38165,434	·33347,747	·29157,069	·25509,364	·19563,014
29	·48866,125	·42434,636	·36874,815	·32065,141	·27901,502	·24294,632	·18455,674
30	·47674,269	·41198,676	·35627,841	·30831,867	·26700,001	·23137,745	·17411,013
31	·46511,481	·39998,714	·34423,035	·29646,026	·25550,241	·22035,947	·16425,484
32	·45377,055	·38833,703	·33258,971	·28505,794	·24449,991	·20986,617	·15495,740
33	·44270,298	·37702,625	·32134,271	·27409,417	·23397,121	·19987,254	·14618,622
34	·43190,534	·36604,490	·31047,605	·26355,209	·22389,589	·19035,480	·13791,153
35	·42137,107	·35538,340	·29997,686	·25341,547	·21425,444	·18129,029	·13010,522
36	·41109,372	·34503,243	·28983,272	·24366,872	·20502,817	·17265,741	·12274,077
37	·40106,705	·33498,294	·28003,161	·23429,685	·19619,921	·16443,563	·11579,318
38	·39128,492	·32522,615	·27056,194	·22528,543	·18775,044	·15660,536	·10923,885
39	·38174,139	·31575,355	·26141,250	·21662,061	·17966,549	·14914,797	·10305,552
40	·37243,062	·30655,684	·25257,247	·20828,904	·17192,870	·14204,568	·09722,219
41	·36334,695	·29762,800	·24403,137	·20027,792	·16452,507	·13528,160	·09171,905
42	·35448,483	·28895,922	·23577,910	·19257,493	·15744,026	·12883,962	·08652,740
43	·34583,886	·28054,294	·22780,590	·18516,820	·15066,054	·12270,440	·08162,962
44	·33740,376	·27237,178	·22010,231	·17804,635	·14417,276	·11686,133	·07700,908
45	·32917,440	·26443,862	·21265,924	·17119,841	·13796,437	·11129,651	·07265,007
46	·32114,576	·25673,652	·20546,787	·16461,386	·13202,332	·10599,668	·06853,781
47	·31331,294	·24925,877	·19851,968	·15828,256	·12633,810	·10094,921	·06465,831
48	·30567,116	·24199,880	·19180,645	·15219,476	·12089,771	·09614,211	·06099,840
49	·29821,576	·23495,029	·18532,024	·14634,112	·11569,158	·09156,391	·05754,566
50	·29094,221	·22810,708	·17905,337	·14071,262	·11070,965	·08720,373	·05428,836
51	·28384,606	·22146,318	·17299,843	·13530,059	·10594,225	·08305,117	·05121,544
52	·27692,298	·21501,280	·16714,824	·13009,672	·10138,014	·07909,635	·04831,645
53	·27016,876	·28075,029	·16149,589	·12509,300	·09701,449	·07532,986	·04558,156
54	·26357,928	·20267,019	·15603,467	·12028,173	·09283,683	·07174,272	·04300,147
55	·25715,052	·19676,717	·15075,814	·11565,551	·08883,907	·06832,640	·04056,742
56	·25087,855	·19103,609	·14566,004	·11120,722	·08501,347	·06507,276	·03827,115
57	·24475,957	·18547,193	·14073,433	·10693,002	·08135,260	·06197,406	·03610,486
58	·23878,982	·18006,984	·13597,520	·10281,733	·07784,938	·05902,291	·03406,119
59	·23296,568	·17482,508	·13137,701	·09886,282	·07449,701	·05621,230	·03213,320
60	·22728,359	·16973,309	·12693,431	·09506,040	·07128,901	·05353,552	·03031,434
61	·22174,009	·16478,941	·12264,184	·09140,423	·06821,915	·05098,621	·02859,843
62	·21633,179	·15998,972	·11849,453	·08788,868	·06528,148	·04855,830	·02697,965
63	·21105,541	·15532,982	·11448,747	·08450,835	·06247,032	·04624,600	·02545,250
64	·20590,771	·15080,565	·11061,591	·08125,803	·05978,021	·04404,381	·02401,179
65	·20088,557	·14641,325	·10687,528	·07813,272	·05720,594	·04194,648	·02265,264
66	·19598,593	·14214,879	·10326,114	·07512,760	·05474,253	·03994,903	·02137,041
67	·19120,578	·13800,853	·09976,922	·07223,809	·05238,519	·03804,670	·02016,077
68	·18654,223	·13398,887	·09639,538	·06945,970	·05012,937	·03623,495	·01901,959
69	·18199,242	·13008,628	·09313,563	·06678,818	·04797,069	·03450,948	·01794,301
70	·17755,358	·12629,736	·08998,612	·06421,940	·04590,497	·03286,617	·01692,737

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seminary endowed, on the Madras system, from a bequest of L.10,000, made by the late Dr Andrew Bell. Inverness manufactures almost nothing except a little linen, but carries on a considerable trade with Aberdeen, Leith, and London, on the E. coast, and with Glasgow, Liverpool, and Ireland, by means of the Caledonian Canal. The number and tonnage of vessels registered at the port on 31st December 1855 were—under 50 tons, sailing vessels 154, tonnage 3651; steam 1, tonnage 19; above 50 tons, sailing vessels 87, tonnage 7,276; steam 2, tonnage 535. The vessels that entered and cleared coastwise during 1855 were—sailing vessels, inwards 1858, tonnage 99,095; outwards 1813, tonnage 87,232; steam vessels, inwards 384, tonnage 55,348; outwards 385, tonnage 52,394. Colonial trade, sailing vessels, inwards 3, tonnage 549; outwards 1, tonnage 183. Foreign trade, sailing vessels, inwards 16, tonnage 2620; outwards 43, tonnage 3643. The burgh is governed by a provost, 4 bailies, and 21 councillors; and unites with Forres, Fortrose, and Nairn, in returning a member to parliament. Pop. of municipal burgh (1851), 9969; of parliamentary burgh, 12,793.

INVERNESS-SHIRE, the largest county of Scotland, comprising, besides its mainland portion, a considerable number of the Hebrides, and having a total area of 2,723,501 statute acres, or 4,256 square miles. The mainland portion lies between N. Lat. 56. 40. and 57. 26., and W. Long. 3. 50. and 5. 50.; and is bounded on the N. by Ross-shire, E. by the counties of Nairn, Elgin, Banff, and Aberdeen, S. by Perthshire and Argyleshire, and W. by the Atlantic. It is 85 miles in length from E. to W., and 57 in breadth from N. to S., and has an area of about 1050 square miles. The exterior outline of the county is very irregular. On the N.E., where the county town is situated, a narrow tract runs out between Nairnshire and the Moray Frith. Farther to the S.E., a portion of it is detached and inclosed by the counties of Elgin and Banff. Argyleshire penetrates it from the S.W., and Ross-shire from the N.W., while its W. coast is indented by Lochs Moidart, Aylort, Nevish, Hourn, and other arms of the sea.

The surface of the county is very varied, consisting of ranges of lofty mountains, alternating with deep, narrow valleys, the beds of numerous lakes and rivers. The deep valley of Glenmore, or the Great Glen, traverses the county from S.W. to N.E., dividing it into two nearly equal parts. It is for the most part about a mile in breadth, and is bounded on either side by precipitous banks. In this glen are Lochs Ness, Oich, and Lochy, which, being united by the Caledonian Canal, form a line of inland navigation between the E. and W. seas, from the Moray Frith on the N.E. to Loch Linnhe on the S.W., a distance of about 60 miles. Of these the lochs comprise 37, and the canal 23 miles. Loch Ness is remarkable for its depth, which is so great that its waters never freeze. On each side of this valley there are numerous glens and straths, separated by mountain ridges with lakes and rivers, displaying all the varieties of picturesque scenery.

The western side of the county, or that portion of it lying between the Caledonian Canal and the Atlantic, is the most wild and mountainous, and is known by the name of the *Rough Bounds*. Its principal divisions are Moidart, Arasaig, Morar, Knoidart, and Glenelg, which contain the glens or valleys of Glengarry, Glenmoriston, Glenurquhart, and Strathglass. The most considerable lakes in this quarter are—Loch Eil, Loch Shiel, Loch Arkaig, Loch Garry, and Loch Maddy. The portion lying E. of the Caledonian Canal comprises the extensive district of Badenoch, S. of which lies Lochaber; and on the N. the Aird, one of the most fertile parts of the county. The divisions also include numerous glens, lakes, and rivers, with extensive woodlands, and a great extent of pasture lands. The valley of Glenroy deserves especial notice for its parallel roads, which were supposed, by Dr Macculloch and others, to have been the shores of ancient lakes, or of one lake occupying successively different levels, but attributed by Agassiz to the action of a glacier from Ben Nevis. The other noteworthy valleys are Strathspey, Stratherrick, Strathearn, and Strathnairn. The most considerable lochs are Treig, Ericht (partly in Perthshire), Laggan, Insch, and Moy.

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It is estimated that two-thirds of the surface of the county are covered with heath. In many large tracts heath prevails to such a degree, that for twelve or fourteen miles scarcely any verdure is to be seen except on the banks of some solitary rivulet. On the S. of Badenoch there is a moss, supposed to be the most extensive in Britain, in which a great number of small lakes are interspersed, some of them containing wooded islands, where deer find a secure shelter. By far the greatest part of the county is occupied with mountains. Ben Nevis, now ascertained by the Ordnance Survey to be the highest mountain in Great Britain, stands on the S.W., a few miles to the E. of Fort William, and is 4406 feet above the mean level of the sea. Nealfourvonie, on the west of Loch Ness, rises almost perpendicularly from the loch to the height of 3060 feet. Cairngorm, which is partly in this county and partly in Banffshire, is 4050 feet high.

The principal rivers of Inverness-shire are—the Spey, which rises in a small loch of that name in the hills between Badenoch and Lochaber, and flowing in a northeasterly direction for about 100 miles, falls into the sea 8 miles E. of Elgin, draining an area of 1300 square miles; the Ness, which issues from Loch Ness, and flows through the town of Inverness, falls into the Moray Frith after a course of 6 miles; the Lochy issues from Loch Lochy, and has a course of 10 miles westward, in which it receives from the E. the Spean, and falls into Loch Eil near Fort William; and the Beauly, which has its source in the N.W., and carries the united waters of the Glass, and two other rivulets, into the firth of the same name. The Findhorn and the Nairn on the E., and the Garry and Moriston on the W., are smaller streams. The River Foyers, which flows into Loch Ness from the S. is remarkable for its celebrated falls, one of which is 30, and the other (about a quarter of a mile lower down) is about 90 feet in height.

Granite, limestone, gneiss, slate, marble, brick-clay, abound in many parts of Inverness-shire. Lead has been discovered in Ben Nevis, and at several other places in that neighbourhood, and also at Glengarry, but none of it is wrought. Silver has also been found in several parts. A vein of plumbago has been found at Glengarry. A great part of the mountain of Ben Nevis is composed of beautiful porphyry. There is no coal, and for want of it the limestone is of little value.

From the trees found in great numbers, and some of them of a remarkable size, in all the mosses, this country must at an early period have been thickly covered with wood; and at present there is here a greater space covered with natural pines than in all the rest of Britain. In Strathspey it is said that three tiers of stocks have been found, directly above one another, in a moss; from which it is inferred that the deepest must have come to maturity, and been destroyed, before the one next above it was formed. This district is still celebrated for its great forests; and the natural woods on Loch Arkaig, in Glengarry, Glenmoriston, Strathglass, Strathfarrer, and at the head of Loch Shiel, are also very extensive. The forests consist chiefly of oak, fir, birch, ash, mountain ash, holly, elm, hazel, and the Scotch poplar. There are also extensive plantations of larch, spruce, silver fir, beech, and plane. The birch is very abundant on the sides of Loch Ness, Loch Laggan, about Rothiemurchus, Glenurquhart, Invermoriston, and Glengarry, and is purposely cultivated for the manufacture of bobbins. Part of the great Caledonian Forest extends for several miles near

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the boundary of this county with Perthshire. Considerable tracts have been planted, chiefly with firs and larches, particularly in the N.E., in Badenoch, and on Loch Eil.

There are several fishing villages on the E. coast, but the sea-fishery is not prosecuted to a great extent. The herring occasionally visit Loch Eil; salmon yield a considerable rent on the rivers Lochy, Beauly, and Ness, and are found also in the Morar, in Loch Insch in Badenoch, at Invermoriston, and Invergarry. Charr is caught in several of the lochs, and flounders and sprats in the Beauly. The moors and woodlands are plentifully stocked with game, viz., red and roe deer, the Alpine and common hare, black game and ptarmigan, grouse, partridges, &c.; and pheasants have lately been introduced. Foxes and wild cats are still numerous, and, in the lakes and rivers, otters. There are also eagles, hawks, and owls; and a multitude of water fowls, particularly swans, resort to Loch Insch, and the other lakes of Badenoch.

The territory of Inverness-shire is divided into estates of great extent, and, in proportion to the rental of the county, of great value. In 1804 more than the half, if we may judge from the old valuation, belonged to seven proprietors, and as much more was held by other six as made the possessions of these thirteen individuals equal to more than two-thirds of the whole; each of them, at a medium, must therefore have contained about 100,000 acres. The valued rent of the county was L.73,188 Scots, the annual value of real property, as assessed in 1815, was L.185,565; as assessed in 1849, L.196,825; and as assessed in 1855, under the new valuation act, L.196,275. The assessment for rogue money is L.150; and for prisons, L.644, 12s. 11d.

The cottar or crofter system is gradually decreasing in this county, and in some parts of it it no longer exists. A few tacksmen or great tenants held the land from the proprietor. They sublet portions to cottars, receiving payment in labour, or in contributions of hens, eggs, and small sums of money. In this way the tacksmen often sat rent free, and it was this class that made the great outcry when the system was changed. Now the land is chiefly appropriated to sheep farming, and good rents are obtained. Part of Glenquoich, for example, lets for about L.500 per annum, which used to bring only from L.20 to L.30 as a *sheiling* for the Kintail men. This practice of sheilings is one of the old forms of the crofter system that has ceased. The people not having pasture enough for their cattle, clubbed and hired a range of pasture ground elsewhere, whither they went with their wives, children, and cattle, for about six weeks in summer, living in temporary bothies, making butter, dancing, singing Gaelic songs, and holding a sort of rural carnival. On all the high farms best adapted for pasture or deer-forests, the crofter system is nearly at an end; but on the low grounds, where the land is improvable, there are thousands of crofters, by whom the population of the Highland counties is kept up. They have a house, land for a cow, and a few sheep, and a certain right of hill pasture, and pay from L.4 to L.10 or L.15 a-year of rent. Lord Lovat, on his extensive estates, encourages this system; he gives leases for nineteen years at very low rents, on condition that a certain amount of land is cultivated. The holding is directly from the landlord on clearly-defined and understood conditions, without the severe exactions of the tacksmen,—to all whose demands they were forced to attend, though their own crofts were neglected. In some instances they are not allowed to multiply to too great a number. Sons, on marrying, must remove from the paternal bothy; and this, though seemingly a harsh, is, in some measure, a necessary restriction; the poor-law compelling Highland proprietors to pay more attention than they formerly did to the state of the people; but good landlords will not apply it too rigidly.

The following tables, made up from the *Report* of the Highland and Agricultural Society of Scotland to the Board of Trade, give the agricultural statistics of holdings in this county of the valued rental of L.20 and upwards, for 1854 and 1855; the number of occupants being 749:— Inverness-shire.

	1854. Acres.	1855. Acres.
Wheat	1,684	1,539½
Barley	2,660	2,220¾
Oats	13,674½	13,704¾
Rye	141	125
Bere	1,014	1,034¼
Beans	85¾	67¼
Pease	234½	162½
Vetches	141¾	186¾
Turnips	5,135	5,286¾
Potatoes	3,524¼	2,916½
Mangold	10	16¼
Carrots	3¼	2
Cabbage	35½	25½
Flax	2	3
Turnip seed	11½	4
Other crops	...	2¼
Bare fallow	572½	506¾
Grass and hay, under rotation	15,313¼	14,226½
Total	44,242¾	42,030¼

The estimated produce of the principal crops for these years were,—

	1854. Bolls.	1855. Bolls.
Wheat	47,573	37,814
Barley	93,100	64,957
Oats	437,584	363,176
Bere	23,068	21,206
Pease and Beans	...	5,227
Turnips, tons	84,984	73,948
Potatoes	6,519	12,176

The amount of stock possessed by these occupants in 1855 were,—

Horses for agricultural purposes above three years old	2,330
Horses for agricultural purposes under three years old	634
All other horses	521
Milk cows	8,301
Other cattle	9,758
Calves	6,002
Sheep of all ages, for breeding	285,919
Sheep of all ages, for feeding	143,156
Lambs, produce of 1855	138,619
Swine	1,667
Total stock, 1855	596,907
Total stock, 1854	568,404

Amongst the antiquities of Inverness-shire, which we can only notice generally, are the circles of stones ascribed to the Druids, which are found in many parts of the county, particularly at Corrimony in its northern quarter; two artificial mounts in the parish of Petty, supposed to have been places for administering justice; round buildings, called Picts' Houses, in Glenelg, and other parts; forts, built without mortar, one of which, called Castle Spynie, 2 miles E. from the church of Beauly, incloses a circle of 54 yards, and another, in the parish of Laggan, stands on a rock, 100 yards in perpendicular height; vitrified forts on the hill of Craig Phadric, about 2 miles from Inverness, Dundhairdghall in Glen Nevis, and Dun Thion, near the River Beauly; and a variety of castles, of which Inverlochy Castle, a building of great extent and unknown antiquity, on the banks of the Lochy, near Fort William, is, perhaps, the most remarkable.

There is a chain of forts stretching across the county, along the line of the Caledonian Canal. Fort George, a regular fortress, mounting eighty guns, with barracks for 3000 men, was begun in 1747, and completed in twenty years, at an expense of about L.160,000. It is situated 12 miles eastward from Inverness, upon a neck of land on the

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Moray Frith, opposite to Fortrose in Ross-shire. Fort Augustus, also a regular fortification, though a place of no great strength, with four bastions, and barracks for 400 men, is situated at the west end of Loch Ness, nearly midway between the east and west seas. It was first built in 1730, at some distance from Loch Ness; but having been demolished by the rebels in 1745, it was afterwards rebuilt nearer the lake. Fort William, built in the reign of William III., is situated on a navigable arm of the sea, called Loch Eil, at the south-western termination of the great valley. These forts are now useless in a military point of view, though kept in a state of good repair, and used as barracks for a few soldiers. On Culloden Moor, a level heath to the eastward of Inverness, on the 16th April 1746, was fought the battle which put an end to the rebellion of 1745.

Inverness-shire contains twenty-eight entire parishes, and shares several others with the counties of Argyle, Nairn, and Elgin. Of these, twenty are on the mainland, and the remainder in its islands. Some of the parishes on the mainland, as well as in the islands, are very extensive. Those of Kilmalie and Kilmorack are about 60 miles in length, by almost 30 in breadth. Many of the inhabitants are Roman Catholics, particularly in the districts of Moidart, Arasaig, Morar, and Knoidart, on the west side. The county sends one member to parliament; and the town of Inverness, along with Forres, Nairn, and Fortrose, chooses one for the burghs. The sheriff holds courts at four places, two of which, Inverness and Fort William, are for the mainland, and two more for the isles in Skye and Long Island.

The population of Inverness-shire by the last six censuses was as follows:—

	1801.	1811.	1821.	1831.	1841.	1851.
Males 33,071	35,411	42,204	44,510	45,538	44,961
Females...39,601	42,260	47,757	50,287	52,261	51,539
Total:.....72,672	77,671	89,961	94,797	97,799	96,500

The occupation census for 1851 shows that the inhabitants are chiefly engaged in, or dependent on, agriculture or cattle rearing. There were of males, 3052 farmers, 357 graziers, 1699 farmers' or graziers' sons, grandsons, brothers, and nephews, of fifteen years of age and upwards, and residing on the farms; 169 farm bailiffs, 6666 out-door agricultural labourers, 814 shepherds, 1702 in-door farm servants, and 27 others connected with agriculture.—Of females, 365 farmers, 2325 farmers' or graziers' wives, 2098 farmers' or graziers' daughters, grand-daughters, sisters, and nieces, of fifteen years of age and upwards, and living on the farm; 1903 out-door agricultural labourers, and 1497 in-door farm servants. There were also 202 gamekeepers, 230 gardeners, 67 woodmen, and 1034 fishermen. There were 20 females and 6 males of 100 years of age or upwards, a greater number than in any other county in Scotland.

According to the census of religious worship and education for 1851, there were in this county 109 places of worship, of which 44 belonged to the Free Church, 35 to the Established Church, 4 to the United Presbyterians, 3 to the Episcopalians, 1 to the Independents, 4 to the Baptists, 1 to the Wesleyan Methodists, and 17 to the Roman Catholics. The total number of sittings was 40,918, and the attendance at each of the services on Sunday 30th March 1851 was, morning 18,086, afternoon 11,692, and evening 5211. The number of day-schools was 162, of which 142, with 9716 scholars, were public; and 20, with 1017 scholars, were private schools. The number of Sunday-schools was 75, with 4485 scholars; of these schools 32, with 1255 scholars, belonged to the Established Church; 30, with 2286 scholars, to the Free Church; 3 each to the United Presbyterians, Episcopalians, and Baptists, and 1 each Independents, Methodists, isolated congregations, and Roman Catholics. There were also 2 mechanics' institutions, and a Young Men's Mutual Improvement Association, having together 546 members.

Inverted ‖ Iona.

INVERTED, in *Music*, signifies a change in the order of the notes which form a chord, or in the parts that compose harmony, which happens by substituting in the bass those sounds which ought to have been in the upper part; an operation not only rendered practicable, but greatly facilitated, by the resemblance which one note has to another in different octaves. Hence we derive the power of exchanging one octave for another, or substituting in the extremes those which ought to have occupied the middle station, and *vice versa*.

INVERURY, a royal parliamentary and municipal burgh of Scotland, county of Aberdeen. It stands at the confluence of the Don and the Ury, each here crossed by a bridge, and is distant 16 miles N.W. from Aberdeen, on the line of the Aberdeen and Huntly Railway. The village is small and straggling; and the inhabitants are chiefly employed in agriculture. The Aberdeenshire canal, completed in 1807, connected it with Aberdeen, and was the means by which a considerable trade in grain, lime, bones, &c., was carried on. The canal has been purchased by the railway company, and a part of the basin filled up to form a track for the line of railway. Inverury unites with Elgin, Banff, Cullen, Kintore, and Peterhead, in sending a member to parliament. Pop. (1851) of municipal burgh, 2084; of parliamentary burgh, 2264.

INVESTITURE, in *Law*, a giving livery of seisin or possession. There was anciently a great variety of ceremonies used upon investitures, which at first were made by a certain form of words, and afterwards by such things as had the greatest resemblance to the thing to be transferred. Thus, where lands were intended to pass, a turf was delivered by the granter to the grantee. In the church, it was customary for princes to make investiture of ecclesiastical benefices, by delivering to the person they had chosen a pastoral staff and a ring.

IODINE. See CHEMISTRY. § *Non-metallic Elements*, 6.

IONA, or ICOLMKILL, a small island of the Hebrides, memorable in our annals for its connection with the early Christian church in Britain, and as having been for centuries a seat of learning and civilization—the "Instructress of the West"—as well as the chosen and venerated place of sepulture of the kings of Scotland, and the native chiefs and lords of the Isles. Thus consecrated by historical associations and devotional feeling, and possessing remains of great antiquity, the little low "Island of the Waves," or "Blessed Island," as its name has been interpreted, is invested with a strong and imperishable interest, and is the resort of pilgrims of all classes and countries—poets, painters, moralists, and devotees. Its appearance from the sea, when the visitor has emerged from the shadow of the dark massive rocks of Mull, or has surveyed the wondrous temple of Staffa, is at first calculated to produce a feeling of disappointment. It presents no outline of precipitous cliffs or fertile shores. The surface is varied by irregular ridges of hills, rising up from the beach, with patches of green pasture, some corn-fields, and a range of cottages—the modern village—fronting the sea, over which is seen the high square tower of the ruined cathedral, from which in former ages a famous peal of bells summoned the islanders to prayer, and was heard far over these solitary and barren shores. The hills in general do not exceed 100 feet in height, but the most elevated of the group, called Dun-ii, rises 330 feet above the level of the sea. The whole extent of the island is but three miles in length by one in breadth; its population, according to the census of 1851, was just 604 souls, consisting of crofters, or small tenants, with their families, who unite the pursuit of fishing with the cultivation of the land, and the rearing of black cattle; and the proprietor, the Duke of Argyll, derives from the entire island a revenue

Iona. of only about L.300 per annum. The riches of Iona, therefore, consist of its past glory and ancient renown. Its treasures are its monastic ruins, sculptured tombs and crosses, the memory of its first great canonized missionary, and the enthusiasm which hallows the spot, "once the luminary of the Caledonian regions, whence savage clans and roving barbarians derived the benefit of knowledge and the blessings of religion."[1]

Iona has been known under many names, and has afforded scope for the ingenuity of etymologists. In writings and charters it bears no less than thirty different denominations or forms of orthography. Adomnan (*circa* A.D. 680) writes it *Hyona*, supposed by some to be the Latinized form of I-thon, the Celtic "Island of Waves," or Ishona, Isle of the Blessed; while Keith and Pennant derive it from the Hebrew *Ionah*, a pigeon, presumed to be an allusion to the name of Columba. Bede refers to it as *Hy* or *Hii* (sometimes commuted into the single letter Y), signifying in Irish "the island," thus pre-eminently distinguishing Iona among the Hebridean archipelago of islands. It is still called Hy, and is so designated on some of the tombstones. At a very early period the island was also termed Icolmcille, or Icolmkill, the island of Colum of the cell or cemetery; while by the Highlanders it has been known as *Innis-nan-Druidhneah*, the island of the Druids, from a tradition that the island was a seat of the Druids previous to its occupation by Columba. The term, however, has been otherwise interpreted to mean the isle of the artizans or workers, which seems appropriate enough to Columba and his disciples.

It was about the year 563 that Columba left Ireland, accompanied by twelve disciples, to Christianize the rude islanders of *Albanich*, or western Scotland, ruled over by Conal, king of the Dalriads. In Ireland (then named Scotia), he had, in consequence of his zeal in planting churches, earned the name of Columcille, or Columba of churches, and he had founded a noble monastery, named, from the number of oaks in the place, *Dearmach* (now Durrough, in King's County). Columba, however, having opposed Diarmid, King of Ireland, for refusing to release a freeman (apparently one of his disciples) was excommunicated by the Synod of Ireland, and by the advice of the Bishop of Clonfert, he repaired to Scotland. He obtained from Conal a grant of the island of Iona, then peopled by five families, and there founded his famous monastery and fixed his chief residence for the remaining thirty-four years of his life. A small bay and harbour, to the S.W. of the island, are still pointed out as the spot where Columba and his followers first landed, and on the shore is a large mound, sixty feet long, supposed to represent the size of the *Currach* or boat which bore the saint to Iona. The original buildings of the monastery were of timber or wattle-work. The apostle of the Scots, according to Adomnan, sent forth his disciples to "gather bundles of twigs to build their hospice;" and for years the establishment at Iona must have been a humble missionary enterprise. A circle of stones, said to be the original cell or place of worship, remains on the island. Columba and his disciples were named Culdees, or hermit-worshippers, who sought divine assistance by prayer in the caves or woods, or secret corners of the island. Their zeal and devotion, however, soon led them to extend their labours, and to add to the number of the faithful. The neighbouring islands were converted, and Columba visited various parts of Scotland and Ireland, while his disciples penetrated into Orkney. Columba resided frequently among the Picts on the N. of the Grampians, and is said by Adomnan to have converted Brudeus the King of the Picts, who had his court at Inverness (*ad ostiam Nessiæ*). He had, however, to engage an interpreter in conversing with Brudeus, and this fact seems to prove that the Picts spoke a language different from the Celtic of Ireland or the Druid Scots. Columba also visited St Kentigern at Glasgow, and at Iona he inaugurated Aidan, king of the Scots. Having founded many churches and monasteries, all in some degree dependent on the parent monastery at Iona, Columba died about the year 597 within his own church at Iona, aged about seventy-seven. He had predicted the time of his own decease, and after ascending the hill which overlooked the monastery, gave it his blessing, and at midnight retired to the church, where he was found dead before the altar. The fond credulity of Adomnan has preserved many supernatural and miraculous legends relating to Columba; fable is blended with truth, and poetry has shed its undying light on the romantic traditions, but enough remains of unquestioned fact, and noble self-sacrificing exertion, to entitle Columba to rank with those great moral heroes who have gone forth to civilize and regenerate mankind.

Iona.

The ecclesiastical rule or system of Iona is thus described by Bede, after the monastery had attained power and importance. "This island has for its ruler an abbot, who is a presbyter, to whose jurisdiction all the provinces, and even the bishops, by an unusual practice, are subject, according to the example of their first teacher, who was not a bishop but a presbyter and monk." The Culdees were a separate and independent sect. They differed from the Church of Rome as to the time for the observance of Easter and the form of the tonsure, which they cut according to the Eastern practice. About a century after the death of Columba, Adomnan, then Abbot of Iona, during a visit to Alfred, king of the Saxons, conformed to the Romish rites, and on his return attempted to induce his own people, and those subject to the monastery of Iona, to adopt his views. They refused to conform, and it was not till the year 716 that the monastery, at the intervention of Egbert, an English priest (who afterwards settled and died at Iona), adopted the Romish custom as to the observance of Easter. Foreign invaders now came to disturb and lay waste the infant colony. First, we learn from the Irish records (*Tigernachi Annales*) that the family of Hii, or the disciples of Columba, were, about 720, driven beyond Drumalban by Nectan, king of the Picts. In 801, and again in 806, the monastery was burned by those pirates, sixty-eight of the inmates being on the latter occasion slain. A century afterwards the Danes ravaged the monastery and slew the abbot and fifteen monks. In 1097 Magnus Baerfaet, king of Norway, visited Iona, and allowed the people to retain their possessions. The monastery continued during the next century to be the resort of pilgrims, but it declined from its former importance. The simplicity of the Culdee worship had yielded to the power of the Church of Rome, and the monastery was appropriated to monks of the Cluniac order, subject to the bishops of Dunkeld. Between the years 1172 and 1180, William the Lion deprived them of certain churches and lands in Galloway, which he annexed to the canons of Holyrood. The island lords occasionally made donations to the church, and Donald of the Isles, who fought at Harlaw in 1411, is said to have presented vessels of gold and silver to the monastery, and to have become a monk of Iona. The last abbot, one of the council of the Lord of the Isles, becoming Bishop of the Isles, obtained in the year 1507 the annexation of Iona to his see. A nunnery had, about the thirteenth century, been in-

[1] Johnson's *Journey to the Hebrides*. This one eloquent sentence of Johnson, conceived in his best spirit, and expressed in his happiest manner, has perhaps done more than all other writings for the celebrity of Iona. The best historical account of the island is to be found in the *Origines Parochiales*, vol. ii., Bannatyne Club, 1854. The ruins are carefully described by Mr Howson in a series of papers in the Camden Society's *Transactions*, Part III.

Iona. stituted at Iona. It was dedicated to the Virgin Mary, and the nuns were of the order of St Augustine and wore a white gown with a rochet of fine linen. There are few notices of this institution; but in 1509 King James IV. appears to have granted letters of protection to the prioress, and in 1574, the then prioress, with the consent of the convent, granted the lands which belonged to it to Hector Maclean of Duart.

At the era of the Reformation, the convention of estates in 1561 passed an act for the destruction of all abbeys and monuments of idolatry, and the Synod of Argyle carried it out with unsparing rigour in Iona. Its conventual buildings were sacked and plundered; of 360 crosses said to have been then standing, only three were left, some being thrown into the sea, and others carried away to serve as tombstones in Mull and the neighbouring islands. A valuable library, with the psalters, and other books used by the monks, and the registers of Iona, also perished at this time. "That any of these may have been preserved in the abbey which rose upon the ruins of Columba's monastery, is, of course, mere conjecture; but though Boece's fables about the books brought from Rome by King Fergus II. must be summarily rejected, there seems no reason to doubt the proposed visit of Pope Pius V. in 1460 to the library of Iona, or the alleged fact, that in 1525 several manuscripts were brought from Iona to Aberdeen, which, though much injured and nearly illegible, appeared to be fragments of Sallust and of some of our Scottish chronicles" (*Origines Parochiales*). Of all the excesses of these iconoclasts, this literary destruction is certainly the most to be deplored.

The ruins and relics of antiquity at Iona consist of part of the cathedral church of St Mary, the nunnery, some small chapels, a building called the Bishop's House, and a number of ancient tombs and crosses. The cathedral is apparently not older than the thirteenth century. It is built of red granite in the usual cruciform shape, surmounted at the intersection of the nave and the transept by a square tower of about 75 feet in height. The building measures internally 115 feet from E. to W. Some grotesque figures, rudely carved, are seen on the columns; and in the chancel are the piscina and sedilia, which Mr Howson considers to be of early English work. On the N. of the church were the cloisters, and, according to Martin, a library; and from a Norman arcade still standing, these appear to have been part of the oldest buildings. The principal altar of the church, formed of white marble veined with gray, existed almost entire in 1688, when Sacheverell visited Iona; and Pennant saw part of it in 1772, but it is now gone. In the choir are the tombs of Macleod of Macleod, Maclean of Ross, and the abbot John Mackinnon. The first represents the figure of a chief rudely carved, and the outline was apparently at one time filled with metal. The second is bolder and more artistic; the chief rests on a pillow, with his dog at his feet, a spear in his hand, a broadsword in his belt, and his shield presenting the figure of a galley. The figure on the tomb of the abbot is recumbent, and the inscription round the margin runs—*Hic jacet Johannes Mac Fingone, Abbas de Hy, qui obiit Domini millesimo quingentesimo, cujus animæ propitietur Deus altissimus. Amen.* In one of the cloisters of the church formerly lay the black stones, described by Pennant and Johnson, on which it was customary to swear oaths and ratify agreements.

The most ancient and interesting of the conventual remains is the chapel of St Oran or Aran, with its burying-ground, a little city of the illustrious dead, that once enjoyed the privileges of a sanctuary. The chapel is small, measuring only 35 feet by 20 feet 8 inches. Its western doorway presents a Norman arch with the beak-head ornament. The burial place (described by Dean Monro as "a very fair kirkzaird)" bears in Gaelic the name of *Reilig Oiran*, and was the place of sepulture of the kings of Scots and Picts, down to the time of Malcolm III., who died in 1093, and of the lords of the Isles and chiefs, to a much later period. Shakspeare, it will be recollected, alludes to the interment of the "gracious Duncan" at Icolmkill:— Iona.

> "The sacred storehouse of his predecessors,
> And guardian of their bones."

And there, too, Macbeth, the murderer of Duncan, is said to have been buried. Dean Monro (who wrote in 1594) states that there were in this sepulchre three little chapels with marble inscriptions; one, *Tumulus Regum Scotiæ*, in which were forty-eight Scottish kings—a palpable fiction or exaggeration;—the second, *Tumulus Regum Hiberniæ*, containing four Irish monarchs; and the third, *Tumulus Regum Norwegiæ*, containing eight Norwegian princes. There is now no vestige of such buildings, but a mound of earth is called, by tradition, the Ridge of Kings. South of the chapel is a red unpolished stone said to mark the grave of a king of France. The most ancient of the monumental stones bearing a date is that in memory of Abbot Lachlan Mackinnon in St Oran's chapel, which is inscribed 1489. Those representing the broadsword across the body, or exhibiting the ancient Hebridean galleys (the stern and prow the same, and curved upwards like the Roman vessels), may be centuries older. Tombs of two bishops, of four priors of Iona, of several chiefs in armour, chiefly Macleans, are still to be seen in the Reilig Oiran; and in the chapel are similar memorials to Angus Oig, a Macdonald of the Isles, the friend of Robert Bruce; to Macquarrie of Alva, Maclean of Grulin, and to one of the family of Campbell, son of the Earl of Argyle. Two of the undated stones bear inscriptions in the Irish character as follows:—*Or do anmin Eogain* (a prayer for the soul of Eogain) and *Or do Mailfatric* (a prayer for the soul of Mailpatrick). Celtic antiquaries, however, are not agreed as to these inscriptions, on which the dust of antiquity rests somewhat too strongly. Near the door of the chapel were to be seen, in 1772, the stones called *Clach-na-brath*, which had been substituted for three globes of white marble, always turned round by visitors, and which it was superstitiously believed were to wear through the pedestal before the end of the world. The remains of the nunnery exhibit traces of Norman architecture. A chapel was attached to the institution, believed to be the burial-place of ladies of distinction, as the Reilig Oiran was appropriated to the graves of eminent men. The tomb of the last prioress, Agnes or Anne Maclean, bearing date 1543, is still left, though in a mutilated state. Of the ancient crosses, a few continue to "cast a melancholy splendour among the memorial tombs, and seem to preside over the grassy graves with a gray and ghastly beauty." Two magnificent stones of this kind are almost entirely perfect. One, known as Maclean's Cross, is 11 feet in height, and stands on a large basement of granite cut into three steps. The second, St Martin's Cross, is about 15 feet in height. Both are richly carved in high relief with Runic knots and various emblematical devices and fanciful scrolls. The freedom of design, and its excellent execution in a material so ill adapted for sculpture as mica-slate, has often been remarked as surprising, and must strike the most incurious observer. The remains of some other crosses are visible, and there appear to have been several in the vicinity of the cathedral. As connected with the monkish period, one of the small harbours in the island bears the name of the *Bay of Martyrs*, being the place where the bodies of those who were to be interred in the holy ground were received by the monks. The sanctity of the island, and the mysterious veneration in which it was held, rendered Iona the favourite burying-place of all families of distinction; and

Ionia. there was an ancient Gaelic prophecy, that seven years before the end of the world a deluge was to sweep over Ireland and the green-clad island of Islay, but that the sainted island of Columba would rear her towers above the flood. Thus the notion of protection was mingled with the reputation of the island for sanctity in making it the resort of strangers to bury their dead. The tutelary saint, Columba, is believed, on certain evenings of the year, to be seen on the top of the church-tower counting the neighbouring islands.

> "When o'er each Runic altar, weed-entwined,
> The vesper clock tolls mournful to the wind;
> Counts every wave-worn isle and mountain hoar,
> From Kilda to the green Ierne's shore."

Collins has also, in his *Highland Ode*, embodied the more magnificent superstition, that the tenants of the royal sepulchres, in certain seasons at midnight, stalk forth in pageant robes and hold aerial councils. So late as the middle of the last century, as related by Pennant, the people of Iona, every Michaelmas Day, rode their horses round the sacred circle of stones called *Cnoc-nan Aimgeal*, or the Hill of Angels, where Columba was believed to have met and conversed with angels. So long do poetical and supernatural beliefs cling to remote localities among a simple, credulous, and imaginative people!

Iona is separated from the Island of Mull by a navigable sound scarce a mile in width, and lies about eight miles S.W. from Staffa. The island possesses marble quarries, which have been opened and worked, but without success adequate to the necessary expenditure. On the S.W. shore are extensive rocks of sienite and serpentine. At Port-na-currach (the spot where Columba is said to have landed) are cliffs of hornblende, and nodules of hard steatite, of a fine green colour, which the children of the island collect and sell to strangers—rushing with them, on the arrival of the steam-boat, to the shores "where once came monk and nun with gentle stir." The soil of the island is light but fertile, and well fitted for the growth of oats, barley, and rye. The pasture, though scanty, is of excellent quality, and the people of the island contrive to maintain and clothe themselves from their native products. They have now an Established and Free Church, with cheap and ample means of education. (R. C—S.)

IONIA, in *Ancient Geography*, a district of Asia Minor, extending along the Ægean Sea, from the Cumæan Gulf to the Mons Grius or Grium, a little way S. of Miletus. Its length in a straight line was thus not much more than 100 miles, but its coast was so sinuous and indented that it had a sea-board of fully more than three times that extent. Inland, however, it nowhere extended more than 40 miles, and in many places it was even considerably narrower. The extreme limits of its eastern frontier were Mounts Sipylus and Tmolus. On the N. it was bounded by the territory of Pergamum and other Æolian cities in Mysia; on the S. it extended a short distance into Caria. Its principal rivers were the Hermus, Cayster, and Mæander.

The inhabitants of this small but valuable and important region were Attic Ionians, who, on the death of Codrus the last king of Athens, set out under his sons Neleus and Androclus to seek their fortune beyond the sea. The causes of this migration are very imperfectly understood. According to one account these two youths, disgusted at the abolition of the regal form of government, and seeing no hopes of preferment under the archonship of their elder brother Medon, rallied round their standard the restless spirits of Attica, and along with volunteers from other parts of Greece emigrated to the western shores of Asia Minor. Another and more probable account is that the Attic Ionians, burdened with a surplus population, and exposed to the incessant attacks of their Dorian neighbours, had gone away in quest of more peaceful abodes to the Asiatic coasts. Landing at Miletus, about B.C. 1044, or, as some say, in 1060, they stormed that city and put all the male inhabitants to the sword, reserving the women to themselves. A number of other cities fell into their power, which they treated in a similar manner; and with these as centres, they soon diffused their civilization over the whole country that owned their sway. Some of the inhabitants they expelled, the rest they subdued, and finally incorporated, yet always in such a way as to leave the Greek the predominant element. Partly by conquest, and partly by colonization, the Ionians soon found themselves masters of twelve principal cities. These were all independent of each other, yet soon found it expedient, for purposes of trade and the settlement of disputes, to form themselves into a kind of confederation, which, from the number of cities composing it, was called the Ionian Dodecapolis. The cities in question were MILETUS, MYUS, PRIENE, EPHESUS, LEBEDUS, COLOPHON, TEOS, ERYTHRÆ, CLAZOMENÆ, PHOCÆA, and the two islands of CHIOS and SAMOS. At a later period, the city of Smyrna was seized by the Colophonians, and admitted into the league. These cities being all colonized chiefly for the excellence of their sites soon rose to great wealth and power. Many of them became in turn the parent states of numerous and flourishing colonies in every corner of the Mediterranean and many parts of the Euxine. Miletus alone is said to have sent forth seventy-five. Another index to their prosperity will be found in the fact that the arts and sciences attained a high degree of perfection in them before the mother country had a single great poet, philosopher, or historian, to boast of. The extant remains of their splendid temples and public buildings give evidence of the taste and magnificence of their architecture.

What the political relations of the twelve cities were to each other we have no means of exactly determining, but there is nothing to warrant the idea that they were ever held together in the bonds of a federal union. Each city was in itself an independent republic, and its constitution, like that of most Ionian colonies, was democratic. They had brought with them from Greece a common race, a common religion, and a common language. And these things, more than any other, seem to have kept them together. When they found it necessary to discuss any business of common interest, deputies from the several states met at the *Panionium*. This was a piece of neutral ground at the foot of Mount Mycale, on its northern slope, in which a temple had been built and consecrated to Neptune. A town soon rose in the neighbourhood, in the Prytaneum of which the deputies seem at one time to have met. It was only in pressing emergencies that business was discussed in these meetings. The general purport of the assembly seems to have been to celebrate in common the rites of their national worship, and to promote good feeling by periodical games and festivals. Danger first threatened the Ionian cities on the side of Lydia. Hostilities broke out as early as the reign of Gyges, and it was left for Crœsus to subdue the last of the cities that held out. Crœsus was in his turn defeated by Cyrus, and the Ionians exchanged the Lydian for the Persian yoke. The conquerors, however, were at first wise enough not to interfere in the internal affairs of the Ionian states. They merely exacted a tribute in money and a contingent of soldiers, and claimed the right of appointing the governors of the towns. In the cities themselves, democratic as they were in constitution, aristocratic factions began to spring up, and as they were generally backed by the Persian satraps, tyrannies were soon established everywhere. Most of these tyrants were themselves Greeks by birth, but governed in the Persian interest. About the year B.C. 500 a strong reaction in favour of their ancient liberty seized the Ionians, and they determined to rebel. The example was set by the Milesians, who were backed by the promise of support from

Ionian Islands.

Athens and Eretria. The allied troops marched against Sardes, which they took and burned, but they were soon overwhelmed by the superior strength of Persia, and the Ionians were left to bear alone the brunt of the great king's anger. They were still powerful by sea, but their towns again fell one by one into the hands of the foe. Miletus was taken and destroyed, and its inhabitants were either killed or carried off into the interior of Persia, where they had lands assigned them. Clazomenæ shared a similar fate, and at the end of six years, during which the revolt lasted, their chains were riveted more firmly than ever. When Persia declared war against Greece, the Ionians were pressed into the service and compelled to fight against their European kinsmen. Their revenge, however, was complete. At the battle of Mycale, B.C. 479, they turned the fortune of the day by deserting in a body to the Greeks, and the subsequent victories of Cimon enabled them to throw off the Persian yoke altogether. Till the close of the Peloponnesian War Athens was acknowledged by the whole Dodecapolis as the head of the Ionian race, and was often made the umpire in their feuds and difficulties. When Sparta, at the close of the fifth century B.C., became the leading power of Greece, the Ionian cities applied to her for protection, which was freely granted till the peace of Antalcidas, B.C. 387, threw them, along with all the other Greek cities in Asia, once more into the hands of the Persians. The conquests of Alexander recovered them for Greece, and enabled them to regain to some extent the power and influence they had once enjoyed. The Roman sway completely put an end to their political importance; but their commercial and literary influence was still felt and acknowledged. The subsequent history of each of these cities will be found fully detailed under the separate head of each. (Grote's *Hist. of Greece;* Thirlwall's *Hist. of Greece;* Chandler's *Travels in Asia Minor;* Leake's *Map of Asia Minor*, &c., &c.)

Ionian Islands.

IONIAN ISLANDS.

THE united states of the Ionian Islands, protected by Great Britain, consist of the following seven larger isles:—Corfu, Cephalonia, Zante, Santa Maura, Ithaca, Cerigo, and Paxo, with their minor dependencies; and are situated off the western coast of Albania and Greece, except Cerigo, which lies to the S. of the Morea; all being within N. Lat. 36. and 50., and between E. Long. 19. 40. and 23. 10. Official returns, obtained in 1836, give, as the entire native population, 204,242; of whom 110,496 were males, and 93,746 were females. In 1831 the returns showed—males 122,422, females 104,276=226,698; and in 1854—males 123,254, females 105,727=228,981.[1]

The islands, whose names have been given, are computed to contain an area of 1097 English square miles, to each of which there appear rather more than 208 persons; the population, however, is very unequally distributed.

The geological formation of the islands, as examined by Dr Holland and Dr Davy,[2] is mostly calcareous, like that of of the opposite continent. In Zante volcanic action is thought still to manifest itself in earthquakes, from which there is never many months' repose. In Corfu and some of the other islands excellent stone for building is abundant; and marble of various hues, and susceptible of high polish, has been quarried, although not for export.

Throughout all the islands the principal soils are these three—calcareous marl, red clay, and sand, which are given in the order of their general abundance.

The ebb and flow of the tides, which are very marked at Venice, are little perceptible on the shores of the Ionian Islands; but the sea around them is greatly affected, in both its *set* and its level, by currents and winds, whose course and effects have not been carefully investigated.

Climate.

The climate of the several islands is not quite the same, but probably does not differ much, in the chief characteristics, from that of Corfu, regarding which accurate observations have been made and published.[3] A table of the extreme variations of the thermometer in each month, for ten years ending 1848, gives a mean temperature of 62°, and shows a surprising uniformity in the temperature of the same month in different years. It indicates the average yearly quantity of rain = 45·83½ inches, which is not more than falls in the chief parts of Cumberland or Westmoreland, and is less than in one or two points in these counties;[4] but it shows that the sirocco or S.E. wind blows 126½ days in the year; and a register of the weather, for every day of 1846, marks great vicissitudes of temperature, equal to 20 deg. within 24 hours, at various seasons—the greatest heat being 93° in July. Frost is rarely severe, or of long duration. In 1846 the thermometer never fell below 40°. Snow has occasionally been known to lie on the flat country, but in general it is confined to the hills, from which it melts after a day or two. But the dry cold winds, passing over the snow which covers the hills of the continent, cause a sensation of cold more piercing than is common in more northern regions.

The mortality among the garrisons is found to be rather less than that at Malta or Gibraltar; but pulmonary patients are speedily cut off, and all those complaints passing under the name of nervous are soon aggravated, particularly in females, by the Ionian climate. The chief local disease is intermittent fever, to which the natives are extremely subject, particularly in damp situations. Cholera first visited the islands in 1850, when it was very fatal in Zante and Cephalonia. Corfu was by some supposed to owe its escape then to the highly electrical state of its atmosphere; but in 1855 Corfu too was attacked, along with the other islands, and suffered severely. Instances of longevity occur in the Ionian Islands, particularly in Ithaca,[5] and Dr Davy met with some instances of very protracted life in Zante[6] in 1824, and one at Paxo in the same year;[7] and a poor man, supported chiefly by charity, died a few years ago at Corfu, having attained, as was said, the age of 104 or 105 years. Such cases, however, are far from common throughout the states; and in the absence of more precise *data*, we must rather incline to judge that the usual term of life is not long, where the species comes early to maturity, and fourscore is spoken of as a wonderful period of life among those who are exempt from exposure and privation. The old registers are not to be implicitly relied on, any more than the vague impression of the common people as to their ages. A table drawn up

[1] *Parliamentary Papers*, Despatch of Sir G. Ward, 3d August 1852, and *Blue Book for* 1854.
[2] *Travels in Greece; Notes on Ionian Islands and Malta*, 1842.
[3] By Mr D. M'Kenzie, sub-librarian to Garrison Library, Corfu.
[4] Above 100 inches, it is said.
[5] Bowen's *Ithaca*, p. 4, Corfu, 1850.
[6] Dr Davy's *Notes, &c., on Ionian Islands and Malta*, vol. i., chap, x., pp. 313-315.
[7] *Ibid.*, vol. i., chap. viii., pp. 175, 176; 181, 182.

by Dr Benzer,[1] an eminent medical practitioner, shows indeed among the Roman Catholics in the town of Corfu, between 1790 and 1820, several cases of persons passing 100 years, and six men attaining 90; but it is not descriptive enough to afford much information.

Products.

Their chief products may be considered, in one sense, common to the seven islands, although they have not been cultivated everywhere with equal success or to the same extent. Olive oil and wine are produced in all; currants in Zante, Cephalonia, and Ithaca; silk chiefly in Zante; and cotton in Cephalonia; flax, wheat, maize, and other cereals, are grown everywhere; oranges, lemons, and citrons, with all the fruits of southern Europe, are abundant throughout.

No animals but goats and sheep are reared in the islands. Some cows are kept to supply the city of Corfu with milk, but they are obtained from Albania; and almost all the horses are imported from the same quarter. From Albania, too, come the oxen for the supply of butcher meat, but they are derived originally from districts farther to the north.

The less productive nature of the soil has stimulated to greater activity of cultivation in Zante and Cephalonia; but elsewhere there is little or no energy; old systems are rigidly adhered to; and the implements of husbandry are almost as primitive as in the days of Homer and Hesiod. The country people are even slow in taking advantage of the good toll-free roads made under British authority, and prefer transporting their produce on the backs of horses to using carts, in one of which the burdens of eight or ten animals could be carried with greater facility.

The oil crop is only biennial[2] under the most favourable circumstances. For some years it has been sadly deficient, no full yield having been obtained between 1834 and 1855. The olive is always grafted, and begins to bear fruit in 15 years; it is commonly left to grow up without pruning or other care, except a little occasional manuring and loosening of the earth round the roots. The fruit is not gathered by hand, but allowed to fall, and then picked off the ground, frequently after it has begun to decay. When collected in sufficient quantity it is carried to the mill, where it is first crushed under a heavy stone worked by horses, and then the pulp is subjected to a screw-press, turned by men. This harvest begins in November, and lasts till March or April. Official returns show the last great crop of 1834 to have amounted to 253,923 barrels (of 16 gallons), of which were exported 197,777.

The currant of Northern Europe (*Ribes*) does not thrive in the Ionian Islands. What bears the denomination is the fruit of a dwarf vine (*Vitis corinthiaca*), which is thought to have originated the word *currant*, through the French name of *Raisin de Corinthe*, given it from the place of its first export to the West. The currant vine bears after three years, and the stocks last for 20 or 30 years. The fruit is ripe in August, and when gathered is spread out to dry on prepared spots; a process which occupies from 14 days to three weeks. The blight so prevalent in Europe did not spare the currants of the islands; but in all places seriously injured, and in most wholly destroyed, the crops of 1853–4–5. The disease is supposed (1855) to be on the decrease however, and the fumes of sulphur have been found a remedy of great efficacy, where the difficulty of applying it has been overcome. The export of currants in 1851 amounted to 40,198,126 lbs.; but in 1854 it was only 10,900,650 lbs., the quality being bad at the same time.

Neither raisins nor figs, nor other dried fruits, are exported; nor are fresh oranges sent away; although various kinds, including the Mandarin orange of Malta, succeed in the islands; nor the singular melons of Cephalonia, which, being hung up in October, remain good till April or May. But, though unimportant, it may be curious to mention, that as citrons ripen in no place nearer to Poland than the Ionian Islands, they have been sent to obtain high prices from the wealthy Polish Jews, who long for them as the choicest ornament of the arbors in which they celebrate the Feast of Tabernacles. The prickly pear (*Cactus Opuntia*), which is the food of the cochineal, thrives in all the islands, of which Zante alone collects the insect, exporting it to Tunis. Probably the same might be done in other parts of the states. Cotton will grow in any of the seven islands. In Cephalonia it is raised in some quantity, and of good quality. *Valonea*[3] forms a considerable article of export from Santa Maura alone, but might probably be grown elsewhere. Madder (*Rubia tinctorum*) grows wild throughout the islands, and is used by the peasantry for dyeing; but it is not cultivated, as it no doubt might be, as a valuable export. A successful experiment has shown that, in Corfu at least, indigo can be grown, and the dye obtained from it; but no practical result has followed.[4]

The Ionian seas contain abundance of fish, yet even the markets of the towns are by no means so well supplied as they might be,[5] the fishermen not caring, in general, to put out far from land.

Manufactures.

In all of the Ionian Islands coarse cloths are made in the villages, for home use; and in most are potteries for a coarse earthenware, the best articles of which are the porous jars made in Zante, for cooling water by evaporation. In several places, but chiefly at Corfu, silver and gold are prettily worked into filigree and chased ornaments; and in Zante silk is dyed, and woven into scarfs and handkerchiefs. The sweetmeats of Zante and Cephalonia are esteemed, and the liqueurs of the latter, particularly an imitation of *Zara Maraschino*, are prized beyond the islands; and the soap of Zante has a good reputation through all the Levant. In the Venetian time the raising and weaving of cotton at Cephalonia is said to have been carried to a great extent, but they are now very limited. Salt is obtained in considerable quantity at both Corfu and Santa Maura by evaporation alone.

The chief export trade of the islands is that of oil to Venice and Trieste, and that of currants to England. The principal imports are of grain from Taganrog and other ports of the Black Sea, as the islands do not grow altogether above a fourth of a year's consumption; and of manufactured goods from England and the Austrian dominions, from both of which quarters they must be admitted at the same duties, according to a provision of the treaty of Paris.[6]

The Ionians, especially those of Cephalonia, are much engaged in commerce, and a large share of the carrying trade of the Black Sea and the Levant is in their hands. The traffic between the sister islands is not important in point of value,

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[1] Given by Mr Montgomery Martin, in his *History of British Possessions in the Mediterranean*, in Colonial Library, vol. vii., p. 332, ed. of 1837.

[2] For a long term previous, till about 1780, the uneven number marked the oil year; but then it changed to the even number, as in the last great crop of 1834. Last year (1855) it returned to the uneven.

[3] It is the acorn crop of the Valóni oak (*Quercus Ægilops*), a product chiefly imported to England from Turkey, to the extent of 8000 tons annually.

[4] Dr Davy alludes to this experiment, and considers indigo might succeed remarkably well, *Notes*, &c., chap. iv., pp. 7 and 8, note.

[5] Domitian's turbot, celebrated by Juvenal, was caught off Ancona (*Sat.* iv., v. 40), but at the entrance to the Adriatic that fish is seldom caught.

[6] Treaty of Paris (5th Nov. 1815), art. vii.; it is given in Jervis's *History of Corfu* (1852, London, Colburn), Appendix F.

but is constant and employs a number of hands; and of small craft, which, in shape and various peculiarities, such as the wickerwork fence overlapping the bulwarks, recall the vessels of classical antiquity.[1]

For short passages, in many places is used a very rude canoe, hollowed out of a single tree, and thence termed *monoxylon*.

A peculiar flag belongs to the Ionian republic, under which its vessels sail, and which is recognised by other powers.

Money. The Ionian government, as the head of an independent state, issues money of its own, but gets it struck in England. The Ionian coins now in circulation are, silver pieces of 6 *oboli*, or 3 pence, and copper pieces of 1 *obolo*, or ½d., and ½ *obolo*, or ¼d., with *piccoli*, or small bits equal to ⅕th of a halfpenny. Besides these, British money of all denominations passes at its full value, with a vast variety of foreign moneys, which become a legal tender after being included in an official tariff of the rates at which they will be taken by the government.[2]

The legal interest of money is 6 per cent. on mortgages, and 10 per cent. on personal obligations. In loans on bottomry there is no limitation, and 3 per cent. a month is the general rate stipulated. Usury is very prevalent, and many ingenious expedients are adopted to evade the stringent laws against it. A most useful remedy has been found in the establishment of the Ionian Bank, set up in 1839 by a joint-stock company of British and Ionian shareholders, having the head office in London, and branches in Corfu, Cephalonia, and Zante, with corresponding houses in Athens and Patras; beginning with a capital of L.100,000, which has since been increased to L.150,000. The bank affords great facilities in discounts and advances, and allows interest on deposits. It enjoys an exclusive privilege[3] of issuing promissory notes. These, being payable on demand, form a convenient and favourite circulating medium.[4] The smaller growers of oil and of currants have been too prone to follow an improvident system in the disposal of their produce, by throwing it into the hands of agents. Oil, requiring some time to become clear from the vegetable matter suspended in it, ought to be kept in quantities in stone vats or troughs. But to save the expense of these and of a magazine, it is common to deposit the oil with a storekeeper, who receives it impure and delivers it pure, of the same quality, but in quantity diminished by his allowed per-centage for his trouble—commonly 3 per cent. In like manner, currants, when removed from the drying ground, need to be placed in a store, safe from damp and insects, where they have to be watched to prevent fermentation, and for this care a certain rate is charged. In both cases the storekeepers register what is taken in, for which they grant receipts, and the owners often draw upon them for money against the value of the deposits; an account-current being kept of such transactions till the sale of the articles, which is frequently managed by the storekeepers, whose first settlement often gives rise to dispute. In the oil-trade, too, it is common for growers to grant oil bills or notes, promising to deliver at a fixed term a stated quantity of oil at a certain price; which results in a gambling speculation on the future market-value of oil.

While money bears such a value as has been stated, it is rather surprising to find the price of land so high as it is, although no exclusive political privileges attach to that sort of property. Estimates of land are based on the average returns for the last 10 years,[5] and are made up so as to allow 4 per cent. on the capital to be expended; but it is well known that, practically, buyers are satisfied if they draw 3 per cent. on their investments.

Insurance. Insurance, with all its wonderful benefits, is little known to the Ionians. Of late years, the Austrian Lloyd Company of Trieste, whose activity is doing so much good in the Levant, has had a branch for insurance of various kinds in the chief Ionian Islands, but its operations seem to have been limited to insurance of ships and against fire. Practically, too, the Ionian Pension Scheme, organized in 1830, serves as a society of mutual assurance, and works well, by maintaining a fund which goes far to save the general revenue from liability to the public servants who retire after having contributed to the fund, the amount of which in 1854 was upwards of L.50,000.[6]

Revenues. The Ionian revenues are mainly derived from export duties on produce[7], import duties, and stamps. In average years the aggregate of the general and municipal revenues might be taken at about L.164,000. The loss from failing crops is now proposed to be made up by a duty on houses, which have hitherto been exempt from taxation.

The ordinary expenditure of the country ought to be within the above amount, especially since the liberal reduction of the sum contributed towards the cost of the military force to L.25,000. But embarrassment in the finances, beginning in 1835, although temporarily checked in 1842 (when the public debt amounted to about 150,000),[8] has gone on without effectual remedy, till proposals to that end were made in 1855 to the Ionian legislature.[9]

Religion. The dominant religion in the Ionian states is that of the Greek or Oriental Church, the patriarch of Constantinople being recognised as the head, although he is not so in Russia or in Greece. The three orders of clergy—bishops, priests, and deacons, are maintained. Each island has its bishop, elected by its own clergy, and approved of by the government, but not consecrated without the authority of the patriarch. In the ceremony of consecration is observed a relic of the old deference to popular approval; for before each of the proper episcopal vestments is put upon the bishop-elect, the assembled multitude is asked by open proclamation, "Is he worthy?" and an unfavourable response would, it is said, cause proceedings to be stayed. The bishops of the four principal islands, Corfu, Cephalonia, Zante, and Santa Maura, have the title of Metropolitan (equivalent to that of archbishop), and discharge by turns, for five years, the duties of the channel of communication with the patriarch; which gives them for the time the style of Exarch, a name derived from that of the representatives of the Byzantine empire at Ravenna and elsewhere. Some of the Ionian sees are of great antiquity, and their

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[1] Bowen's *Ithaca*, Appendix I.

[2] Amongst these are the Mexican and South American dollar, rated at 4s. 4d. Doubts have been started in the Mediterranean as to the good policy of admitting them as currency, as their fineness is sometimes questioned, and their inequality in weight is constantly found. Hence it is argued, the heavy coins will be used as bullion, and none but light ones will be sent to places where they are currency at the same value as the Spanish Pillar dollar. Of 1000 South American dollars weighed at Malta in 1834, 718 were over weight, 41 exact weight, and 241 under weight. See pamphlet *On Currency of Malta*, by a British Merchant, Malta, 1850. In Austria these dollars go for 4s. 2d. only. The dollar of account in the Ionian States is the Venetian or imperial = 4s. 2d., marked $. The Pillar dollar is = 4s. 4d., and is marked $.

[3] For twenty years from 23d October 1837.

[4] The smallest are = L.1, and the largest, 100 Spanish dollars = L.21, 13s. 4d.

[5] Formerly five years; altered to ten, after so many failures of crops.

[6] L.50,910, 19s. 9d.

[7] Chiefly one of 18 per cent. *ad valorem* on oil and currants, fixed in May 1833, by 14th act of 4th parliament.

[8] Speech of the Right Hon. J. A. Stewart Mackenzie, Lord High Commissioner, 3d March 1842, in *Ionian Government Gazette*.

[9] Speech of the Right Hon. Sir John Young, Lord High Commissioner, 18th June 1853, in *Ionian Government Gazette*.

bishops may be recognised in early councils of the church. It is commonly said that the Greek Church permits its clergy to marry; but this is not a correct mode of stating the extent of the indulgence, which is limited to allowing persons, who have married before ordination, to retain their wives and yet enter the sacred profession; and the rank of bishop is denied to a churchman not a bachelor or a widower.[1] The clergy are extremely ill paid, and not unfrequently take a share in commercial or other occupations. As a body, in spite of honourable exceptions, they cannot he deemed other than ignorant, and not highly regarded by the community; and comparatively few of the higher classes enter the sacred profession. The Oriental Church has never withheld any part of the Bible from the study of the laity. None, however, without some education, could have profited by such a license till of late years, when British and American religious societies have circulated versions of the Scriptures in modern Greek. The liturgy of the Eastern Church is in the ancient Greek of the fathers, and many of the prayers are reputed to be compositions of St Basil, and the same language is employed in the pastoral letters of the patriarch. The Ionian church has not followed the example set in Greece of prohibiting the marriage of its orthodox with heretics, and is very tolerant towards Protestants, while it views Roman Catholics with jealousy, and Jews with abhorrence. Throughout the seven islands the number of both clergymen and churches is far beyond what is required, the latter exceeding 2000. Except the prelates, the clergy are not supported by the general treasury, but by the income of ecclesiastical property, now in the hands of government, and by special endowments. Many churches are in the hands of fraternities, and still more in those of lay patrons, who provide for the service out of the income, dues, and offerings, and are not called on to account for the overplus.[2]

The Latin Church, which was dominant under the Venetians, has a bishop resident at Corfu, but not permitted to take his title from an Ionian diocese; and out of the former property of the establishment the ecclesiastical body is supported. The Roman Catholics are not numerous, and consist more of foreigners than descendants of Venetians and other settlers.

The Church of England has a military chaplain at each of the three principal stations for the troops—Corfu, Cephalonia, and Zante. The appointment of a government civil chaplain was for the first time made in 1836, but it was discontinued after about three years. Since that period, the civilians at Corfu have occasionally, with aid from religious bodies in England, raised by subscription funds to make up a salary for an officiating clergyman. The islands, being a foreign state, are not within the proper diocese of the bishop of Gibraltar; and the act of parliament enabling government to contribute to the endowment of chapels at some of our Mediterranean factories has been held inapplicable to them as it at present stands.

Several thousand Jews are to be found in the islands, most of whom are domiciled in the town of Corfu, having originally come from Spain. In former times they were exposed to great ill usage, and even now do not escape the contumely of the vulgar, who will not allow them to show themselves at Easter. Till of late years their cemetery was not permitted to be inclosed, and they still labour under various disabilities, civil as well as political. They may become attorneys but not advocates, and are excluded from the public service. Medicine is open to them, and among their practitioners are always to be met with men eminent for skill and ability. The laws respect their sabbaths and some of their high festivals, by exempting them from being called to attend the tribunals on those days. Their chief occupation is trade, in which many have acquired wealth and respectability.

Language.

The language of the country people in the islands has always been Greek, more or less corrupted. That employed in good society and in commerce, as well as in legislation and official business, was Italian, till the recent adoption of Greek as the language of the legislature, courts of justice, and all public departments. The Italian commonly spoken partook, naturally, in a great degree of the peculiar Venetian dialect. The several islands dispute the purity of their Greek. Corfu, from the mixture of other languages, and the comparative neglect of the native dialect by the higher classes, was supposed to have had its Greek more debased; and Santa Maura, having less intercourse with foreigners, claimed for its vernacular speech the first place in point of correctness. When Greek journals were printed in Corfu, Cephalonia, and Zante, some years ago, their style was reckoned by competent critics little inferior to that of the contemporary Athenian newspapers. Nevertheless, whether the reflection be agreeable or not to their self-complacency, the Ionians may rest assured, that in the Hellenic world the true standard of language will be looked for at Athens, not at Corfu. English is pretty generally understood, and is spoken well by some who have never been out of the island; but its employment as the sole language of translation has not been provided for so distinctly as the constitution of 1817 directed to be done, before the introduction of Greek into daily use should take place.

Education.

Public instruction forms an important branch of expenditure, about L.10,000 a-year being the charge for schools in all the islands and the university at Corfu.[3] In the lifetime of the late Frederick Earl of Guildford, who was its chancellor and spent large sums of his own upon its chairs and students, and while, during the subjection of Greece, the Ionian Islands were in some measure the metropolis of the Hellenic race, this last establishment might be said to flourish. Now, without extraneous support, and with a more favourably situated rival at Athens, it has become unsuited to the wants of the population. A beneficent lady, the late Countess Mocenigo, in bequeathing funds for educational purposes, directed scholarships to be awarded to meritorious students, for enabling them to go abroad and finish their education in the colleges of larger countries; and many think the Ionian government would do better to act upon a similar system while improving and extending the schools within the states. As a stimulus to acquire some elementary instruction, the election laws prohibit any elector from using the franchise till he has shown he can both read and write; and it is satisfactory to find the ability to read and write so diffused, that out of 981 persons (943 males and 38 females) brought before the Corfu tribunals[4] superior to the police court, between 1st May 1843 and 1st May 1844, 210 was the number of those who appeared ignorant of both.

Justice.

During the rule of Venice, the islands observed the Vene-

[1] The popular opinion, that a married priest may become a bishop, if his wife will separate herself from him and retire into a convent, is understood to be uncanonical.

[2] An instance of this is the church at Corfu containing the relic of St Spiridion, and belonging to one of the Bulgari families.

[3] Students at university in 1852 = 72; at Minor College, Corfu, 79; and at the schools throughout the islands, as stated in the table accompanying Sir H. G. Ward's Despatch of 25th August 1853 (*Parliamentary Papers*)—Corfu, males 1393, females 225; Cephalonia, males 1301, females 132; Zante, males 1030, females 180; Santa Maura, males 591, females 30; Ithaca, males 571, females 75; Cerigo, males 579, females 70; Paxo, males 246, females, 21.

[4] *Statistica Penale, dal* 1 *Maggio* 1841 *ai* 30 *Aprile* 1844, by Dr Giulio Tipaldo Pretenderi—a set of very well-arranged tables, published at Corfu, 4to, 1846.

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tian statutes, civil and criminal, recourse being had when they were silent or defective to the Roman law of Justinian. Under the French dominion (1807-1817), the legal system of Napoleon was not established. After the local legislature was organized by the constitution of 1817, various enactments were passed, abrogating or modifying former laws. The same constitution contemplated the exchange of the Venetian laws for entire codes, which should form a part of the constitution itself, and receiving like it the previous sanction of the crown, have a character of permanency, from the impossibility of their alteration by the Ionian parliament. In 1841, by what seems a violation of this positive provision, there were issued a civil code (of about 2100 articles), and a criminal code (of about 800 articles), with relative codes of procedure, all derived mainly from the *Code Napoleon*. These bodies of laws have received some modifications, but have been allowed to stand in the situation of purely local laws, and liable to change by the ordinary legislature. Each island has a judicial establishment of its own, consisting of civil, commercial, and criminal courts, together with police magistracies. From these courts, beyond a certain amount of value, and a certain scale of punishment, there is an appeal to the supreme council of justice at Corfu, which decides in last resort—the appellate jurisdiction of the privy council not extending to the Ionian Islands as a foreign state. This court is composed of four members; two Ionian, named by the senate, and two, either British or Ionian (but in practice always the former), appointed by the crown. These judges take the chair for a year in rotation; but the president not having a casting vote, when they are equally divided in opinion, the question is carried before the lord high commissioner and the president of the senate, and the voice of the former preponderates. The number of cases decided in appeal is nearly 1000 each year, by far the greater part being reviewed on written pleadings without being argued *vivâ voce*. Trial by jury, in a modified shape, is resorted to in cases of alleged libel, having been introduced as a provision of the press law of 1848.[1] It has been little resorted to, and cannot be said to have given satisfaction. The courts in all the islands have the assistance of a highly intelligent and respectable bar. Every see has an ecclesiastical court in which its prelate sits alone; the court of appeal being composed of the exarch (or the bishop next him in succession to the office) and three clergymen, the prelate having the casting vote.

Descent.

How far the Ionians can be looked upon as true descendants of the Greeks of antiquity, it is not easy to determine. Some German authorities consider that Fallermayer[2] is correct in supposing the present continental Greeks to be wholly of Sclavonic origin, dating from the seventh and eighth centuries, a conclusion rather judged too sweeping with regard to Greece Proper, and which is less applicable no doubt to the islands, whose rural population was not so exposed to be cast off or mingled with foreign races. This, with the arguments founded on language, character, and often physiognomy, warrants the belief that among the country people there is yet some of the ancient Greek blood.[3] The inhabitants of the towns are more likely to be of mixed origin, and most of the higher classes seem to be of foreign descent. Each island has widely ramified septs or clans who have the same name, like the *nomen gentile* of the Romans, while the particular families have some distinguishing appellation. Few of the sirnames had other than vowel terminations till it very lately became fashionable to add a Grecizing *s* to the heretofore final letter. As written in Italian times, we find, at Corfu, many houses of the Theotoky, Bulgari, &c.; in Zante, the Volterra, Salamos, &c.; in Ithaca, the Petalà, Caravía, and Dendrino, &c.; while in Cephalonia, the principal names form an Italian heroic verse, when thus arranged, "Loverdo, Metaxà, Tipaldo, e Vocca." The name of Tipaldo is thought to be derived from the French Thibaut, and that of Corafà (in Cephalonia) from the Italian Caraffa. At Corfu the Venetian name of Dandolo is found unchanged, and the Zambelli of Santa Maura belongs to the noble house of that name established at Trent. The heraldry of the islands is Venetian, and has been jealously maintained. Some Ionian families, ennobled by the Venetian seigniory, and amounting at present to about 50, have the hereditary title of Count, which is borne before their Christian name by all members of the house, male and female, but is transmitted by the male only. Sounding titles are liked. The president of the senate is styled "His Highness," the senators "the Most Excellent," members of assembly "the Most Noble," and every elector is qualified to write himself "Noble," that having been ruled by the constitution of 1803; a mode of republican equalization by levelling up instead of levelling down. Several families, untitled as well as titled, are understood to trace their pedigrees up to a period anterior to the Venetian rule; and one or two charters of the Neapolitan time (before 1386), and even of the Greek empire, are said to be extant in their archives.

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In 1818 the Prince-regent instituted "the Most Distinguished Order of St Michael and St George," divided into three classes, and originally giving precedence in Great Britain; but by a later statute having that effect only when the sovereign shall so declare on investiture. It was mainly designed to reward Ionians and Maltese; but the commissioners of inquiry into the affairs of Malta some years ago,[4] did not consider it had been of any utility in that colony, and perhaps the same view might be taken of it in relation to the Ionian republic.

Property.

In 1825 the Ionian legislature[5] put an end to entails, prohibiting them for the future, and giving great facility to the cutting off of those in existence. The old entails, under the form of perpetual trusts, had been designed to favour the nearest blood of a family rather than individual successors, and most commonly allowed all the male heirs of equal grade to participate. They thus locked up lands from commerce, and impeded their improvement, failing at the same time to obviate the endless subdivision of property. So far had this last evil gone, that the fifth part of a single olive-tree was actually a point in dispute not many years ago, and still smaller fractions have been spoken of. There are no great fortunes inherited, but many families are in comfortable circumstances; and some holders of land, who also engage in trade, are believed to be wealthy; in one case, report has attributed to the party no less than L.100,000; but if this be not an exaggerated estimate, it is founded in great measure on credits which could not be realized at pleasure. If we take as a measure of Ionian incomes the highest official salaries, that of the president of the senate, before a recent hasty reduction, was L.1350, and that of each senator was the half. Families of high respectability are satisfied with assigning to a daughter a marriage-portion of 6000 Spanish dollars = L.1240, which may ultimately come to be the chief source of her support in widowhood.

The price of labour in the larger islands is high. In 1824 field labourers got 1s. 3d.[6] a-day, and in 1855 not less.

Cheapness of living might be presumed from the moderate incomes of the native gentry; but foreigners do not

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[1] Act 68th of 8th parliament.

[2] *Geschichte der Morea.*

[3] See the question as to the Hellenes generally, discussed in a note to chap. lxvi. of Thirlwall's *History of Greece.*

[4] *Parliamentary Papers*, Report of Malta Commissioners (Messrs Austin and Lewis).

[5] Act 34th of 2d parliament.

[6] Dr Davy's *Notes*, vol. i., chap x., p. 376.

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find this in the larger places where the conveniences of life are to be had; and to obtain the same amount of comfort as in any part of Great Britain beyond the capital, the same sum must be spent in the islands alluded to.

Habits.

In externals, the higher orders of Ionians are becoming assimilated to those of Western Europe. Few ladies now wear the dress of their own islands, but submit to the fashions of London and Paris. The female peasantry keep up the proper costumes of their districts, which are very various, and sometimes costly, from the profusion of gold and silver ornaments. The attire of the men is more uniform and simple, except when the plain brown jacket is exchanged for a blue one enriched with embroidery. They like to appear in their best at the church festivals, when they meet also to dance in the open air. Their dances, although traditionally derived from those of the ancients, have little variety or grace, and no animation except in some executed by men alone. In the lower ranks, an oriental feeling still prevails, and women are generally treated as inferiors, and the lazy husband makes the wife his drudge, enforcing his commands with the stick, of which it is a point of honour for her not to complain. The upper classes are giving ladies their due place in society; but from some aristocratic feelings, do not welcome the birth of a girl, who may one day carry her dowry away from the family. There is a strong dislike to women remaining unmarried; yet the objection to their going into society is but gradually disappearing. Marriages in every grade are for the most part arranged between the families, and the parties most concerned often see each other for the first time after their union has been settled. Divorces seem to have been granted formerly on slighter ground than would now be held sufficient, and they occur less frequently. The Greek Church does not sanction any one's marrying oftener than thrice, and prohibits matrimony between cousins three times removed,—a restriction at one time thought to extend still further.[1]

Baptismal names are in many cases taken from the patron saints; whence Spiridion is so common in Corfu, Gerasimo in Cephalonia, and Dionisio in Zante. Ancient names however abound,—Aspasia for girls; Leonidas, Socrates, and Themistocles, for boys. To strangers the effect is odd, as they do not readily regard the name as an ordinary appellative, but think of its ancient bearer or of its meaning, and start at hearing that Aristides is a fraudulent bankrupt, or that Zoë (life), and Athanasius (immortal) are both dead. Saints are sometimes invoked on account of their names,—as in marriage contracts, Procopius;[2] and in parturition, Eleutherus.[3]

Greek families frequently take into their service young girls, who receive very small wages, but are treated with much indulgence and familiarity, and have the promise of a dowry to assist their settlement in life, after they shall have reached a suitable age.

In the country districts there are many usages which may be traced back to antiquity; and the mode of living has little changed from the earliest times. The "villani" are addicted to gambling, and the old game of the "morra" is seen almost as much as in the Campagna di Roma. The educated classes have emancipated themselves from superstition; but it has great sway over the vulgar, and an oath on the relics of a saint is regarded with much higher awe than one upon the Gospels. A mixture of superstition and idleness used to cause such observance of saints' days and other festivals, that, including Sundays, there were above 200 days on which work was not done; but the church does not require this cessation from labour, and it is practically limited to particular festivals, which are quite numerous enough. Much as the Jews are abhorred, it is curious that at Easter families of every rank kill a lamb, when the church bells ring joyfully on the Saturday just an hour before noon, and mark a cross with the blood on the lintel of the door, from which it is never washed off. Belief in the effect of the "evil eye" is very strong and general; and it is supposed to cause harm to children, animals, and property. Nay, witchcraft, in the shape of spells and philtres to create love, and of fortune-telling, is not exploded. The terrible "vendetta" of Southern Europe is not entirely eradicated from the Ionian people, but it is much tamed, although it often displays itself in malicious mischief to the property of the hated individual; and in its most dreadful form it would be rarer than it is, did the present law, adopted in 1847, not require proof of premeditation, which it is extremely difficult to bring forward. Inebriety is not an Ionian vice; among the lower orders it is extremely rare, and among the higher classes is almost unknown. Music is generally relished in the Ionian States; all ranks evince the gift of a good ear, and the opera is a favourite recreation in the islands which can command one.[4] Many excellent musicians, vocal and instrumental, are to be met with among both ladies and gentlemen of the best society.[5]

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Character.

Of the Ionian character a passing stranger is likely to take a favourable impression. In manner, they resemble well-bred Italians rather than the French of the present day. To great politeness they add ready speech, and take pleasure in making themselves agreeable; or perhaps in the more refined art of making their hearer imagine that he has rendered himself agreeable to them. Their perception of character is almost intuitive, and affords them an incalculable advantage, where they wish to persuade. They discuss with temper, as well as ingenuity, in business as well as in society. In their family relations there is much kindliness and good nature, where neither interest nor passion enters. Children are indulged to a fault, and permitted to give vent to their feelings, instead of being taught to restrain them. From the mode of contracting marriage, it is said that, although society is never shocked by improper manifestations in public, the standard of matrimonial morality is by no means high. But the most generally besetting sin of the Ionian is that which was so conspicuous among the ancient Greeks—mendacity. In the idle rumours of the day it is wonderful how many minute details are given, with apparent accuracy, on the principle laid down by the servant in Sheridan's comedy, who thought one lie must be supported by many.[6] Then in more important matters the widely-spread evil is of serious magnitude. As regards others, the courts of justice every day experience the utmost difficulty in ascertaining exactly the truth. Want of good faith in fulfilling engagements is common, to an extent very astonishing in a country where there is commerce, and consequently credit; yet the high profits expected from money, and the low return looked for from land, prove the difficulty of recovering capital lent out. Other contracts than those regarding loans are constantly violated, and parties do their utmost to overreach one another with an ingenuity well worthy of a better motive, and with a degree of disapprobation from society noways commensurate. Litigation is therefore begun with boldness, and continued with obstinacy; and it is well known that the Ionians are more unreasonable and troublesome than any of those who come in the way of business to the British consulates in

[1] *i.e.*, A degree more; and to have applied the rule to spiritual affinity, or that caused by relationship to one's godfather and godmother.
[2] They say Προκόπιος προκόπτει.
[3] The freer or deliverer; in Italian, *San Liberale*.
[4] Corfu every year, Zante and Cephalonia occasionally.
[5] Signora Angri, who sung lately at Covent Garden, is a Corfiot.
[6] *The Rivals*, Act ii., sc. 1, Fag *loq.*

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the Levant. In the political affairs of the Ionians, the charge of tergiversation is vehemently bandied about, but it produces little effect on those who receive it, or on the public at large. Like the Greeks of antiquity, the Ionians are ambitious, vain, and as impatient of the pre-eminence of others, as any who have felt "envy, the vice of republics;"[1] so that the rustic who could not endure to hear Aristides called "the just," would not appear singular in the Septinsular States.

If genius has not displayed itself among the Ionians, the talents of many of them have, in various walks, led them to honourable distinction. In the sixteenth century the grammarian Matteo Devari (Matthæus Devarius), a native of Corfu, wrote his Latin treatise on the Greek Particles, since superseded by the larger works of Hoogeveen and others, but valuable at the time of its posthumous publication.[2] Eugene Bulgari, who died in 1806, archbishop of Cherson, was also a Corfiot, whom the Empress Catherine II. drew to Russia, on account of his celebrity for Greek scholarship. Ugo Foscolo belonged to the same island, and so does the Cavaliere Andrea Mustoxidi,[3] whom we name though living, as he has already a European reputation for his Italian version of *Herodotus*. Carburi the engineer, who performed the herculean task of transporting to St Petersburg the huge mass of granite for the pedestal to Falconet's statue of Peter the Great, was from Cephalonia. Thence, also, went into the service of France, Count Loverdo, who became a general under Napoleon. Corfu was the birthplace of Count Giovanni Capo d'Istria, who attained a high rank among diplomatists, and rose to be president of Greece, the station he occupied when assassinated by Greek hands, from which he was justly entitled to look for protection and support. In the fine arts, Corfu may boast of the late Cavaliere Prossalendi, whose ability as a sculptor is attested less by the bronze statue of Sir Frederick Adam, which the artist left unfinished, and which was completed by others after his death (to stand on the esplanade of Corfu), than by works which may be seen and admired elsewhere.[4]

Corfu.

Corfu[5] (anc. names *Scheria*,[6] *Phæacia*, *Corcyra*).—This island, the most northern of the Ionian States, lies along the coast of Albania (Epirus), for the chief part, at a distance of about 6 or 8 miles, but at one point of the N.E. channel being little farther than 1¼ mile. It is of a curved form, not very unlike the sickle,[7] to which the ancients compared it; its extreme length is about 40 miles; its breadth varies, nowhere exceeding 12 miles;[8] at the town of Corfu it is about 6, but lessens gradually towards the southern extremity. Towards Albania, or E., it turns the hollow side, having nearly in its centre the town and harbour of Corfu. The island may be said to be separated into three parts by hills running across it; the northern range being that of San Salvador[9] (the ancient Istone),[10] and San Pantaleone; the southern being formed of the hills of Benizze; while the middle section of the land is backed by the mountain of Santi Deca[11] and other hills, descending close or near to the sea on their western sides. San Salvador is something above 3000 feet high, and Santi Deca is not much inferior. The whole country presents the utmost diversity of ground, and is well clothed with wood, while many places display the most varied and luxuriant vegetation. The want of streams capable of producing much effect in the landscape is made up for by the sea, which towards the E. wears the resemblance of an extensive lake, with the Albanian mountains towering beyond, bare indeed, but picturesque in outline and hues, with their second range lofty enough to add to the view snow on their summits till after the close of June. The prospects from the more elevated spots are magnificent, taking in both seas, and in clear weather discovering the line of the Italian coast, near Otranto, although above 70 miles away. In all directions the villages, with the churches and belfries, add greatly to the effect, placed as they commonly are in high and prominent situations, and mingled with wood.

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The town of Corfu (pop. above 20,000) stands upon very uneven ground, forming the broad part of a peninsula, whose termination in the citadel is cut from it by an artificial fosse, formed in a natural gulley, having a salt-water ditch at the bottom. Seen from the water, or from a height, it is picturesque in masses, but in detail it is not to be praised for either beauty or comfort. Having grown up within fortifications, where every foot of ground was precious, there is nothing spacious, except the handsome esplanade between the town and the citadel; and there are no buildings of importance. The palace is large, but the exterior has no architectural merits, although internally its apartments are very stately. In several parts of the town, in which there are not many streets fit for wheel-carriages, may be found houses of the Venetian time, with some traces of past splendour, but they are few, and are giving place to structures in the modern French style, which are more convenient for habitation.

Travellers generally agree that Corfu is the most beautiful of all the Greek isles, except, perhaps, Candia (anc. Crete), which is less easily visited. But foreigners who have been long in Corfu complain of the monotonous colour of the olive, whose grayish-green is little relieved by the cypress and pine, or mulberry and *jujubier*. This is the more to be regretted since the island is adapted for many different trees, such as various descriptions of oak, plane, Spanish chestnut, walnut, &c. The government of Venice gave at one time premiums to landowners for planting olive-trees, partly to encourage so desirable a product as oil, and partly to discourage the raising of wheat, which might interfere with that from the continental estates of some Venetian nobles. Once planted, the olive has suited the people. The number of trees in Corfu has been guessed to be not much below six millions; the produce in the last full oil year (1834) was 236,016 barrels of 16 gallons

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[1] Longfellow, *Evangeline*, part i., l.

[2] Maffeo Veniero the poet, archbishop of Corfu (ob. 1586) was not an Ionian, but born at Venice of a noble house.

[3] This writer, as historiographer of the Ionian Republic, has completed a History of the Ionian Islands in Italian, which is understood to be already in the hands of the Ionian government, but why its publication is delayed has not been explained.

[4] His marble statue of Diana is in the collection of the Duke of Devonshire, and his Hero watching for Leander (also in marble) was possessed by the late Lord Nugent. Prossalendi died in 1837.

[5] Derived, it is believed, from κορυφή, in allusion to the two peaked rocks on which the citadel stands, or perhaps directly from the modern Greek κορφή being written κόρφόι, which sounds the same— Κέρκυρα is now preferred.

[6] Dr Smith, in his *Classical Dictionary* (*voc.* Phæates) thinks that Scheria was not the same with Corcyra; but the ancient authorities seem to treat them as identical. Phæacia appears employed by Latin writers, as Pliny and Tibullus, but it is never used by Greek authors. Homer names Scheria as "land of the Phæacians," without expressing that the entire island belonged to them.

[7] They gave it sometimes the appellation of Drepane [Δρεπάνη], whether referring to the implement of Ceres, or the one so cruelly used by Chronos against Cœlus (Hesiod, *Deor. Gener.*, 158–200).

[8] When the greatest width is called twenty miles, the measurement is taken from the east end of the projecting part, likened to the handle of the sickle, which ought rather to be computed in the length.

[9] This is the old Venetian way of writing the Italian "Salvatore."

[10] So fatally celebrated in the beginning of the Peloponnesian War.

[11] This is often worse corrupted into Santa Decca. The Greek name is οἱ Ἅγιοι δέκα, or "the ten saints;" who they were is unexplained.

each.[1] Single trees of first quality yield sometimes as much as one jar, or 2 gallons of oil, and this with little trouble or expense beyond the collecting and pressing of the fallen fruit. The trees being allowed to grow unrestrained are much larger and more wide-spreading than those in Provence or Tuscany, and some are of great age, not under three centuries, and frequently the stem is decayed almost to the bark, which still sustains the branches. It is worthy of remark that Homer names, as adorning the garden of Alcinous, seven plants only—the wild olive,[2] the oil olive,[3] the pear, pomegranate, apple,[4] fig, and vine.[5] Of these, the apple and pear are at present reckoned very inferior in Corfu; the others thrive as well as they did, and are accompanied by all the fruit-trees known in southern Europe, with addition of the Japan medlar (or loquat), and in some spots of the plantain or banana. Of fruits found in perfection farther north, the cherry and strawberry agree with Corfu. When undisturbed by cultivation, the myrtle, arbutus, bay, and ilex form a rich brushwood, and the native *flora* is extensive.[6] The few individuals who have taken care of gardens and other rural properties in Corfu have reaped ample fruits of their pains; but Corfiot proprietors in general display little taste for the country, to which they do not resort except in autumn. This sort of absenteeism is probably increased by the tenure of land, which locks up most estates in Corfu, and is peculiar to it. It is termed "*colonia perpetua*," or perpetual tenant-right, and is regarded as a kind of lease, yet being in its effects more akin to a subinfeudation. The landlord grants a lease to the tenant and his heirs for ever, for a rent, payable in kind, fixed at a certain proportion of the produce. Of old, a tenant thus obtaining half the produce to himself, was held to be co-owner of the soil to the extent of one-fourth, and if he had three-fourths of the crop, his ownership came to one-half. Such a tenant could not be expelled but for non-payment, bad culture, or transferring his lease to another person without the landlord's consent. Attempts have been made to prohibit so embarrassing a system.[7] Agriculturists preferring this tenure, the existing laws permit it,[8] but require an express stipulation[9] for giving the tenant any right to what has been viewed as property in the soil, while it is really more of a security, and merely entitles the tenant to be paid for his apparent share, if he is asked to sell his entire rights. In paying the rent or portion of the olive crop due to the landlord, whether by *colonia* or ordinary lease, the parties do not wait till the oil is pressed to find how much makes a fourth or a half, as may be, but just before the fruit drops, valuators, mutually appointed, estimate how much each tree will probably yield, and upon their calculation delivery of the fruit or the oil is made, let the true quantity afterwards produced be greater or smaller than that estimated—an arrangement which savours more of gambling than of business. Agricultural improvement will not have fair room till such evils be remedied. Traces still exist of the large old fiefs (baronie) in Corfu, as in the other islands, in the form of quit-rents (known in Scotland by the name of feu-duties), generally equal to one-tenth of the produce. But they have been much subdivided, and the vassals may by law redeem them, by payment of capital yielding, at the rate of 6 per cent., the same annual return.[10] There existed for some time in Corfu, apparently till late in the seventeenth century, a singular colony of gipsies, tolerated by the government, which assigned them a certain district to inhabit, under the exclusive jurisdiction of a particular noble family.[11]

The Corfiot peasantry are reputed the idlest of all the Ionians. The olive receives little or no culture from them; cereal crops have their soil prepared with the aid of the plough; and the vineries alone are laboured by the broad heart-shaped hoe. The vintage begins on the festival of Santa Croce, which according to old style is the 26th of September: it is not a pretty or lively scene, and little care is taken in the various operations. The fermentation in vats is very short; for sweet wines not more than four or five days, and sometimes three only: the rest of the process goes on in the cask. None of the Corfu growths are prized.

Cottagers cultivate no gardens for themselves, and every day countrymen may be met carrying out from Corfu market the herbs he has bought there, like the Roman villa-owners ridiculed by the epigrammatist;[12] and it is well known that a considerable sum[13] goes annually to buy in Apulia the garlic and onions which might have been raised round the villages. The old fortifications of the town being so extensive as to require a force of from 10,000 to 20,000 troops to man them, have been in great part thrown down, and a simpler plan is in progress, limiting the defences to the island of Vido for the harbour and to the old citadel, with the New Fort, and possibly a third point, for the land. Opportunity will ultimately be afforded for the town to spread, which is greatly needed. The chief improvement, after the introduction of water, already effected, is sewerage, towards which nothing of importance has been done. From the rocky site, no small cost must be incurred; but, for health and comfort, no measure so essential could have been taken, and it ought to have preceded every object of ornament or convenience. The largest dependency of Corfu is Fano, an island lying about 13 miles to the N.W., about 12½ miles in circumference, with its hill, Maraviglia, rising about 1500 feet. It is at present renowned for its honey; but its most interesting claim to notice arises from its being thought to correspond with the isle which, under the name of Ogygia, is assigned by Homer[14] to Calypso. Corfu and its dependencies contain very few and unimportant remains of antiquity. The site of the ancient city is well ascertained, about 1½ miles to the S.E. of Corfu, upon the narrow piece of ground between the sea-lake of Calichiopulo and the Bay of Castrades, in each of which it had a port. And the third harbour, occasionally mentioned, may have been, either where the present one is, or perhaps rather in a small bay under the hill of Ascension, below the remains of a temple, popularly called of Neptune. This relic is of very simple Doric, and now in its mutilated state presents

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[1] This is nearly, if not exactly, the measure. So it is fixed by act 9th of 3d parliament, 26th May 1828, to have effect from 1st February 1829. The barrel of 16 gallons is by the same act subdivided into 4 "metri," the metro into 4 gallons, and the gallon into 8 "dicotili." Besides these, there is the popular measure of the jar=½ metro, or 2 gallons. The price fluctuates much, but 2s. 1d. a gallon is nearly the common rate.

[2] Φυλίης ἰλαίης, *Odyss.*, v. 477.

[3] Ὀγχναι· ῥοιαὶ μηλέαι. *Odyss.*, vii. 115.

[4] Συκαῖ, *Ibid.* 116.

[5] Σταφυλή, *Ibid.* 123.

[6] See *Flora Corcirensis* of Pieri, published at Corfu above twenty years ago. Florists admire the many varieties of anemone and orchis. The apples [*poma*] of Alcinous are twice alluded to by Ovid, *Am.* i., 10–56; *Pont.* iv., 2–40, an honour they do not now seem to deserve; and on what foundatian Statius calls the orchard of Alcinous "twice bearing" ["bifera Alcinoi pomaria," *Sylv.* i., 3-81] we are at a loss to conjecture. The like epithet given by Virgil [*Georg.* iv., 119] to Pæstum, with respect to its rose-gardens, is not merited in modern days. Dr Davy would consider the pomegranate as a later introduction, and interpret ῥοιά by plum; but lexicographers make pomegranate the translation. See Liddell and Scott's *Lexicon*, and Päpe's *Wörterbuch*, *voc.* Ροιά.

[7] In 1827, by act 85th of 2d parliament.

[8] Ionian Civil Code, art. 1629.

[9] *Ibid.*, art. 1631.

[10] Ionian Civil Code, art. 1677.

[11] A good deal of curious local information on this subject might be gathered.

[12] Martial, *Epigr.*, iii. 47.

[13] Said to amount to 23,000 Spanish dollars = L.5100.

[14] *Odyss.*, vii. 244. Some would make it Gozo, near Malta, which had this name according to Strabo, ix. 407.

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some curious peculiarities of construction.[1] The remains of the other city Cassiope, now termed Cassópo, show signs of solid masonry, but nothing more: the fane of Jove has disappeared. The entire demolition of the city of Corcyra is less surprising, as the modern town, and the vast works of defence round it, must have caused a demand for materials ready to the hand.

The isle of Ptychia[2] has not been identified to the satisfaction of antiquaries; but the modern Leftimo is identical with the Leucimne of Thucydides.

The Venetians have left many memorials of their lengthened sway. A striking one is their naval arsenal on the little sea-lake of Govino, about 5 miles to the N.W. of Corfu harbour. It is quite a ruin, but is of no mean size; and it has been thought that it might be useful some day to clear out the Govino harbour for refitting vessels, as the operation could not be difficult, from the soft nature of the mud and sand with which the place is filled up. Area in English square miles, 227; greatest height in English feet, 3000. Pop.—males, 37,796; females, 32,736,—total, 70,532.

Paxo.

Paxo (anc. *Paxos*[3]) lies next after Corfu to the S., at a distance of about 8 miles. Its form is oval, being about 5 miles long and 2 broad. It is very rocky, and for their supply of water the inhabitants depend greatly on artificial cisterns, although there are springs, particularly that of Remitti, about 3 miles from Gajo. The chief produce is oil, esteemed the best in the Ionian States. The head town is Port Gajo, on the E. side, within a rocky creek, sheltered by an islet. The land of Paxo rises from the sea-shore gradually to Papandi, a village which is nearly in the central and highest position on the island. Area in English square miles, 26; highest point in English feet, 600. Pop. in 1854—males, 2729; females, 2396,—total, 5125.

Santa Maura.

Santa Maura (anc. *Leucas, Leucadia*) is about 60 miles to the S.E. of Corfu. Its length is about 20 miles, and its breadth between 8 and 9. The surface is very uneven, presenting a range of hills, loftiest at their north-eastern point, and running down to their south-western termination in the white cliff, about 200 feet high, celebrated as Sappho's Leap. The channel between the Greek district of Acarnania and the island of Santa Maura is at one part as narrow as 1200 yards, and had long been fordable, till measures were begun a few years ago to open out a passage for vessels. Here the fort to which properly belongs the name of Santa Maura stands on an accumulation of sand, having between it and the body of the island a shallow lagoon, of width varying from 100 yards to 1½ mile. We may conjecture that the island was originally disjoined from the coast of the continent, and that the opening was afterwards filled up by the deposit of sea-sand. In the age of Homer it was called a promontory (Ἀκτή); but this would be applicable either before separation or after rejunction. The Corinthians first cut the canal; but it had closed up again before the Peloponnesian War, so as to be unnavigable for galleys. The Romans are supposed to have cleared it out afresh, probably under Augustus; and a cut, proposed to be 3 miles long and 16 feet deep, was begun a few years ago; but it is not yet completed, and perhaps never will be so. Between the fort and the island, across the shallows of the lagoon, a canal for boats has been deepened and fenced with walls. A huge aqueduct, serving as a causeway, was made by the Turks to connect the fort and the island; but it was injured by an earthquake in 1825, and has not been repaired. The chief town Amaxichi (of about 4000 inhabitants) stands on the edge of the lagoon, in a low and damp situation. It enjoys abundance of water introduced by the Saracens, whose conduits admitted of modern restoration. The houses are in general confined to two stories, the lower of stone and the upper of wood, as the safest mode of construction, to escape the effects of the earthquakes. The sites of the ancient cities of Nerikos and Leucas have given rise to doubt; but the view taken by the able compiler of Murray's *Handbook*[4] seems to reconcile difficulties. Some Cyclopean and other remains of antiquity are to be found near Amaxichi; and foundations of the temple of Apollo on the rock of Leucate may be traced. The island is luxuriant in its vegetation, and most of the Ionian fruits are thought to come to greater perfection here than elsewhere. The principal crops are oil and wine for export, and grain for two-thirds of their own consumption. The currant grows, but is not raised for commerce. Some parts of Santa Maura are said to be very healthy, and they must have the advantages of elevation and of pure water; but all the vicinity of the shallows is liable to fever. Area in English square miles, 180; highest point in English feet, 3000. Pop. in 1854—males, 10,678; females, 9365,—total, 20,013.

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Ithaca.

Ithaca (anc. *Ithaca*), 5 miles S. of Santa Maura, and 3½ miles E. from the northern part of Cephalonia, to which it is nearly parallel. It is about 17 miles long and 4 broad; but not uniformly so, particularly near the middle, where it is deeply indented from the E. by the Gulf of Molo, within whose southern horn is the Bay of Vathi, at the head of which stands the town of the same name,[5] the capital of the island, with deep water close to the shore. The general appearance of Ithaca is that of a ridge of rock, with steep sides, and in one hill rising to great elevation, and may be termed rugged rather than grand, some of the valleys being gayer, from the vines and flowering shrubs with which their sides are clothed. The town of Vathi makes a picturesque curve round the end of its bay, which seems landlocked, and is overhung by hills. It contains above 2500 inhabitants. Few, if any, of the present Ithacans can claim descent from the subjects of Ulysses; as the incursions of corsairs and wars with Saracens had so depopulated Ithaca before the beginning of the sixteenth century, that the Venetians had the island repeopled from the continent of Greece. The Ithacans are industrious husbandmen and sailors, their chief crops being the currant and wines, which last are esteemed above any produced in the sister islands. Of grain they are unable to raise above one-fourth of their annual supply. The chief mountain, Anoge, perhaps 3000 feet high, may be the ancient Neritos, and on the hill of Actos (about 400 feet high) tradition points out the ruins of the castle of Ulysses; as it also shows the port of Phorcys, in a creek off the port of Vathi; and the grotto of the nymphs[6] in a cave on the side of Mount Santo Stefano, within which are stalactites, that scholars would gladly recognise as the "webs of stone." Area in English square miles, 44; highest point in English feet, 3000. Pop. in 1854—males, 5936; females, 5412,—total, 11,348.

Cephalonia.

Cephalonia (anc. *Cephallenia*[7]) has its north-eastern part nearly parallel to Ithaca, at a distance averaging about 4 miles, the remaining portion stretching to the S.E. It is the largest of the Ionian Islands, its extreme length being 31 miles, its breadth varying greatly, from about 20 miles in the southern portion to 3 and less in the projecting part opposite Ithaca. The whole country is hilly, the main range running from N.W. to S.E., and filling up the island with its skirts. The ancient Mount Ænos, now Monte Negro or Black Mountain,

[1] See Jervis's *History of Corfu*, p. i., ch. i., note to p. 19.
[2] Thucyd., iv. 46. [3] The plural word Παξοί includes the rock of Antipaxo, S.E. of Paxo. [4] Ed. of 1854., p. 78.
[5] Derived from the character of the bay, Βαθύ, deep. [6] *Odyss.*, xiii. 103–8.
[7] Called also Melæna by Pliny, *Hist. Nat.*, iv. 12. Cefalonia is the spelling of the Italian name in the Constitution of 1817.

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is the loftiest part of the *sierra*, and rises 5306 feet, being the highest land in the Ionian group, and often retaining snow for several months. The name of Black was given to this mountain from the darkness of its pine woods,[1] which still constitute the most striking feature in Cephalonian scenery, although their extent has been sadly curtailed by fires, the most serious of which was caused in a popular tumult. In the western part of the island a gulf runs up from the S.; and on its E. side stands the chief town, Argostoli, with about 8000 inhabitants; and on the W. side its rival, Lixuri, with fully 5000. Not far from Argostoli are the ruins of the ancient Cranii, and Lixuri is close to, or upon those of Pale; but the principal, and apparently oldest city, Samos (or Same[2]), has left Cyclopean walls, with other considerable and interesting remains on the bay of Samos, which opens into the E. side of Cephalonia; and on the same side stood Proni (or Pronni), above the vale of Racli and its blossoming oleanders. The soil of Cephalonia requiring culture, the natives have always been extremely active, and have turned to advantage all available spots, by forming terraces on the steep sides of the hills. Little corn is grown, but some wine and oil. The chief staple, however, is the currant, in the production of which this island is superior to Zante for quantity. A singular natural phenomenon occurs at the mouth of the harbour of Argostoli, and 1½ mile from the town, in the course taken by four streams which flow inwards from the sea, and are lost in cavernous openings in the land—one of them running so strongly that it is employed to turn the undershot wheel of a corn-mill.[3] The island is ill supplied with fresh water; no streams flow, and springs are apt to fail in dry summers. The well near the monastery of San Geronimo, the vulgar believe to be the subject of an annual miracle in its overflowing, when the relics of the saint are brought past it on his festival. The fact has been observed by many free from credulity; and it can been accounted for, without supposing priestcraft, by the pressure of the crowd on the occasion affecting the soil round the water, as Dr Davy thinks, and as he noticed with regard to another well near Lixuri.[4] Cephalonia retained longer than the sister islands traces of feudal influence exerted by the landed proprietors, some of whose estates were widely extended, and included at least one village which bore their family name.[5] Area in English square miles, 348; highest point in English feet, 5306. Pop. in 1854—males, 38,524; females, 31,957,—total, 70,481.

Zante.

Zante (anc. *Zacynthus*[6]), in its northern extremity, is about 8 miles S. of Cephalonia; and, stretching towards the S.E., is 22 miles long, and between 7 and 11 broad. A considerable part of the immediate line of the sea-shore is rocky and bare, but the interior is highly cultivated and rich. The capital, named also Zante, stands on a bay upon the E. coast, opposite the Morea, which is within sight. The town is pretty, consisting of good houses, not crowded, but situate in a semicircle round the harbour, and partly on the slope of the hill (350 feet high) which bears the citadel, once a Venetian castle; and the numerous minaret-looking steeples give the whole something of an oriental character. The country beyond seems one fine valley, bounded by hills, of which Mount Vrachiona towards the N.W. is the highest. The present olive-trees are not in such masses as to maintain the classic appellation of the "woody Zacynthus;" but the smiling vineyards and the gay gardens surrounding the fine country houses of the gentry, go far to justify the modern proverbial title of "Flower of Levant." The Zantiots are particularly industrious, and in consequence secure to themselves a full measure of comfort. The gentry are fond of the country and its beauties, and reside much at their villas, where they prosecute horticulture with zeal and success. The lower orders in Zante are less prone to theft than their Ionian brethren; but their quick tempers lead them oftener to make use of their hands on slight provocation. The higher classes are distinguished for their sensible and obliging disposition, and even among Ionians for their pleasing manners and address. Zante has little to show of antiquity, but one of the pitch wells described by Herodotus[7] remains precisely as he left it; the other is now more inactive than when seen by Dr Davy in 1834.[8] They are situated near the southern extremity of the bay of Chieri, about half a mile from the sea. The mineral tar was mixed with pine-pitch before use; now, however, it is not employed for anything but tarring boats of the country. In the bay of Catastari, what is popularly called a "grease spring" issues from the rock of a sea-cave. It was examined in 1834 by Dr Davy, who considers the substance reputed "grease" to be barégine, or glairine.[9] The chief crop of Zante is the currant; but wine is also made for export: oil too is produced almost annually, owing to the more careful culture of the tree. The currant harvest here, as in Cephalonia, is a very busy and lively season, occurring mostly in August, and lasting through part of September. The drying of the fruit requires almost three weeks, and is greatly dependent for success on the total absence of rain—a single shower affecting the quality, and therefore the price. The competition of the produce of the Morea, which is shipped from Patras, is most formidable to Cephalonia and Zante, and the blight of the vines has caused a serious defalcation in the crop of the islands for the last three or four years. When the growers obtain 70 Spanish dollars (L.15, 3s. 4d.) per 1000 lbs. of fruit, they thrive well, because 20 dollars (L.4, 6s. 8d.) are a remunerating price. During the suspension of agriculture in Greece from the War of Independence, 1000 lbs. of Cephalonia or Zante currants were sold for 100 Spanish dollars (L.21, 13s. 4d.) No wonder, then, that the growers talk of their produce in the most eulogistic strain, and say that the first-rate well-dried fruit has the hue and lustre of the finest black Genoa velvet. Whether from volcanic action below its crust or from other causes, Zante is subject to earthquakes of amazing frequency; fortunately, severe shocks have not been felt at shorter intervals than of about twenty years. The last took place on 30th October 1840, which did considerable damage to buildings, especially the military quarters; but the preceding one, which occurred 29th December 1820, was far more serious in its effects. It has been remarked, as a sign of the greater dryness of the atmosphere of Zante than that of Corfu, that the fire-flies, which in spring evenings are seen in brilliant myriads at Corfu, are by no means numerous at Zante, where,

[1] The so-called Cephalonia pine, well known to British nurserymen, is not, scientifically speaking, of the Pine tribe, and when large has something of the general appearance of the cedar.

[2] So it seems to have been called in Livy's time, *Hist.*, xxxviii. 30. Samos or Same is mentioned by Homer (*Il.*, ii. 631), who uses it as a name for the island, although he also names it Cephallenia (*Odyss.*, iv. 671).

[3] It is to be regretted that this curiosity has not been more carefully examined. Might not it afford good means of making tidal experiments, free from disturbing causes?

[4] Dr Davy's *Notes*, vol. i., chap. iv., p. 161.

[5] Thus Metaxata, the place celebrated by being Lord Byron's last residence in Cephalonia, derives its appellation from the Metaxa family.

[6] Called also Hyrie by Pliny, *Hist. Nat.*, iv. 12.

[7] *Herodot.*, iv. 195.

[8] Murray's *Handbook*, ed. 1854, p. 93; Dr Davy's *Notes*, vol. i., ch. iv., p. 153–9.

[9] *Ibid.*, i. pp. 147–153.

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on the contrary, are many glow-worms, which are rather rare at Corfu. Area in English square miles, 156; highest point in English feet, 2274. Pop. in 1854—males, 20,575; females, 17,870,—total, 30,445.

Cerigo.

Cerigo (anc. *Cythera*[1]) lies at a distance of not less than 150 miles from Zante, the nearest of the Ionian group, and about 8 miles from the southern coast of Greece. Its length from N. to S. is nearly 20 miles, and its greatest breadth about 12. There are many rocky hills, and below them considerable undulations of surface; streams too abound; and there is no doubt of the country being in various parts fertile; yet, although called anciently the favourite abode of Venus, it possesses little natural beauty, except in some of the vales; and has been little cultivated, having more pasture land than any other of the seven islands. From its situation, at the meeting as it were of seas, the currents which sweep round Cerigo are strong, storms are frequent, and the air is said never to be quite calm. Some wine and corn are grown, and the quality of the oil is good, although its quantity is not large. The honey of Cerigo is highly prized, but it is not in general carefully prepared for exportation. The people are industriously disposed, and many labourers go annually to seek employment in the Morea and in Asia Minor. The first village of Cerigo is Capsali, near its southern extremity; but there is little of a regular harbour there or on any part of the coast; the best anchorage however, being at San Nicolo, at the centre of the E. side of the island. This latter is supposed to be on the site of the ancient port of Scandea. Cythera, the capital, had stood within a mile and a half of the northern coast; but no trace can be pointed out with confidence of the famous shrine of the ruling divinity of the place. Area in English square miles, 116; highest point in English feet uncertain. Pop. in 1854—males, 7016; females, 5991,—total, 13,007.

Cerigotto.

Cerigotto (anc. *Ægilia*[2]) is the principal dependency of Cerigo, and lying about 20 miles to the S.E. is nearly at the middle of the direct course between Cerigo and Candia.

A question has been raised whether the islands of Cervi, commanding Vatika Bay, and Sapienza, commanding the harbour of Modon (anc. *Methone*), both possessed by Greece, ought not to be deemed Ionian dependencies, in terms of the Russo-Turkish treaty of 21st March 1800, referred to in the treaty of Paris (5th November 1815); nay, some have imagined the same words might be so construed as to include the islet Sphagia (anc. *Sphacteria*), within the Bay of Navarino.

History.

The earliest notice we meet with of these islands is in Homer, who represents to us the Phæacians of Scheria living happily under the kingly government of Alcinous,[3] and Ithaca under Ulysses,[4] whose sway extended over Cephalonia, Zante, and the opposite continent, all his subjects appearing to bear the name of Cephallenians,[5] but whose entire force did not exceed 12 ships. The other Ionian islands are not named, and Leucadia was attached to Epirus. Fables later composed, but referring to earlier ages, make Corfu be resorted to by Macris[6] of Eubœa, who had fed the infant Bacchus on honey; and afterwards by Jason and Medea; and Hesiod makes Venus, on rising from the sea, touch on Cythera.[7] When history dawns on the islands, they are under republican government. A colony from Corinth was founded at Corfu, probably about B.C. 734,[8] expelling the Cretans, who with the Liburnians had been in occupation of the island. Leucadia too was colonized by the Corinthians, who cut or cleared out the canal, and rendered the place an island. Zante received an immigration from Achaia, and Cerigo was made a dependency of Sparta.

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The maritime progress of Corcyra causing some disagreement with the parent state, the earliest sea-fight recorded took place between them about B.C. 695. Before the expedition of Xerxes, the fugitive Spartan king Demaratus asked and received shelter from the Zacynthians. When the great Persian invasion took place, the Corcyræans had a fleet of sixty sail; but they did not send them to aid the Greek cause, retaining them to be ready to side with the victors, as appears from their having offered themselves previously as allies to the great king. Leucadia had three vessels at Salamis; and 200 Cephallenians of Pale fought at Platæa. On the flight of Themistocles from Athens, the conquerors did not imitate the earlier generosity of the Zacynthians, and obliged the fallen statesman to implore the protection of the king of the Molossians. A new quarrel having arisen between Corinth and Corcyra about the colony of Epidamnus (Rom. *Dyrrachium*, mod. *Durazzo*[9]), founded by the latter in Illyria, the Epidamnians invoked the aid of Corinth, and the Corcyræans solicited the interference of Athens. Both the parties called in embraced the opportunity, which promised an extension of influence for or against an island which then ranked as third maritime power in Greece. In the first battle the Corcyræans had a decided advantage, and took 15 Corinthian ships before getting the assistance of Athens; but in a second engagement, after their force was augmented by 10 Athenian galleys, both sides claimed the victory, which ended the Corcyræan war (B.C. 432), during which the Zacynthians were united to the Corcyræans. Next year (B.C. 431), Sparta having joined with Corinth against Athens, the Peloponnesian War broke out, and lasted for thirty years. In it Cephallenia became the ally of Athens, without offering opposition.[10] The same was the case with Zacynthus. Cythera was taken and garrisoned by the Athenians, but restored to Sparta at the peace of B.C. 429. The Corcyræans were not directly parties in this fierce contest, farther than by occasionally aiding the Athenians with ships; yet civil dissensions raged within the island with fearful violence. The aristocratic and democratic factions, as either gained the victory, wreaked the utmost vengeance on their opponents. They took different sides respecting foreign politics, the former being supporters of the Lacedæmonians, and the latter of the Athenians; and in the worst period of their troubles, Thucydides openly says the popular party made faction the pretext for their personal animosity and gain, debtors making away with their creditors. In the fifth year of the war (B.C. 427), the democrats gave vent to their savage passions, in a way that reminds us, in all its details, of the horrors of the 2d and 3d September 1792, in the prisons of Paris. Corcyra was the place of review of the fleet destined for the fatal Sicilian expedition; but after its ill success, Corcyra seems to have fallen off from the Athenian alliance, and various minor steps were taken by Athens and Sparta to recover or preserve their weight in the councils of Corcyra. In this the Athenians were the more influential, although at a later time they are found under the necessity of supporting the aristocratic party, contrary to their former system; and in B.C. 343, the island was so far

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[1] Once called Porphyræ, according to Pliny, *Hist. Nat.*, iv. 12.
[2] Pliny, *Hist. Nat.*, iv. 12.
[3] *Odyss.*, vi.
[4] *Il.*, ii. 631; *Odyss.*, iv. 671, &c.
[5] *Il.*, ii. 138–144.
[6] Apollon. Rhod., *Arg.*, iv. 542; this name might really mean Long Island.
[7] *Deor. Gener.*, v. 198.
[8] Thirwall's *Hist. of Greece*, chap. xii., vol. ii., p. 93.
[9] Thucydides (i. 13) says it was 260 years before this time, and if we suppose him to mean the period of which he was writing the epoch corresponds to that of Periander.
[10] Thucyd., ii. 30.

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separated from Athens, as to join Corinth in aiding the Syracusans.[1] In 312 and 310, B.C. the Corcyræans strenuously helped the people of Apollonia (mod. *Pollona*) and Leucadia against Cassander,[2]—their last effort and success. In the course of the many wars consequent on the division of the empire of Alexander the Great, Corcyra had sundry vicissitudes; in B.C. 301, it was taken by Cleonymus the Spartan. He was soon driven out by Agathocles of Syracuse, who made it the dowry of his daughter Lanassa, who, quitting her first husband, Pyrrhus of Epirus, gave herself and the island to Demetrius Poliorcetes. In B.C. 274, Ptolemy, son of Pyrrhus, took Corcyra, which seems to have remained for a time connected with Epirus. In B.C. 229, Teuta, queen of the Illyrians, in a roving expedition, like those of modern buccaneers, made herself mistress of Corcyra; but getting into a quarrel with the Romans, was forced to surrender it to them in the following year. Leucadia, again become a promontory, fell into the hands of the Romans during their contest with Philip V. of Macedon (B.C. 179); but not without a gallant struggle.[3] Zacynthus was ceded by the Achæans[4] to the Romans in B.C. 191, and Cephallenia was reduced in B.C. 189,[5] not, however, till the town of Same had stood a close siege for four months by M. Fulvius the consul. During their wars against Macedon the Romans often made Corcyra their winter quarters, and had the assistance of its ships. In the civil wars it favoured Pompey[6] and his party; and at it Cicero and Cato are understood to have parted. Here Octavius reviewed his fleet before the battle of Actium, B.C. 31. According to traditions of the church, Christianity was early preached at Corcyra by the same Jason and Sosipater who are mentioned in the New Testament,[7] and who suffered martyrdom on the spot marked by a small church of Byzantine plan, said to be the oldest Christian temple in the island, and to occupy the precise site of the original fane raised on the hallowed ground, now within the suburb of Castrades. Under the Roman empire the Ionian Islands were sunk into parts of the province of Achaia,—the whole island of Cephallenia being at one time the estate of a wealthy Roman.[8] Agrippina touched at Corcyra with the ashes of Germanicus.[9] Nero, in his musical progress to Greece, visited Corcyra, and sang before the altar of Jove at Cassiope.[10] After this we find no historical events relative to the islands under the earlier emperors, except that Titus is said to have landed at Corcyra on his way from the conquest of Judea, and Hadrian to have gifted Cephallenia to the Athenians. In the decline of the empire, the Huns under Alaric (A.D. 398), and Attila (A.D. 441), with the Vandals under Genseric, ravaged the Ionian islands, as well as most of Greece. Belisarius and Narses recovered those provinces for Justinian; but Sclavonic invaders of various tribes repeated their devastations at very brief intervals.

By the Emperor Heraclius I., the Ionian Islands were attached to the prefecture of Lombardy; and to it, or to Sicily, they continued united for about 250 years, till Leo the Philosopher (about A.D. 890) formed them all, or most of their number, into a distinct province, under the title of the *Tema* of Cephallenia; and, in this condition, they were to be accounted as belonging to the Eastern empire, after Italy had been divided into various states. Towards the close of the eleventh century, the Norman conquerors of Naples, warring against the western portion of the Byzantine empire, turned towards the islands of the Ionian group; and in A.D. 1081, Robert Guiscard captured Corfu;[11] and not long after, Cephalonia. On the revolt of the latter island in 1085, he was proceeding to bring it again into subjection, when he died at Cassopo in Corfu.[12] A second conquest of Corfu was made in 1146, by Roger king of Sicily, nephew of Guiscard, but it was recovered by the Emperor Manuel Comnenus, with the co-operation of the Venetians, in 1132. In 1192, Richard Cœur-de-Lion landed at Corfu, on his ill-starred voyage from Palestine, after the fourth crusade. On their way to the fifth crusade, the combined forces from the taking of Zara (1203) halted to refresh at Corfu, where they seem to have been gladly welcomed, and to have found the country very fertile and abounding in forage. Here, however, the news of Walter of Brienne's marvellous successes in Apulia and Naples caused a sort of mutiny, and many of the warriors prepared to give up the expedition against Constantinople, intended in favour of the young Alexis, who had joined the Western army at Zara. With some difficulty, the dissension was healed, and the crusade proceeded.[13] Alexis appears to have been recognised as their emperor by the Corfiots. When the Greek empire was exchanged for the Latin, at Constantinople, the Venetians obtained various possessions, and amongst these Corfu. A famous Genoese corsair, Leon Vetrano, took it from them, but on his defeat and execution the senate of Venice (in 1206) sent thither ten noble families,[14] granting them fiefs in order that they might colonize it. The republic soon afterwards took Cephalonia and Zante, the former of which was held under them by a succession of five counts of the family of Tocco,[15] who appear to have also held Santa Maura, and probably Zante, at the same time. Through the rest of the thirteenth century, and most of the fourteenth, the Ionian Islands were a prey, by turns, to corsairs, and to Greek and Neapolitan claimants. At last, while the civil wars of Naples gave a good opportunity, the Corfiots voluntarily placed themselves under Venice, the first maritime power of the age (9th June 1386).[16] Acting with mercantile caution, the senate did not think its title sufficient until ratified (16th August 1401) by Ladislaus[17] king of Naples, on payment of 30,000 ducats, thus extinguishing the right which had been maintained to Corfu through the Duchy of Taranto. In 1485 Zante was obtained by purchase from the Turks in a very depopulated condition; and in 1499 Cephalonia was captured from the same masters. The dreaded Barbarossa, on the part of Soliman II., ravaged Corfu in 1537, and the great fleet of Selim II. did nearly the same in 1570, not touching the citadel however. In 1571 Corfu was the station at which Don John of Austria reviewed the grand Christian armament of which he was generalissimo, before

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[1] Diod. Sicul., lib. xvi., cap. 11. The Spartan expedition under Mnasippus against Corcyra, in the same year, is recorded by Xenophon (*Hellen.*, vi. 2), who describes the island as particularly rich in vineyards and pastures.

[2] *Ibid.*, lib. xix., cap. 5, 6.

[3] Liv., xxxiii. 17.

[4] Liv., xxxvi. 31, 32.

[5] Liv., xxxviii. 28, 29.

[6] Pompey's cavalry had a part of their forage from Corcyra (Cæsar, *Bell. Civ.*, iii. 58); but it rather seems to have been a small supply.

[7] Jason, in Acts xvii. 5, 6, 7, and 9; Sopater, in Acts xx. 4; and both Jason and Sosipater (who are called his kinsmen by St Paul), in Romans xvi. 21. Being canonized by the Eastern Church, their festivals are held on the same day, 29th April o.s.

[8] C. Antonius, in time of Strabo (29 B.C.), whose words, however (lib. x.), may perhaps be thought to mean merely that Cephallenia was as subject to him as a private property. They are given in a note to chap. lx. of Thirlwall's *History of Greece*, the positive sense being attributed to them in the text (viii., p. 462).

[9] Tacit. *Ann.*, iii. 1.

[10] Sueton., *Ner.*, 22.

[11] Sismondi, *Repub. Ital.*, ch. iv.; Giannone, *Storia di Napoli*, lib. x., cap. 5.

[12] Giannone, *ut sup.*, cap. 6, whose authority seems preferable to that of writers who make Robert's death occur in Cephalonia.

[13] Michaud, *Hist. des Croisades*, lib. x.

[14] Morosini, *Historia di Venetia*, lib. 7.

[15] Michaud, *Eclaircissements à liv. xi.*, § 3.

[16] Sismondi, *Repub. Ital.*, tom. iv., ch. iii.

[17] Morosini, *Hist.*, lib. xvii.

[18] Sismondi, *Repub. Ital.*, tom. viii., ch. x.

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sailing to fight and win the battle of Lepanto—one of the most glorious but unavailing victories which history records.[1] Even after Lepanto, the Turks continued for a year to hold Santa Maura, which the Venetians had abandoned in 1570. Venice paid an increased tribute for the island of Zante. Corfu had been fortified in 1559; and to what was then built the republic added, by degrees, the extensive works which afterwards protected it. The last and greatest struggle for its possession was in 1716, by the forces of Achmet III., which were defeated by the Venetian troops under the gallant Count Schulenburg,[2] who had before earned fame by his retreat across the Oder, in face of Charles XII. of Sweden, and by his conduct at the battle of Malplaquet, under the orders of Prince Eugene. Under the sway of Venice, her government was represented in the Ionian Islands by a provveditore, against whose misrule a check was established, in permission to the city of Corfu to send to Venice a deputy styled "Nuncio," through whom complaints might be addressed to the senate. As the republic decayed at home she could not remain healthy abroad; and in her last years there was no doubt much corruption and abuse of all kinds in her dependencies. In her better days, however, she has probably been unjustly censured. Terrible as antagonistic factions were to each other in the struggle for political power, the lower classes were not unheeded by the state.[3] The statute-book was disfigured by the retention of threatened demembration and other marks of barbarous times, but practically they had fallen into disuse—and in civil matters, although the courts were left a degree of arbitrary authority which must have been very embarrassing to judges, still, the administration of justice in Venice was regarded as pure, and the commonalty could enjoy what they prized—"Pane in Piazza e guistizia in Palazzo." The decisions of the famous Council of Forty were highly esteemed.[4]

On the fall of the Venetian republic in 1797, the treaty of Campo Formio, [5]which gave Venice to Austria, annexed the Ionian Islands to France; and in 1798 the French government ratified the arrangement, and their division into three departments. But a Russo-Turkish force came to drive out the French in the close of that year; and in the spring of 1799 Corfu capitulated. The Allies in 1800 erected the Septinsular republic, which, with various modifications, was but another name for anarchy and confusion, till a secret article in the treaty of Tilsit, in 1807, declared the Ionian Islands an integral part of the French empire. In this condition they remained till the British forces, under General Oswald, took Zante, Cephalonia, and Cerigo in 1809, and Santa Maura in 1810. Colonel Church reduced Paxo in 1814; and after the abdication of Napoleon Corfu was, by order of Louis XVIII., ceded to Sir James Campbell. At the congress of Vienna, no settlement had been made of Ionian affiairs, which were definitively arranged by the treaty of Paris (signed 9th November 1815); the contracting powers being Great Britain, Russia, Austria, and Prussia. By this it was agreed to revive the Ionian republic (which had ceased to exist in 1807), and place it under the exclusive protection of Great Britain, Austria enjoying the right of equal commercial advantage with the protecting country. In fulfilment of the treaty, a charter was passed by the Legislative Assembly, called for that purpose, and ratified by the Prince Regent in 1819,[6] which formed the Ionian constitution till some change was introduced of late years. Few historical events have occurred in the islands since 1818. The first is the asylum opened in them, with Ionian citizenship to the unfortunate refugees from Parga, on the cession of their country to Turkey in 1819, a measure[7] which we ought not to do more than regret as a cruel necessity at the time of its being carried out; but which might have been obviated by greater vigilance on the part of British diplomacy at Vienna or Paris. In 1819 some disturbances connected with taxation occurred at Santa Maura; and in 1821 a more serious tumult arose there, having some relation to the war of independence, then being waged in Greece. The French revolutionary movement of 1848 was used as an example in Cephalonia, and an insurrection, with the less immediate aim of annexation to Greece, and the more immediate object of pillage, begun in Cephalonia, required to be suppressed by the military. No acts of timely rigour having been employed to check the unruly, a more extended and violent outbreak there in 1849 needed to be put down by martial law, and several executions of wretches who had been guilty of brutal murders and other crimes of fearful atrocity, together with high treason.

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In making the treaty of Paris, Prussia no doubt had little interest; Austria may have felt some jealousy, regarding British interference with harbours and places of strength so near her own ports in the Adriatic; while Russia may have been disposed to make the Ionians some atonement for her treachery to them in 1807, and besides to keep up some sort of influence, however indefinite, with her co-religionists in so important a part of the Mediterranean, and so near to Greece, where things were not yet ready for opposition to Turkey. Great Britain may have considered it advisable to try the experiment of protection, instead of running the risk of greater cost, by adding to the long list of her colonies; yet, there is much reason to believe the proprietors and commercial men of the islands would not have objected to becoming subjects of the British Crown, had it been proposed.

The constitutional charter[8] of 1817 was drawn up with unquestionable ability, and for some years worked well in practice; but we must regret that it was deceptive. Instead of openly asserting an influence in the affairs of the protected state, it secured that indirectly, appearing to be something quite different from what it really was. The military possession of the islands having been conferred on the crown by the treaty of Paris, the charter added some

[1] It was fought on 7th October; and the grateful piety of the Church of Rome observes, as a festival of thanksgiving, the first Sunday of the month (Muratori, *Annal. d'Ital.*, 1571). Lepanto is now chiefly remembered by many for its having cost his left hand to Spain's greatest genius. Cervantes received two other wounds also, in the action, in which he highly distinguished himself. Navarrette, *Vida de Cervantes*, p. vii., prefixed to Baudry's edition of *Don Quicote*, Paris, 1845.

[2] This is the marshal's true name, not unknown in England, where his sister, a favourite of George I., was created Countess of Kendal in Great Britain, and Duchess of Munster in Ireland. Venice honoured Schulenberg's memory with the marble statue which adorns the esplanade of Corfu. The vulgar, however, think St Spiridion shares the merit, and the holy man's relic is carried in procession to a part of the wall over the scene of the final repulse of the Moslem, on the 19th August, the anniversary of that miraculous interposition. On the defences and siege of Corfu, and its history in general, *vide* Jervis's *History of Corfu*, 1852. Schulenburg's *Memoirs*, published about fifteen years ago, are said to form an interesting addition to a department in which German literature is not as yet rich.

[3] Daru and other modern writers seem anxious to paint the Venetian administration in as odious colours as possible, to justify the extinction of the republic; but they overstep justice.

[4] The members voted by ballot on each point submitted to them.

[5] Signed 17th October 1797.

[6] Signed by his Royal Highness 9th August 1817; the formal installation of the new constitution taking place on 1st January 1818.

[7] Act 14th of 1st parliament (22d May 1819).

[8] A copy of the English version of the original Italian is given by Mr Jervis in his *History of Corfu*, Appendix G; and it is also found entire in Montgomery Martin's *Statistics of British Colonies*, Appendix vii.

provisions regarding a militia, should it ever be embodied, and declared that the Ionian treasury should make certain payments towards meeting the expense of maintaining 3000 men in the garrisons, and of the fortifications. The united states of the Ionian Islands were to be governed, under the superintendence of a British lord high commissioner, by a senate which was to exercise all executive functions, and to be the upper house of the legislature, having also the power of issuing temporary enactments during the recess of parliament. The president of the senate was to be named by the crown for a period of 2½ years; and he was to have the initiative[1] and casting vote in the senate. The other five senators were to be chosen by the legislative assembly from their own body. The seat of government being at Corfu, the senate was represented in the other islands, and at Corfu, by a regent named by the senate; the regents to be aided by a municipal council named by the electors of the legislative assembly. The legislative assembly was to consist of 40 members, 29 of whom were to be chosen by the persons qualified to elect, under the Russian constitution of 1803, which brought the franchise very low, without distinction of real property. The remaining 11 were, *ex officio*, the six past senators, and five of the past regents. The nomination of candidates was confined to a standing committee,[2] made up of the 11 *ex officio* legislators, who issued a double list, from which the voters must make their selection. The assembly was to meet biennially for a session of three months, and to expire in five years; the lord high commissioner having the power to prorogue the parliament for six months, and the crown to dissolve it by an order in council. For a bill to become a law, it was necessary that it should be passed by the assembly and senate, and be approved by the lord high commissioner, whose veto had the effect of throwing it out for that session; and the crown enjoyed the prerogative of annulling, by order in council, any statute within a year from its passing. The chief authority given to the lord high commissioner lay in his sanction being necessary to make valid every act or appointment of the senate, except the pardon of criminals for other offences than those treasonable against the protecting sovereign. Besides this, the lord high commissioner was the head of the health office and of the police; and, in fine, was armed with the undefined power of "alta polizia."[3] In each island his Excellency was to have a representative or resident of his own choosing, to watch over the proceedings of the regent and local administration. The courts of justice occupied a branch of the charter, but the details respecting them need not be entered upon.[4] The direct appointment of three public servants[5] was reserved to the crown, and of two[6] to the lord high commissioner; and those selected might be either British or Ionian. It was provided, that on the termination of a parliament, whether by expiration of its quinquennial term, or by dissolution, all offices should become vacant; and consequently, even officers appointed from England, but holding commissions from the lord high commissioner, required then to be renewed. In practice, however, this rule was very rarely used for throwing public servants out of employment, and the establishment of a pension scheme for a large class of functionaries, who were compelled to contribute to its fund, was a virtual pledge that they should not be arbitrarily dismissed; yet, on the opening of the tenth parliament in 1852, the above provision was revoked by the incoming government, and many public servants, including 13 judges, were dropped out of the service, and no redress could be obtained.[7] The last points of the charter to be noticed, are, that all printing was left in the hands of the government, and the right of petitioning the throne was accorded to all Ionians under certain regulations. Under such a constitution, the lord high commissioner could, directly, prevent anything; and it is easy to see he could, indirectly, cause almost anything, and that the professed freedom was covert despotism.

The first change introduced into the Ionian system was liberty of the press, given by statute in 1848;[8] but unaccompanied by a good law of libel, and clogged with a crude attempt at trial by jury, it has proved more than useless. The next was the adoption of modern Greek as the official language in 1852,[9] a badge of nationality which the charter of 1817 had contemplated, but with prudent reserve had deferred *sine die;* and which of course cannot have a tendency to increase the spread of British ideas among the Ionians.

The abolition of the local courts of appeal[10] has been already alluded to, and being administrative need not be here noticed farther than as a step which has not given any general satisfaction to the Ionian public. The other changes were political, and have had more important consequences.[11] They consist of an addition of two members to the assembly—the abolition of the 11 *ex-officio* legislators, and of the committee formed by them—entire freedom of election, both parliamentary and municipal—a wider extension of the franchise—and vote by ballot. On the other hand, the nomination of the five senators from among the members of assembly for the respective islands was given to the lord high commissioner, with power also to select two of the five senators from among electors qualified to sit in parliament.[12] The results of these changes have not been gratifying. The first assembly (9th) which met after the new rule of election, was dissolved after a brief term of turbulence and absurdity, discreditable equally to its ability and its discretion. The next parliament (the 10th) still in existence, after a display of violence and factiousness, heightened possibly by the breaking out of the war in the east, became in no degree more practical during its session in 1855, and deservedly drew upon itself the marked though calm rebuke of the representative of the British government.[13]

It is said, that the chief framer[14] of the constitution of 1817 anticipated its requiring alterations after 20 years; and it is to be regretted that some were not effected by degrees, commencing at an earlier period, instead of so many and so important concessions from the protecting power being made at once, ere the Ionian public were prepared to take so large a part in the administration of their affairs. Liberty of the press should have been granted long ago, in order to the creation of public opinion, which cannot be

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[1] With little exception.
[2] Styled the primary council.
[3] High police seems to have meant political police.
[4] See above, under § *Justice*.
[5] The secretary to the lord high commissioner and two judges of the supreme court.
[6] The treasurer-general and the chief secretary to the senate, regarding whose appointment reference was always made to the Colonial Office.
[7] A highly respectable judge, then near the time entitling him to a high rate of pension, appealed in vain to the Colonial Office.
[8] Act 68th of 8th parliament, 9th June 1848.
[9] In fact, it came into operation on 31st December 1851, by act 76th of 8th parliament, 2d June 1849.
[10] In 1844.
[11] The new electoral law, in art. 87th of 8th parliament, 28th December 1849.
[12] Resolution of Assembly, 5th session of 8th parliament, 18th December 1849.
[13] Message of Sir J. Young to the Assembly, 13th July 1855, in *Ionian Gazette*, 15th July 1855.
[14] Sir Thomas Maitland.

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said to exist in the Ionian Islands;[1] and freedom of election might have come next. Some connection with Russia had always been kept up by a few Ionian families through intermarriage and public employment; and some fellow-feeling was known to exist towards those professing the same religion; but persons long resident in the islands were surprised to find, after hostilities began in 1854, that the Ionians almost universally showed not only an utter want of sympathy with the western allies, but satisfaction at the slowness of their progress. A firm persuasion of the invincibility of Russia prevailed; and there could be little doubt that her interests had been urged, either indirectly through Greece, or directly by emissaries, or perhaps by both means. Defeat of the Czar would cause all this to subside; still the consideration ought not to be forgotten, if the affairs of the Levant are to undergo some re-adjustment. From time to time a report has gone abroad, that Great Britain meant to obtain the sanction of the other powers, and particularly of the parties to the treaty of Paris, for making Corfu and Candia colonies, Greece compensating Turkey for the cession of the latter, and receiving the six Ionian islands in return. All Ionians who had much to lose, would dread the annexation to Greece so loudly clamoured for[2] by a section of the seventh parliament; and, on the contrary, would prefer being admitted to all the advantages of British subjects, which they know to be enjoyed by the Maltese. The thinking part of the community, too, must have known that a large amount of British capital would soon be poured into a colony possessing so vast natural resources, waiting to be more fully and profitably developed. Although the public has felt the ill effects of too little care of their finances, and individuals have had reason to complain of particular acts[3] of the British Government and its representatives, the Ionians must be fully aware that they could not have been so well situated under any other state, none having so free a constitution. Taxation was lighter, not exceeding 10s. a-head, and the aid given by the protecting power towards the cost of the garrison had been a subject of great liberality on the part of the crown;[4] and their own money, with four or five times as much more, was annually spent by the garrisons within the islands. A heavy penalty required to be paid for their nominal nationality, in the want of occupation for the educated classes, who could not be admitted into the British army or navy, or the civil service; and who, although confined to law and medicine in profession, would never, but in their utmost need, avail themselves of the permission proffered them by Earl Grey, to go as settlers to Australia.[5] To Great Britain the advantages were principally negative, in preventing any other power from holding so important positions in the Adriatic as Corfu, Cephalonia, and Zante have been reckoned by the highest authority;[6] and those advantages can be secured almost as effectually by the system of protection as by colonization, and with less cost to the treasury. The sums expended on the fortifications and military buildings of Corfu, down to 1849,[7] amounted to L.456,311, of which the Ionian treasury paid L.307,627, leaving the British Government to meet the deficiency of L.148,624; and the pay and all expenses of the garrison of at least 3000 men, cannot be under L.100,000 a-year; so that, even supposing the works to have been entirely stopped since 1848, the entire outlay on account of the Ionian Islands for the 38 years between 1817 and 1856, appears not less than L.3,800,000, which, after deducting the Ionian contribution at its higher rate of L.35,000 a-year, or L.1,330,000, leaves L.3,450,000 for troops, and L.148,624 for buildings; or, in all, L.3,598,624; which is probably short of the true expense defrayed by the protecting state.

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In conclusion, it might be observed, that the Ionian movement party has raised a cry of "violation of the treaty of Paris" by Great Britain, in taking any part at all in the internal affairs of the island, and has pretended that nothing beyond military possession of the fortifications was meant to be given to this country, and has endeavoured to excite a wish for nationality more independent of any protection, if not a union with Greece. The so-called liberal party would extort further concessions from the crown, and reduce the lord high commissioner to a cipher; a third, named by the others the retrograde party, but embracing many of the most judicious men, who have the greatest stake in their country, would be well pleased to revert to the state of affairs in 1818, and let the work of reform be commenced afresh, and by degrees; and persons who have heard all these matters treated of on the spot, and witnessed the progress of the Ionian Islands for some years, consider that if the protection be maintained, the last and quietest of these views is the safest and most promising, when the Russian fascination shall have passed away from the clever people who have forgotten—they cannot have forgiven—Tilsit. (W. B—R.)

IONIC *Order.* See Architecture.

Ionic *Sect, The,* was the oldest of the ancient schools of philosophy. It originated in Asia Minor, under Thales of Miletus, about 600 B.C. Its most famous leaders after Thales were Anaximander of Miletus, Pherecydes of Syra, Anaximenes of Miletus, Heraclitus of Ephesus, Anaxagoras and Hermotimus of Clazomenæ, and Diogenes of Apollonia. From Asia Minor the spirit of the Ionic philosophy passed into Greece, at first with Anaxagoras, and afterwards with Archelaus, the master of Socrates. Thus Athens, taught from Ionia, became in turn the headquarters of philosophy, and the parent of the most celebrated Greek schools. The interval between Thales and Archelaus embraced a period of about 150 years. The philosophers of the Ionic school directed their attention principally to physics and morals. A few only of their principles and beliefs can now be ascertained from the fragments which have come down to us. In mental philosophy Pherecydes broached the doctrine of the immortality of the soul; Heraclitus speculated on the nature of the difference between the sleeping and waking state of an intellectual being, and on the individual sense, as distinct from general reason, the latter being the seat of all truth, the former of all error. Anaxagoras first drew the line of distinction between spirit and matter, and drew attention to the regulative faculty in man.

In physiology the great question which the Ionic philoso-

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[1] Unless we take as a proof of it, that sometimes a legislator who returns home, after giving obnoxious votes, is pelted with lemon by his displeased constituents.

[2] *Parliamentary Papers: Ionian Islands.* Despatch of Sir H. Ward, 13th December 1850.

[3] See the *Ionian Islands, by an Ionian,* 1851, London, Ridgway; and the various works cited in it.

[4] It had been one-fifth of the entire revenue, but after various abatements was fixed at L.25,000.

[5] *Parliamentary Papers:* Despatch of Earl Grey to Sir H. Ward, 13th August 1849. *Ionian Islands under British Protection,* p. 129, 130.

[6] The late Sir Charles J. Napier. See his work on *The Colonies,* 1833, London, Boone.

[7] See official table in Jervis's *History of Corfu,* Appendix H.

phers attempted to solve was, What is the original element, if only one, or what are the original elements, if more than one, of which the universe consists? Thales believed in one—water; Pherecydes in earth; Anaximenes and Diogenes in air; and Heraclitus in fire. Archelaus believed in two—heat and cold, as represented by fire and water. Those who believed in a plurality of elements, whether two or more, considered the mechanical action of these upon each other as sufficient to account for the existing state of things; whereas those who admitted only one were obliged to endow it with a principle of vitality and development to account for existing variety. The latter of these schemes is known as the dynamical theory, the former as the mechanical. But the labours of the Ionic philosophers were not confined to such speculations. Thales made such observations in astronomy as enabled him to calculate eclipses; Anaximander and Anaximenes constructed sundials and maps; Heraclitus endeavoured to explain the causes of eclipses, and of the successions of the seasons; while Anaxagoras turned his attention to the milky way, comets, winds, thunder, meteoric stones, &c. These labours of the Ionic philosophers cleared the way for all those schools which, at a later period, undertook to explain the physical world, and served at once as a model and a starting point for Leucippus, Democritus, Empedocles, Aristotle, and, finally, for Epicurus. In fact, most of the schools which arose in Greece, from the time of Thales to that of Socrates (B.C. 600 to B.C. 400), and constituted the first philosophic period, were in some sort so many offshoots from the Ionic philosophy. Pythagoras, born at Samos, became the pupil of Pherecydes; Xenophanes, the founder of the Eleatic school, was a native of Colophon; Abdera, the birth-place of Leucippus and Democritus, and the seat of the school which they founded, was a colony from Phocæa; and, besides, Democritus was the pupil of Anaxagoras. In the course of its development the Ionic school was contemporary with the Abderitan and Eleatic systems, as also with that of Empedocles and Pythagoras. The first of these philosophies occupied itself with nearly the same questions as the thinkers of Ionia. Empedocles admitted, as the first principles of things, the elements of fire, water, earth, and air, thus attempting to harmonize the opinions of Heraclitus, Thales, Pherecydes, Anaximenes, and Diogenes. The Pythagorean and Eleatic schools, on the other hand, were hostile to it. They were the idealists of that early period, and, consequently, in direct antagonism to the materialistic views of the Ionic philosophy. See THALES, ANAXIMANDER, &c.

IONIUM MARE, a term in use among the ancient geographers for that part of the Mediterranean which washed the western shores of Greece and Epirus, and separated them from Italy and Sicily. The origin of the name, and its exact purport as at first employed, are alike very doubtful. The term is first found in Æschylus, though what meaning he attached to the words cannot be clearly ascertained. Herodotus and Thucydides both talk of the "Ionian Gulf," which, as described by them, can only mean the Adriatic; and the first of these historians often alludes to the "Ionian Strait," indicating by that term the passage between the heel of Italy and the Epirote coast. In course of time a wider but vague and indefinite meaning was attached to the term. Polybius employed it to indicate a part of the Mediterranean extending from the entrance of the Adriatic southwards to the Peloponnesus. At a later period Pliny included under it the Sicilian and Cretan seas. Later still all these arbitrary subdivisions of the Mediterranean were merged in the extension of the name Adriatic, which comprised them all. See ADRIATIC SEA.

IOWA, one of the United States of North America, lies between N. Lat. 40. 40. and 43. 30., and W. Long. 90. 12. and 96. 53. It is bounded N. by the Minnesota territory, E. by the Mississippi River, which separates it from the states of Illinois and Wisconsin, S. by Missouri, and W. by the Missouri and the Great Sioux River, the former of which separates it from the Indian Territory, and the latter from Minnesota. Greatest length from E. to W., 307 miles; greatest breadth, 196 miles; area, 50,914 square miles.

The surface of Iowa is somewhat elevated and generally undulating. It has no mountains, nor even hills, of any great height. Table Mound, a conical elevation with a flat summit, 3 or 4 miles from Dubuque, is perhaps 500 feet high. On the borders of the rivers there are frequent "Bluffs," which are generally from 40 to 130 feet high. The highest ground in the state is a plateau in the N.W. called *Coteau des Prairies*, which enters it from Minnesota. The southern part of the state abounds with grassy lawns and verdant plains, intersected by numerous rivers, the chief of which are the Des Moines, the Skunk, the Iowa, and the Red Cedar (a branch of the Iowa), rivers which flow in a S.E. direction into the Mississippi. The banks of almost all of these rivers are skirted with belts of wood. The distinguishing feature, however, of Iowa is its unique and admirably diversified prairies, sometimes spreading out into vast plains. The entire state is named a "rolling prairie" by the settlers, from the resemblance its surface bears to the rolling swell of the ocean. From the absence of wood, the scenery becomes wearisome and tame.

The soil of Iowa is in general fertile. Near the confines of the Coteau des Prairies the country is hilly and desolate; the high lands being covered with gravel, support but a scanty vegetation, while the low grounds are marshy. It appears, however, from the surveys which have been made, that no state in the Union has a smaller proportion of inferior land. Dr Owen, in his geological report, remarks that "the soil of Iowa is generally excellent, and of easy cultivation." "The valleys—especially of the Red Cedar, Iowa, and Des Moines—present a body of arable land, which, taken as a whole, for richness in organic elements, for amount of saline matter, and due admixture of earthy silicates, affords a combination which belongs only to the most fertile upland plains." The climate is generally more healthful than most of the new states. The openness of the country renders it less liable than is usual to the influence of malaria; the air on the upland prairies is buoyant, and rendered free from all pernicious influences by the refreshing breezes that blow periodically over them. The rapid flow of its rivers also carries off in the valleys those miasmatic influences which otherwise tend to the production of disease. The winter is occasionally severe, but the severity is not so great as is usual in the same latitudes. The summer also is less oppressively hot.

Iowa is strictly an agricultural country. Its fine prairies and rich natural pastures afford peculiar facilities for rearing cattle and sheep. Wool-growing has accordingly become one of the staple employments of the settlers. The raising of hogs is an occupation equally common and profitable. The value of live stock in 1850 was estimated at L.737,855, and slaughtered animals at L.164,233. The amount of wool produced was 373,898 lbs. Considerable progress has recently been made in agriculture, as shown by the increase of the various productions of the state. For instance, in 1840 there were only 154,693 bushels of wheat grown; in 1850 there were 1,530,581; in 1840, 216,385 bushels oats; in 1850, 1,524,345; in 1840, 1,406,241 bushels maize; in 1850, 8,656,799. The value of orchard products in 1840 was 50 dollars; in 1850, 8434 dollars. All the other productions common to similar latitudes are grown in Iowa, and have increased in an equal or greater proportion.

Manufactures have as yet made little progress in the state. Having only existed for little more than ten years as an independent state, time has not been afforded to develope its manufacturing resources. Possessing within

Iowa.

itself abundance of the two grand elements for manufactures—coal and water-power—there can be no doubt that Iowa will yet be distinguished as a manufacturing state. In 1850 the number of manufacturing establishments, producing each to the value of 500 dollars annually and upwards, was 482. Of these there were three for the manufacture of cast iron, fourteen tanneries, and one woollen factory. The others were chiefly employed in the manufacture of articles for ordinary and domestic purposes and agricultural implements. The home-made manufactures in the year ending 1st June 1850 were valued at L.44,258.

The minerals of Iowa are not of great variety. The vast bituminous coal-field of the state occupies most of its central and southern portions. For upwards of 200 miles the River Des Moines passes through this great deposit, the area of which has been estimated at about 20,000 square miles, embracing a country equal in extent to more than one-half of the state of Indiana. The beds of coal, which are 100 feet in thickness, lie near the surface, and may be worked at small expense. The lead mines of Iowa are a continuation of those of Illinois and Wisconsin. The workings are old and have been very productive. They occur in the N.E. of the state, Dubuque, one of the oldest settlements in N. America, being the chief town of the lead-mining district. Dr Owen, in his *Geological Survey*, remarks that the lead-mines of Iowa produce as much of that metal as the whole of Europe, except Great Britain, and that their capabilities are unbounded. Zinc is found chiefly in the form of electric calamine, in cellular masses in connection with the lead. This mineral occurs in some "diggings" also in a state of carbonate and in others as a sulphuret. Copper is found in the same localities as zinc. It has also recently been discovered in Cedar county in considerable quantities. Iron-ore is abundantly distributed, but as yet only a small quantity of it has been converted into metal. In the geological survey of the state above referred to, it is affirmed that its resources and capabilities are such that 10,000 labourers and miners might be profitably employed within its boundaries. Iowa has no direct foreign commerce, but its trade with the ports of the Atlantic and the Mexican Gulf is very considerable and rapidly increasing. The exports consist of agricultural and mining products. The home traffic of this state is also very considerable. The facilities which it possesses both for internal trade and foreign commerce are very abundant, and in a short time will be greatly increased. A railroad 180 miles in length has been projected between Dubuque, the capital of the lead-mining district, and Keokuk, the chief port of the state for foreign trade. Keokuk, Davenport, Lyons, and Dubuque will also shortly be connected by railroads with the interior. The system of railroads which has been projected are to converge in the city Iowa. Besides these, which will radiate through the state in various directions, the grand trunk line is proposed to be carried from this city westward to Council Bluffs on the Missouri, and will form a part of the great Pacific line which is to terminate at San Francisco in California. Through Iowa will also pass a branch of the great chain of north and south railroads connecting St Louis with the extreme settlements of Minnesota territory. When these are completed, both the home and foreign commerce of the state will be indefinitely increased. The valley of the Des Moines River contains at present half the population, as well as half the agricultural wealth of the state, and its prosperity may for some time depend as much upon the improvement of navigation on this river as upon the execution of these projected railroads. The Des Moines rises in the Coteau des Prairies, in the S.W. of Minnesota, and flowing through the state, in general in a S.S.E. direction, divides it into two nearly equal sections, and after a course of 400 miles, falls into the Mississippi at the S.E. extremity of the state, about 4 miles below Keokuk. Iowa has many other interior rivers which are navigable for various—some of them for considerable—distances. The Skunk is more than 200 miles in length, and flows through a fertile country. It pursues a course of 150 miles in a S.E. direction nearly parallel to Des Moines. The Iowa, from which the state takes its name, has in general a S.S.E. direction, and after a course of upwards of 300 miles, discharges itself into the Mississippi by two mouths, forming a delta, the sides of which are about 6 miles long. It is navigable by steamboats at all seasons to Iowa city, 80 miles from its mouth, and for boats of light draught much farther up. The Red Cedar (a branch of the Iowa) is navigable for 60 miles. The Wapsipinicon, the Makoqueta, Turkey, and Upper Iowa Rivers have courses varying in length from 100 to 200 miles, and are navigable for distances of 20 to 60 miles. They flow in an E. or S.E. direction into the Mississippi. The Great Sioux, an important tributary of the Missouri, forms the N.W. boundary of the state; its length is estimated at 300 miles. The tributaries of the Missouri in this state are of minor importance.

Iowa.

Iowa is divided into 49 counties. In 1840 the population of the state was 43,112, including 172 free coloured persons and 16 slaves. In 1850 it had increased to 192,214, including 333 free coloured persons. Iowa sends two representatives to congress and two members to the senate. Iowa city is the capital of the state. Pop. in 1850 was 1183. Burlington, the most populous town, had, in 1850, 4082 inhabitants. Dubuque and Keokuk are next in importance.

The present constitution of Iowa was adopted in 1846. It gives the right of suffrage to every white male citizen who has resided in the state six months, and thirty days in the county in which he claims to vote.

The legislature consists of a senate of 30 members elected for four years, and a house of representatives of 69 members for two years. The number of representatives must not exceed 72, and the senators must not be less than one-third, nor more than one-half of that number. The governor, who is chosen for four years, receives 1000 dollars per annum. The members of the legislature receive each 2 dollars a-day for the first 50 days of the session, and 1 dollar a-day afterwards. The justiciary consists of a supreme court, circuit or district courts, and courts of local jurisdiction. The supreme court consists of a chief and two associate justices elected by the joint vote of the legislature for six years. They receive each 1000 dollars per annum. There are 10 district courts, each of which is presided over by a judge chosen by the people of the district for five years, and receiving a salary of 1000 dollars a-year. Justices of the peace preside in the courts of local jurisdiction, and have power to decide in all civil cases where the amount in dispute does not exceed 100 dollars, or by consent of parties, 500 dollars.

On 1st November 1854 the funded debt of the state was L.15,959, the interest of which is about L.1520.

There were in Iowa, in 1850, 148 churches, of which 50 were Methodist, 24 Presbyterian, 17 Roman Catholic, 16 Baptist, 14 Congregational, 8 Christian, 5 Quaker, and 14 minor sects. The average number of persons to each church was 1298. The value of church property amounted to 177,400 dollars.

A superintendent of public instruction is chosen by the people for three years, under provision of government. The constitution provides also for a state university, and the establishment of three normal schools. In 1850 this state possessed 3 colleges, having 8 teachers and 75 pupils. In 1854 there were 1520 district schools, attended by 44,115 scholars, taught by 961 male teachers, and 772 female.

The first white settlement in Iowa was made at Dubuque

Iphicrates.

as early as 1686 by French Canadians. The state originally formed a part of the province of Louisiana, and was purchased in 1803 from the French, by the United States. The territory now comprising the state of Iowa, was a part of the Missouri territory from 1804 to 1821; and after that it was placed successively under the jurisdiction of Michigan and Winsconsin territories. It was erected in June 1838 into a separate government, with the title of the Territory of Iowa, and including within its limits the whole Minnesota territory west of the Mississippi. In 1846 it was circumscribed within its present boundaries, and admitted into the Union as an independent state.

IPHICRATES, an Athenian general who plays a conspicuous part in the history of Greece in the first half of the 4th century B.C. He owes his fame chiefly to the improvements which he introduced into military tactics, and the marked success that attended their adoption. The Greek states, at that time at war with each other, carried on hostilities by rapid incursions into each other's territories, and retreats as rapid when a force had been collected sufficient to repel them. To the soldiers who took part in these forays lightness was an indispensable element of safety. Iphicrates, who was the first to see this, resolved to organize a body of troops that should combine the advantages of light and heavy armed men. For this purpose he substituted a light oval targe in room of the heavy round buckler then in use, doubled the length of the sword and of the spear, and replaced the steel coat-of-mail by a linen corslet. These troops he called "Peltastæ," from the target which they bore; and such was their discipline and efficiency, that in a short time none of the ordinary Greek hoplites would meet them in the field, except the *élite* of the Spartan infantry. Their ordinary method of attack was to break the line of the enemy, either by a feint or by a dense rain of missiles. This done, the hoplite, with his cumbrous panoply, and short, thick sword, had no chance against the agile movements, and long, keen rapier, or equally terrible pike of the nimble Athenian. The Spartans, though they affected to despise these Peltasts as mere skirmishers, were more than once taught a deadly lesson at their hands. A Spartan corps, returning home from the capture of the Piræus by Agesilaus, in B.C. 392, was attacked by Iphicrates in the neighbourhood of Corinth, and destroyed to a man. This exploit of the Athenian commander soon became noised abroad throughout Greece. This victory, besides the immediate advantages that resulted from it, was peculiarly valuable to the Athenians, whose credit it redeemed, while the pride of Lacedæmon was sorely humbled at the defeat of its bravest warriors by a band of light-armed mercenaries. Encouraged by his success, Iphicrates proceeded rapidly to follow it up. Town after town fell into his hands, and Athens bade fair to retrieve her old place in the van of the Greek states, when the peace of Antalcidas put an end to the war. The latter half of Iphicrates' military career was as brilliant as its outset had been. He served with high distinction in the Hellespont, and afterwards in Egypt, whither he had been sent to assist the Persians in subduing that country. His conduct in Thrace tarnished his good name for a short time. He had married a daughter of Cotys, king of that country, and sided with his father-in-law against his native land, when he went to war with Athens for the possession of the Thracian Chersonesus. For his conduct in this affair he was afraid to return home, but the Athenians soon pardoned him, and gave him a joint command in the Social War. For his conduct in this office he was brought to trial on his return home; but the eloquence of Lysias procured him an honourable acquittal. From this time Iphicrates continued to live quietly in Athens, where he died at a very advanced age, though the exact date of his death is unknown.

Ipswich || Irak-Arabi.

IPSWICH, a borough and river-port of England, capital of the county of Suffolk. It stands on a gentle slope at the confluence of the Gipping with the Orwell, on the line of the Eastern Counties railway, 68 miles N.E. of London. In the old part of the town the streets are mostly narrow and irregularly built; and some of the old houses are decorated with curious carvings. In the modern part the streets are wide and regular, and lined with neat and substantial buildings. Ipswich is rapidly improving, and is altogether a clean, healthy, and pleasant town. It contains 12 parish churches, none of which are architecturally remarkable, and several dissenting places of worship. There were, in 1851, 91 day-schools, with 4253 scholars. Among the public buildings are the shire and town halls, custom-house, corn exchange, gaols, cavalry barracks, theatre, assembly-rooms, baths, lunatic asylum, and hospital. The grammar-school founded by Cardinal Wolsey, a native of the town, has 6 scholarships and 2 exhibitions at Pembroke College, Cambridge. There are also a mechanics' institute, with library, a public library, news-rooms, museum of natural history, a blue-coat school, and several almshouses. Ipswich was formerly celebrated for its woollen manufactures, but these are now all but extinct. It chiefly depends at present on the manufacture of agricultural implements, ship-building, and its shipping. It is about 18 miles from the sea by the river, which is navigable to the town for vessels of upwards of 200 tons. It is the seat of a considerable trade, the chief exports being corn, malt, and agricultural implements; the chief imports, coal, iron, and timber. The shipping registered at the port on 31st December 1854 was,—sailing vessels 167, tonnage 13,763; steamers 6, tonnage 295. Those entered and cleared at the port during 1854,—coasters, inwards 1183, tonnage 87,876; outwards 715, tonnage 34,264;—colonial and foreign traders, inwards 106, tonnage 11,076; outwards 84, tonnage 8101. Ipswich is governed by a mayor, 10 aldermen, and 30 councillors, and returns 2 members to parliament. Pop. (1851) 32,914.

IRAK-AJEMI, a large province of Persia, nearly corresponding to the ancient Media, lies between N. Lat. 31. and 37., and E. Long. 46. and 53. It is bounded, N. by the provinces of Azerbijan, Ghilan, and Mazanderaun, E. by Khorasan and Yzed, S. by Fars and Khuzistan, and W. by Turkey. It consists of an elevated table-land, traversed by several ranges of barren hills which run from W. to E., inclosing several valleys from 10 to 15 miles in breadth. The soil, which is uncultivated, except in the vicinity of the villages, is good, and readily produces rich cereal crops, and excellent fruits, with tobacco, opium, cotton, saffron, &c. The valleys and plains abound with excellent pasturage. Wool, goats' hair, and silk, form important sources of wealth to the inhabitants. Cotton fabrics, leather, glass, earthenware, with stuffs of gold and silver thread, are the chief manufactures, and along with the natural productions of the province, constitute its principal exports. The chief emporium of trade is Ispahan, once the capital of Persia.

IRAK-ARABI (the ancient *Babylonia*), a district of Asiatic Turkey, pashalic of Baghdad, lying mostly between the courses of the Euphrates and Tigris, S.E. of Baghdad. It contains the ruins of Babylon, Selucia, and several other cities.

IRELAND.

History. IRELAND, one of the largest of the European islands, is situated to the west of Great Britain, from which it is separated by a narrow channel called the Irish Sea and St George's Channel on the east, and is bounded on its other sides by the Atlantic Ocean, through which it can maintain a direct communication with the continents of Europe, Africa, and America. The advantageous position, the fertility of the soil, and the salubrity of the climate, have conferred upon Ireland commercial facilities, which are capable of being greatly increased. How far these natural advantages have been made available towards the internal improvement of the island itself, and the general benefit of the empire of which it forms an important part, may be best ascertained from the following details of its history and statistics.

HISTORY.

The Irish nation is undoubtedly of Celtic origin. This truth is stamped in indelible characters in the names of the rivers, towns, mountains, and other objects of historical notoriety throughout the island; it is proclaimed by marks equally indelible in the relics of antiquity, the tumuli, the cairns, the cromleachs, and the druidical circles, the remains of which, after having triumphed over the ravages of time and repeated revolutions, are now perpetuated in the pages of the antiquary's researches. The name of the island itself confirms the assertion. Eri or Erin, its most ancient appellation, and that to which the natives still cling with the attachment of veneration, is derived from the Celtic Iar or Eir, which signifies western. Most of its more modern names may be easily traced to this source. By the Grecians, to whom, though unacquainted with its localities, its general geographical position and bearings were not unknown, it was called Ierna, being honoured by them with the rank of the third of the islands of the ocean, and yielding precedence in this respect only to Taprobane and Britain. Ptolemy names it Iouerna; Juvenal and Mela, Iuverna. Diodorus Siculus, approaching more nearly to the aboriginal word, calls it Iris. Marcianus Heracleota and Eustathius adopt the term used by Ptolemy, but corrupted by the latter into Bernia. By the Britons it was called Iverdon; and the Saxons, attaching to the native name an epithet from their own language, called it Ierland or Ireland. Its later name, Hibernia, may be traced somewhat more circuitously to the same source, although much etymological and antiquarian ingenuity has been employed to deduce it from other circumstances. Some choose to derive it from its climate, calling it Hibernus, on account of its wintry temperature, as unjustly in fact as erroneously in etymology; others from Iberus, a Spaniard, or a river of Spain. One writer ventures still further. Postellus, in his strictures on Mela, deduces it from the Hebrew, "Irin quasi Iurin," the land of the Hebrews, "who, knowing that the empire of the world would be established in a very strong corner to the north-west, made themselves masters as soon as possible of those parts, and of Ireland." Bochart traces it to the Phœnician; Hibernia, according to him, or Ierne, being nothing more than Ibernæ, or the furthest habitation, because, beyond Ireland westward, all was ocean, according to the ancients. This derivation may be easily made to harmonize with that deduced from the Celtic, serving also to corroborate the opinion now very generally entertained, that the Celtic Irish and the Phœnician were kindred branches from the same eastern stem. Another name from another source has been fixed upon Ireland, one of different derivation, and of later acceptation, as not being known until the fourth century after Christ, when the country was generally designated throughout the learned world of that day by the name of Scotia. Some writers take the word to be a corruption of Scythia, from which region they suppose the nation to have emigrated; others, amongst whom are Whitaker and Chalmers, assert that the people acquired this name from their habits of roving and spirit of enterprise; the term "sceite," according to them, signifying dispersed or scattered. The name of Ogygia has also been applied to it, and adopted by O'Flaherty in his *Chronological Annals*. Certainly, if the Ogygia, which Plutarch places west of Britain, be any thing more than an imaginary formation, it must signify Ireland. Yet if so, it should more properly be considered as an epithet given to it on account of its antiquity than as a proper name; the Greeks applying that word exclusively to what was of an origin beyond existing records. History.

A recurrence to the Greek and Roman writers will show that the country thus designated was not considered by them as the habitation of a single nation. On the contrary, its coasts are described by Ptolemy as being possessed by a number of tribes of various names; whilst with the interior he seems to have had no acquaintance. His nomenclature has been followed by succeeding geographers, with little variation. According to these authorities, the northern regions were possessed by the Venicnii and the Robogdii; the eastern by the Darnii or Darini, the Voluntii, the Blanii or Eblanii, the Cauci, the Menapii, and the Coriondi; the southern shores were possessed by the Brigantes, the Vodii, the Uterni or Ivernii, and the Vellebori; the western coast was the residence of the Gangani or Cancani, the Auteri, the Nagnatæ, and the Herdini or Herpeditani. Whitaker supposes the interior, comprehending all the inland counties, to have been peopled by a tribe which he calls the Scoti.

The native annalists present a very different picture of the ancient state of the country, which, although much disfigured by the fables of romance with which the bards, the only historians of the time, chose, for very obvious reasons, to embellish their narratives, must be supposed to rest upon a groundwork of reality. Rejecting, therefore, from their accounts what is evidently fabulous, and suspending the judgment as to circumstances of doubtful or obscure character, the temperate investigator of truth will be able to trace a series of historical connections, to which assent may be conceded, at least to the same extent as to those parts of the recognised histories of other countries, in which it is acknowledged that truth verges upon fiction. With this clue to the investigation of a train of occurrences which affect to penetrate further into the darkness of antiquity than those of any other nation, except the Jewish, the investigation of the history of Ireland may be ventured on from the earliest period at which the most enthusiastic advocate of its primeval origin thinks himself justified in fixing his first footsteps, until we arrive, through the periods of doubt, at those of undisputed historical certainty in our own times.

According to the native historians, Partholan, the sixth in descent from Magog, Noah s second son, settled in Ireland at the head of a thousand men, and took possession of a country in which no one appeared to dispute his right of occupancy. But he did not long enjoy his possession of it in tranquillity; for at the same time, or shortly afterwards, there arrived a band of lawless adventurers, of the stock

History. of Nimrod, the descendant of Ham, who were distinguished by the name of Fomorians, or Fawmorries, a name still applied to strangers by the native Irish. With these took place a series of deadly hostilities, which terminated in a battle so bloody and so decisive, that not a single stranger was left alive; and the ground was so infected with the putrefying corpses, which the residue of the followers of Partholan were now too few and weak to inter, that a plague broke out, which destroyed all the survivors, and left the country totally uninhabited for thirty years.

At the termination of this period, Nemedius, another descendant of Japhet, made a settlement on the island with a thousand men, from the borders of the Euxine. The tranquillity of his settlement was also disturbed by the incursions of tribes of Fomorians, here said to be African pirates, with whom his followers carried on an incessant warfare, but with different ultimate success; for the strangers, being reinforced with fresh supplies from their own countrymen, at length defeated the Nemedians with such slaughter, as to force the scanty remains of this second colony to return to the country whence they had originally emigrated. They took their departure in three companies. The first, under Breac, proceeded to Thrace, where they took the name of Belgæ; the second, under Jobath, proceeded no farther than Bœotia; and the third, under Bridtan, repaired to the neighbouring island of Britain, where they formed the tribe of the Brigantes. From this Bridtan, the Psalter of Cashel, a record of great authority in the first and second ages of the Irish, traces the origin of the Welsh.

The Fomorians, when sole masters of the country, went to war amongst themselves, and carried their dissensions to such a height of animosity, that the island was a second time utterly depopulated, and continued so until some of the descendants of the Thracian Nemedians, to the number of about five thousand men, returned thither, under the command of the five sons of Dela. The Irish annalists distinguish this colony by the name of Fir-bolgs; a name said to be applied to tribes living in caves, whither the natives used to have recourse for shelter in cases of extremity. To this colony is attributed the division of the country into five principalities, which continued, though not without interruption, till the English invasion. The names of the states of the pentarchy were, Leinster, Munster, Ulster, Connaught, and Meath. The principal chieftain of each division was honoured with the title of king, a name applied very liberally at all times to the petty dynasts who arrogated supreme authority over their own territories, however limited; but the ruler over Leinster was recognised as sovereign, to whom submission was tendered, and from whom protection was claimed, by the other members of the pentarchy in cases of danger. This system of government continued undisturbed for eighty years, through a succession of nine sovereign rulers, when it was broken in upon by the intrusion of another colony of the same stock, called by the Irish writers Tuatha-na-Danans; a name said by some to have been given them as being the descendants of the three sons of Danan, a profound adept in the art of magic, and by others, as being divided into the three tribes of Tuatha or commanders, Dee, druids or priests, and Danan or bards. The chronicles of the time state, that having been driven out of Bœotia by their inveterate enemies the Fomorians, after wandering through various countries, they settled in Norway, where they were hospitably received; whence they removed to Scotland, and, after a residence there of seven years, proceeded to Ireland, carrying with them several necromantic curiosities, the most remarkable of which was the fatal stone, or stone of destiny, to which tradition attached the belief that the sovereignty would remain with that nation whose king was crowned upon it. The tale would be unworthy of historical notice, were not an observance of the present day connected with the superstitious credence to which it owes its birth. The stone, after having been preserved for many generations in the line of the Irish Milesian monarchs, was taken to Scotland by a king of that family, by whom it was fraudulently detained, and used as the inauguration stone of the Scottish kings until the time of Edward I. of England, who, on his conquest of the country, transferred it, together with all the other appendages of royalty, to London, where it is still kept, under the name of Jacob's stone, and is used in the ceremonial of the coronation of the kings of Great Britain. The Belgæ defended themselves for some time with great spirit, but they were at length totally defeated. Numbers of them withdrew to the neighbouring islands and coasts of Scotland; and those who remained were reduced to a state of abject slavery, under which they remained during the whole time their enemies held the dominion, which the latter were enabled to do, without molestation from a foreign enemy, for an hundred and ninety-seven years, under a succession of nine sovereigns. History.

The dynasty of the Tuatha-na-Danans was terminated by an event similar to those which had extinguished the two previous colonies. An expedition from Spain, under the eight sons of Milesius, landed in the south-west of Ireland, and after encountering many perils, partly by the violence of a storm, by which five of the leaders were lost, partly by the resistance of the old settlers, they obtained possession of the entire country, which was divided between Heremon and Heber, two of the surviving sons of Milesius; Amergin, the third, having no share in the government, but acting rather as a councillor to both, a function which his literary acquirements entitled him to assume. The southern part fell to Heber; Leinster and Connaught to Heremon, who fixed his residence at Teamor, now called Tarah, in Meath. A war soon broke out between the brothers, which was terminated by the total defeat of Heber, the aggressor, who was killed in a battle fought at Geisiol, or Geashil, in the King's County. But his death did not put an end to the domestic dissensions of the family. A few years after, Heremon put his remaining brother to death, and thus obtained the sole dominion, which he held for thirteen years, till his death. His time was chiefly employed in repelling invasions of the Britons and of the Picts. The government then continued through a race of twenty kings of the same family, of whom nothing worthy of mention is recorded; the annals of the period containing merely the intestine dissensions of the chiefs of the several branches, and their wars with the Britons and Picts, until the crown descended to Ollav Fola, of the family of Ir, one of the sons of Milesius who had perished on the first landing in Ireland. During his reign, which commenced about 900 years before Christ, the Fez, or triennial meeting of the subordinate chieftains, priests, historiographers, and bards, was instituted at Teamor, or Tarah, in which, besides the regulation of all matters affecting the government and the enacting of laws, a minute investigation was entered into of the national monuments and records. Whatever was then deemed genuine and authentic, was inserted in a volume called the Psalter of Tarah. This legislator closed a reign of forty years, spent with benefit to his subjects and honour to himself, by a natural death, a circumstance very unusual in the annals of those times, and left the undisputed succession to his son, who enjoyed it for seventeen years, and also had the unusual good fortune to die in the same manner. The annals of the succeeding monarchs, for the space of 260 years, present nothing but a reiteration of war and mutual destruction, to such an extent, that out of thirty-one kings, who held the reins of government during that period, all but three are recorded to have fallen in battle, or by a violent death. The only occurrences worthy of notice that can be gleaned from the his-

History. tory of this barren period, are, the erection of a mint, the formation of a standing army by the allowance of a fixed pay to the soldiery, and the invention of the small boats, formed of wicker-work and covered with hides, now called corraghs.

Kimbath, who ascended the throne 460 years before Christ, has obtained an honourable celebrity by his efforts to revive and improve the institutions of Ollav Fola. He formed a national police, and regulated the artificers and tradesmen, whom he placed under the jurisdiction of a council of sixty of the nobles and learned men, without whose license no person was permitted to practise any mechanic art. The foundation of the royal palace of Eamania, near Armagh, is attributed by some writers to him; whilst others give the credit of it to his widow, who succeeded him, and reigned seven years, when she was cut off by her successor, who in his turn fell by the hand of Hugony the Great, in revenge for the death of his foster mother. This last-named monarch, with whom the line of Heremon would have terminated had he died without issue, was married to the daughter of a king of France, and kept possession of the crown during a vigorous and active reign of thirty years. He obliged the Picts to pay tribute, and extended his dominion over the Western Isles. He also abolished the pentarchical form of government, dividing the country into twenty-five provinces, over each of which he placed one of his twenty-five sons, and causing the public revenues to be collected according to this arrangement. But neither his virtues nor his abilities were sufficient to save him from the usual fate of Irish monarchs, nor to prevent the recurrence of acts of slaughter amongst his posterity. He was slain, after a reign of thirty years, by his own brother, who fell by the hand of one of Hugony's sons, who in his turn perished by the treachery of his only brother. Amongst the successors of Hugony, Eochy, surnamed Feileagh, or the Melancholy, has made his reign memorable by founding the royal seat of Croghan, in Connaught. It is also celebrated as being the era of the red-branch knights of Ulster, who were said to have had a residence at the palace of Eamania. His successor Eochy introduced the custom of burying in graves instead of burning. Conary More, who reigned for thirty years according to some writers, and sixty according to others, is famous for having enjoyed the longest, happiest, and most tranquil reign in Irish history. Such periods are not those which furnish most materials for the annalist. Of the particulars of his life, though so highly celebrated, little is recorded. He was killed in battle by the king of Wales, though other accounts state that he was treacherously burned in his own palace of Teamor, which also became a prey to the flames. In the reign of Crimthan, one of his successors, who had married the daughter of a Pictish chieftain, the Irish were the auxiliaries of the Picts against the Romans. The information of the leader of a rival faction to this prince is said to have induced Agricola to entertain the idea of conquering the island with a single legion and some auxiliaries. Whatever might have been the result of such an invasion under a general of acknowledged military talents, it is certain that the Roman power in Britain declined so rapidly from this time, that the Irish made frequent irruptions into the Roman province, and returned to their own country loaded with spoil. Feredach, one of the successors of Crimthan, owes his title of the Just to his chief councillor Moran, whose rigid impartiality in the dispensation of justice is recorded, in the figurative language of the bards, under the allegory of a collar, invented and handed down by him to his successors in office, which had the supernatural effect of pressing upon the neck of the wearer in case his decision deviated from the strict rule of equity, so as to strangle him if he persevered in his iniquity. Feredach was killed after an unsettled reign of seven years, by an insurrection of the peasantry, to whom the name of Attacots was given; a name which afterwards was carried into North Britain, where, though at first applied to disturbers of the public peace, it ultimately became the distinguishing title of a tribe inhabiting the country adjoining the Roman wall. After a period of civil commotion, Tuathal, upon attaining the sovereign power, exerted himself to restore the ancient constitution of Ollav Fola, and the pentarchical division of the country. To him is attributed the appropriation of the central province of Meath, as a demesne or mensal land for the supreme monarch. Here he restored the royal residence, and founded an edifice for the sacred fire, to which the Druids and priests were to have recourse on the last day of October, to perform a solemn sacrifice, and to supply fire to all the people, who were bound to extinguish their usual fires at that time, and to relight them from this hallowed source. He built similar palaces and temples at Uisneacht in Connaught, at Flaodha in Munster, and at Tailltean in Ulster, where there was a fair, to which parents brought their grown-up children and contracted them in marriage. He also was the originator of the fine afterwards known by the name of the Boromé, or Leinster tribute, imposed upon the king of that province for having caused the death of two daughters of Tuathal, whom he inveigled away under a treacherous promise of marriage. This monarch died in battle. The reign of Conn Keadcahagh, or Conn of the Hundred Battles, is best known by the division of Ireland which he was compelled to make with Mogha Nuod, king of Munster. The line of demarcation was fixed by a rampart and fosse, extending across Ireland from Dublin to Galway, the country to the south of which was called Leagh Mogha, or Mogha's share, that to the north Leagh Cuin, or Conn's share; names still familiar amongst the Irish. Cormac, the grandson of Conn of the Hundred Battles, signalized himself by his efforts to restore the ancient regulations of the monarchy; but having lost an eye in suppressing a rebellion excited by one of his own family, and being thus excluded from the throne through the prevalence of a prejudice which forbade a mutilated person to continue monarch, he closed his life in retirement, during which he drew up a treatise, yet extant, called the Book of Advice to Kings; a work extolled by the native writers as worthy to be written in letters of gold, a perfect standard of policy to all ages. In his reign flourished the celebrated Irish militia, known by the name of Fiana Erion, and commanded by Fein M'Cooil, commonly called Fingal. It was a military association, into which admission was attainable only by convincing testimonies of great strength, activity, and intelligence; besides which, an engagement was required on the part of the newly-admitted member to choose a wife solely for her merits, never to ill-treat a woman, and not to turn his back upon an enemy, even though nine times as numerous as the body to which he belonged. The regular number of this force was said to be nine thousand men, divided into three battalions. After a variety of exploits, which have furnished materials to much of the legendary romance of the time, the body was annihilated during the succeeding reign, at the battle of Gabra or Gawra, in Meath, where Oscar, the son of Ossian the poet, fell. Passing over a series of several kings known only by name, Nial of the Nine Hostages signalized himself by his military expeditions in Scotland, England, and France. His career of conquest was cut short in the last-named country, where he died of the wound of an arrow treacherously discharged against him on the banks of the Loire. His immediate successor, Dahy, met with an untimely fate in the same country by lightning. He was the last pagan king of Ireland. In the third year of Logary, or History.

History. Lae-ra, who succeeded Dahy, Palladius arrived in Ireland, being sent on a mission thither by Pope Celestine for the conversion of the natives. He was not, however, the first who had been thus employed. The names of St Albe, Declan, Iber, and Kirian, are quoted as his predecessors in the pious work. But their labours were confined to particular districts, nor does it appear that they acted under the authority of the see of Rome. Either through ignorance of the language, or want of spirit to withstand the ferocious opposition of his pagan adversaries, Palladius was compelled, after having founded three churches, to relinquish the design, and to quit the country, in order to save his own life and those of his followers; but he was prevented by death from returning to Rome to give an account of his mission. The completion of the work so inauspiciously commenced was reserved for St Patrick, whose success has acquired him the title of the apostle of Ireland. He was a native of North Britain. When sixteen years old he was brought prisoner to Ireland by Nial of the Nine Hostages, during one of his foreign expeditions, and spent seven years in slavery in the country, where his employment was the herding of swine. The law of bondage at that time extended no longer than the seventh year, at the expiration of which time he returned to his native country; and, after having studied under his uncle, the Bishop of Tours, he found his way to Rome, where he was selected by the pope to renew the attempt which had already failed; an undertaking for which his knowledge of the language, acquired during his captivity, peculiarly qualified him. To Ireland, therefore, he proceeded with twenty disciples or assistants, which number was increased to thirty-four in England, where he touched during his voyage. His first reception on his landing at Wicklow was very discouraging. The report of his arrival had already reached the Pagan prince who had expelled his predecessor. The same spirit of hostility was directed against the new comer, and Patrick and his company were assailed and forced to take refuge on board their ships. But, though discouraged, he was not disheartened. Instead of relinquishing his purpose, he proceeded to the island afterwards named Holm-patrick, where, having refreshed himself by a short leisure, he proceeded to Ulster, and preached before the chieftain of the district so forcibly as to convert him and his family, and to obtain license to found a church there. In the second year of his mission he presented himself before the Fez, or council at Tarah, where he proved equally successful; Logary the king declaring himself a convert, and many of his subjects following his example. Nor does it appear that the subsequent progress of the apostle was checked by any untoward circumstance. The remainder of his life, which was protracted to an unusual length, was spent in traversing the country, spreading around a knowledge of the Christian doctrine, gaining over converts, and founding churches and monasteries. The chief of his religious foundations was at Armagh, which soon became a school of theology, so famous that students flocked to it from all quarters in such numbers, that at one time it was said to have communicated instruction to seven thousand students. The exertions of Patrick were not wholly confined to the preaching of the gospel. He gave his advice and assistance in the reformation of the government. At his suggestion, Logary summoned an assembly of the princes, historians, and antiquaries, to revise the records and chronicles of the country; and their amendments were deposited in the public archives, under the name of "The Great Antiquity." Fragments of copies taken from this work were to be met with for many centuries afterwards, under the names of the Book of Armagh, the Psalter of Cashel, the Book of Glandaloch, the Leabhar Gabala, and others, from which subsequent writers have derived much of their information respecting the ancient history of the country. History. Patrick did not retain the government of the bishopric erected by himself in Armagh; but having appointed Binen or Benignus his successor in the see, and having made a visit to Rome, he spent the remainder of his life chiefly at Saul, near Downpatrick, where he had founded a monastery, in which he closed a career of active and successful labours, in the hundred and twentieth year of his age, and was buried in the neighbouring abbey of Downpatrick.

Although the exertions of St Patrick produced an effect so great upon the public mind, that, for many years after, the founding of religious institutions, and the lives and deaths of the ecclesiastics engaged in maintaining and extending the new faith, formed the chief subjects of history, it does not appear that the change of religion produced the beneficial alterations that might have been hoped for from it on the political aspect of affairs. The brief notices of the civil occurrences continue to exhibit little more than a reiteration of the turbulence, crime, and desolation, that had marked the era of paganism. The only event of importance that diversifies the tissue of domestic and foreign warfare which forms the subject of the annals of those days, occurred during the reign of Hugh, the son of Ainmireagh, in which an assemblage was convened at Drumkeath, in Derry, for the express purpose of curbing the license of the bards, now become intolerable. The privileges annexed of old to this order, whose properties as well as persons were inviolable in all civil commotions, whose lands were freed from tribute, and whose houses were respected as sanctuaries, had rendered the numbers of the profession so great, and entailed such a burden on the state for their support, that they were several times before about to be banished from the country. At the assembly now held, they found a zealous and useful friend in the celebrated Columbkill, who left his monastery of Iona to be present here, and prevailed so far as to procure a mitigation of their treatment, by changing the decree for their banishment into one for the diminution of their numbers. It was therefore resolved, that in future the king of Ireland, each provincial sovereign, and the lord of every subordinate territory, was to maintain a bard to preserve the genealogies and record the acts of the respective families; and that a suitable salary was to be allowed him, in return for which he was also to instruct the youth in history, poetry, and antiquities. The whole body was placed under the control of an arch-poet, in whom was vested the power of admitting qualified persons. Thus restrained as to numbers and means of acquiring wealth, their properties were as hitherto exempted from taxation, and their persons privileged. Yet, during this gloomy period, in which the internal state of the country exhibits so little to cheer the inquirer, it became celebrated throughout Christendom, on account of the piety and learning of the inmates of its religious establishments. In the fifth century Sedulius made himself known as a poet, an orator, and a divine, and spread a knowledge of his acquirements, and the fame of the country in which he had imbibed them, through France, Italy, and the western regions of Asia. Columbkill, already transiently noticed as the founder of the monastery of Iona or Hy, the burial-place of the Scottish kings, adorned the sixth century. So also did Congall, the founder of the monastery of Bangor, famed for the multitude of religious men whom its learning and the strictness of its rules led to it. In the seventh century flourished Columba, the founder of several monastic institutions in France and Italy; Aidàn, to whom the conversion of the Northumbrians is attributed; Finan, who followed him in the same field of missionary labour; Argobast, who preached in Alsace, and was thence raised to the see of Strasburg; Adamnanus, who visited the court of Alfred, king of Northumberland; and Cuthbert, the son of one of the petty kings

History. of Ireland, who, after having been prevailed on with much difficulty to take charge of the bishopric of Holy Island, in the same part of England, resigned it for a life of studious retirement in the Isle of Farn, where he closed his life. In the eighth century lived Sedulius the younger, who assisted at a council held at Rome by Gregory II., and was afterwards a bishop in Spain; also Vergilius, a philosopher as well as a divine, as appears by a treatise of his on the Antipodes, written against the then received opinion of the shape of the earth, which he proved to be a globe, and not a plain surrounded by the heavens at its verge. He spent some time in France at the court of King Pepin, by whom he was highly esteemed.

The state of Ireland was now destined to suffer from another element of convulsion. About the commencement of the ninth century, the Danes began to extend to it their predatory ravages. Their first attacks were trifling and occasional, more of the nature of piratical incursions than preconcerted invasion. But in proportion as the success of their first assaults rendered them more daring, and their more extended knowledge of the country made them better acquainted with its fertility, their bands became more numerous, and better prepared for continued hostilities; whilst at the same time the unsettled state of the country, caused by the intestine wars of the native princes, carried on either for the purpose of attaining the supremacy, or for exacting tribute from their inferiors, prevented that combination of defence which alone could ensure success against the foreign enemy. In the middle of the same century, Turgesius, king of Norway, had virtually rendered himself monarch over the greater part of the island. He maintained himself in it with all the cruelty and arrogance of an usurper. Danes were placed in all the subordinate kingdoms. Every district had a Danish officer placed over it, and even every house was required to maintain a Danish soldier. The use of arms was prohibited to the Irish. A tribute of an ounce of gold was exacted from every householder, the non-payment of which was punished by the mutilation of the nose, whence the tribute was known by the name of the nose-tax; and, to complete the climax of degrading submission, the bridal favours of new-married virgins were exacted by the Danish chief of the territory, and were sometimes commuted, at his caprice, for a sum of money. The country had groaned for thirteen years under this complication of insult and injury, until it was at length roused to shake off the degrading yoke. Turgesius had erected a rath for his residence in the neighbourhood of Tarah, where lived Malachy, who still retained the title of king among the Irish. Turgesius claimed his daughter. Malachy, conscious of his inability to resist the demand openly, yet unwilling to sacrifice his only child without an effort, sent along with her a number of young men disguised as her female attendants, who fell upon the Danes in the rath, slaughtered them, seized Turgesius, and handed him over bound to Malachy, who had advanced with a band of armed men to their aid. The captivity of the tyrant was the signal for a general insurrection of the Irish, by which the Danes were forced either to fly aboard their shipping, or to take refuge in the maritime towns that acknowledged their authority. Turgesius, after being kept some time in prison, was drowned in Lough Innel. On the expulsion of the Danes, the country reverted to its former state of internal dissension. Cormac M'Cuillenan, king of Munster and bishop of Cashel, an union of civil and spiritual jurisdiction then not uncommon, claimed a tribute from the king of Leinster, which, on refusal of payment, he proceeded to enforce by the power of his arms. But on entering his adversary's territory, he found him strengthened by the support of the king of Ireland. The unexpected intelligence threw such a damp upon the spirits of his troops, that many deserted him before the battle: those who stood firm were soon routed, and Cormac himself was killed by a fall from his horse, whilst endeavouring to escape amongst the fugitives. This king is best known in history as the compiler of a book of annals, called the Psalter of Cashel, from which succeeding writers derived much information. It has been many years lost. History.

The internal dissensions of the country encouraged the Danes to make another effort for subjugating the island. A large force landed in Leinster, under the command of Setrick, said by some writers to have been a son of Turgesius, by whom Dublin was taken, and the possession of it secured by a signal victory obtained over the combined forces of the Irish, in which Nial, king of Ireland, and many of his generals, fell. The distractions of the country, thus augmented by the presence of a foreign enemy, obtained a temporary intermission by the accession of Brian Boree to the sovereignty. This prince, the great hero of the Irish, was brother to the king of Munster, on whose death he succeeded to the throne of that province, from which he not only expelled the Danes, who had made a settlement in Limerick, but extended his dominion over the whole southern division of Ireland. The brilliancy of his achievements against the common enemy induced the rest of the subordinate chieftains to unite in a confederacy for deposing Malachy, the reigning monarch, and raising Brian into his place. The object was effected with little difficulty, and, what was more unusual in the revolutions of the country, with no bloodshed. Malachy was of a mild and undecided character. After a feeble effort to revive the spirit of loyalty among the subordinate princes of the northern division, to the chief of whom, O'Neill, he offered a large portion of his dominions, he resigned the crown without a struggle. The new monarch was publicly proclaimed and inaugurated at Tarah. After receiving the submissions of the kings of Ulster and Connaught, and reducing some refractory chieftains who disputed his authority, he directed the combined energies of all the states against the Danes, whom he expelled from the island, with the exception of such as consented to embrace Christianity. These he located in the great seaports of Dublin, Wexford, Waterford, Limerick, and Cork. Having thus removed the obstacles arising from a foreign enemy, he directed his attention to the general civilization of the kingdom, by founding or restoring the places of worship and seminaries of education, building bridges, opening passes, erecting fortresses, and fitting out a fleet to oppose the Danes on their own element, before they could effect a landing. In the accomplishing of these objects, he spent the latter part of a long and glorious reign. But its termination was marked by a circumstance that undid all his labours. The subordinate king of Leinster, irritated at an insult offered to him in the court of Brian, made overtures to the king of Denmark for a union to expel him from the throne. These were gladly accepted. A large fleet was sent from Denmark, which landed a body of troops near Dublin, where they were joined by those of the king of Leinster. Brian was not negligent in discovering, or tardy in adopting measures to resist, this new combination. At the head of a numerous and well-appointed army, collected from all the other provinces, he marched to meet the enemy. The battle was fought on the plains of Clontarf. It was bloody and desperate, but decisive; the Danes were utterly defeated, and forced to fly to their ships. The Leinster men, abandoned by their foreign friends, were cut to pieces without mercy. The exultation of triumph would have been as unmixed as the victory was glorious, had it not been clouded by the death of the monarch, who, though too far advanced in years to take part in the engagement, led the army to the field, and was killed in his tent, whither he had remained during the conflict, by a party of straggling Danes, as they

History. were flying. His eldest son Mortogh fell in the battle. Malachy, the deposed monarch, seized the opportunity of reviving his claim to the vacant throne. His conduct during the late crisis had been more than dubious. He had made a show of assisting the Irish with the forces of Meath, which province he had been allowed to retain, but, on the commencement of the battle, withdrew his men to a neighbouring eminence, where he continued an inactive spectator of the struggle. His claim was acquiesced in. But his resumption of the reins of authority proved only the signal for the renewal of those scenes of turbulence and anarchy which the commanding talents of his predecessor had kept under control. The apprehensions of subjugation to a foreign power were indeed removed. The victory of Clontarf discouraged any further effort of the Danes, whom alone the native rulers dreaded. These were left to carry on undisturbed their schemes of self-aggrandizement and mutual contention. The only event to diversify the gloomy monotony of incessant civil discord, was a synod of the clergy at Kells, held in 1152, under Cardinal Papiron, the pope's legate. Heretofore the connection of the Irish church with the see of Rome had been very slight, and altogether voluntary. It was governed by the two Archbishops of Armagh and Cashel, and a number of bishops, whose system of control was regulated by domestic synods. At the assemblage now spoken of, the supremacy of the see of Rome was acknowledged, and four palls were given to the Archbishops of Armagh, Cashel, Dublin, and Tuam.

Things continued in this state till the time of Roderic Connor, whose reign forms the commencement of a new era, which overthrew all the ancient forms and constitutions of government, and gave to the tide of political events a new turn, by which they have been influenced to the present time. Notwithstanding the proximity of England to Ireland, there had hitherto been but little intercourse between the two countries. Wales, then an independent state, interposed between them. The Saxons were not a people of commercial or adventuring enterprise; and, even after the final consolidation of England into an established monarchy under the Normans, the views of the monarchs of this line, whether for extension of territory or for commerce, were directed towards the states of the Continent, whence they had derived their parentage. We read indeed of an invasion, and even a subjugation of part of Ireland, by Edgar, king of the Northumbrians. If such occurred, it has left behind it few or no historical traces. The episcopal see of Dublin acknowledged the supremacy of that of Canterbury, from which it received its canons and rights of ordination. The Danish character of the city, which, until after the English invasion, was always considered as a subordinate seaport, accounts sufficiently for this peculiarity; and that the connection between the two kingdoms had nothing in it savouring of subjection on the part of Ireland at the time now about to be entered upon, appears from the fact, that at the synod of Armagh, assembled in 1170, to inquire into the cause of the arrival of strangers from England for the purpose of conquest, the impending calamity was imputed to the sins of the people, and more especially to the practice of buying English children, and making them slaves. Giraldus Cambrensis, in stating the fact, adds, "that the English, by a common vice of their country, had a custom to sell their children and kinsfolk into Ireland, although not driven to it by extreme poverty."

Dermot M'Murrough, king of Leinster, had incurred the hatred of his own subjects, and of the other princes, by his tyranny. His breach of the laws of hospitality in carrying off the wife of O'Ruark, king of Breffney, gave particular offence to Roderic, by whom he was consequently driven from his dominions. In his distress he History. had recourse to Henry II. of England, under whom he offered to hold his crown as a tributary, if restored by that monarch's exertions. The offer was very grateful to Henry. He had long before turned his thoughts to the acquisition of Ireland. As early as the year 1154, he had procured a bull from Adrian, who owed his elevation to the papacy to Henry's influence, conferring on him the sovereignty of the island, in order to its civilization, upon payment of the tribute of Peter's pence to the court of Rome. But his domestic difficulties and continental engagements had hitherto obliged him to postpone any active measures to accomplish his object. He was now in Guienne, embarrassed by rebellion amongst his French subjects, and by his disputes with the papal see, and therefore was forced to confine himself to general expressions of assent, confirmed by a permission to all his English subjects to assist in the restoration of his new ally. Supported by this authority, Dermot turned homewards, and, after vainly attempting to engage adventurers in Bristol, he at last formed a treaty with Richard Clare, earl of Pembroke, better known by the name of Strongbow, a Welsh baron, who, having impaired his patrimony, was easily engaged to take part in a desperate enterprise, on the uncertain expectation of inheriting the kingdom of Leinster after Dermot's death, by a marriage with his only daughter, which was to be the reward of his exertions if successful. Through Strongbow's influence, he also engaged the assistance of Robert Fitzstephens, constable of Abertivi, and of Maurice Fitzgerald, a Welsh chieftain. Having secured these auxiliaries, Dermot returned to Ireland, where he lived concealed in the monastery of Ferns, the confidence of whose inmates he had gained by liberal donations to their house, until the arrival of his new friends warranted him in asserting his former station.

Fitzstephens was the first to fulfil his engagement. He landed at the headland of Bag-and-Bon, in the estuary of the Bannow, with a following of but thirty knights, fifty gentlemen, and three hundred archers. Small as the number was, their discipline and superiority in military equipment justified Dermot in throwing off the veil on their appearance. The first movement of the combined force was upon the town of Wexford, a Danish dependency of the crown of Leinster, which surrendered on the first appearance of the enemy, and was, with the two adjoining cantrids of Forth and Bargie, given to Fitzstephens by Dermot, as a foretaste of what was to be hoped for in his service. The next movement was against the king of Ossory, in the Queen's County, who, after a gallant struggle, was also forced to acknowledge the superiority of the Norman mode of warfare. After a hard-fought contest of three days, the passes of his borders were forced, and himself compelled to fly. The news of these successes soon compelled Roderic to take the most decisive measures. At the head of an army collected from all the subordinate provinces, he advanced to drive the rebel king and his foreign auxiliaries into the sea; but the interference of the clergy prevented the appeal to arms. A treaty was concluded, by which Dermot was restored to his former rank, on condition of dismissing his foreign forces, and paying a fine for his outrage against O'Ruark. His son was delivered to Roderic as a hostage, along with others, for the fulfilment of the terms.

The arrival of Maurice Fitzgerald, who landed at Wexford with ten knights, thirty gentlemen, and an hundred archers, gave a new turn to affairs. Fitzstephens, who was then engaged in erecting a fortified post at Carrig, which commanded a pass on the Slaney, near Wexford, resolved to maintain his position. Little influence was necessary to induce Dermot to aid an effort as profitable

History. in expectation as perfidious in act. Encouraged by the hope that this new supply would be the prelude to the influx of fresh bands of well-trained warriors, he indulged in the prospect of gratifying his revenge on the causes of his degradation, and even of seating himself on the throne of supreme sovereignty, through the powerful aid of his English allies. For this purpose, after having reduced the city of Dublin to submission by the devastation of the neighbouring district of Fingal, thus establishing his rule over the whole of his former dominions, he sent to urge Strongbow to hasten his arrival.

This nobleman, not satisfied with the general permission already given by Henry, went to that prince, then in Normandy, and having obtained a vague and equivocal assent, prepared for the vigorous prosecution of his enterprise. He first sent over Raymond le Gros, with a detachment of ten knights and seventy archers; who, landing near Waterford, defeated a body of three thousand Irish, collected from the neighbouring country on the spur of the moment, and maintained his position in an intrenched camp until supported by Strongbow himself, who brought to his relief a body of two hundred horse and upwards of a thousand archers. He then, aided by the junction with Dermot, who had hastened to the place, made himself master of Waterford, and thence proceeded to Dublin, which was taken by assault. Roderic, alarmed at the successes of the English, after having called in vain on Dermot to abide by the late treaty, and having, according to some accounts, beheaded that king's son, in consequence of his father's refusal to fulfil the terms of it, collected another army to oppose the invaders. Dermot's death at this juncture gave a new character to the contest. Strongbow, by his marriage with that prince's only daughter, had succeeded to his royal rights; but being unsupported by any of the Irish chieftains, who viewed with apprehension and envy this intrusion of a stranger, he found himself cooped up in the city of Dublin, with his small band of Englishmen, to stand the brunt of the entire Irish army, with which Roderic had invested the city. But he was delivered from this critical situation by one of those exertions by which a vigorous mind surmounts difficulties. He had been reduced to the necessity of proposing a capitulation. The only terms offered him were the immediate evacuation of the country. Such a surrender of all their brilliant prospects was to these daring adventurers a prospect worse than death. Mito de Cogan, by whose valour in leading the assault the city had been taken, now proposed a sally. His advice was followed. Strongbow, at the head of a select body of ninety knights, attacked the Irish camp. The assault was so sudden and unexpected, that Roderic had scarcely time to escape from the bath, where he was then refreshing himself. The panic spread through all parts; and this great army was dissipated almost without a blow. The English followed up their good fortune by marching to Wexford to relieve Fitzstephens, who was blocked up by the Irish in his castle of Carrig. In the passage thither, the army had to force its way through the passes of Idrone, where O'Ryan, the dynast of the territory, disputed the ground with it successfully, until his death turned the fate of the day. It is said that the English were so severely pressed in the engagement, that Strongbow's son, a lad rising into manhood, fled from the fight, for which he was hewn in two by his indignant father. A mutilated figure on a small monument placed by the side of Strongbow's tomb in Christ Church, Dublin, is still adduced as evidence of the truth of this extraordinary event.

The successes of Strongbow excited the jealousy of Henry, who began to apprehend in them, not the enriching of a subject, whence the monarch might derive honour, but the aggrandizement of a rival in power. He History. forbade any of his subjects going to the assistance of the English in Ireland, and commanded the immediate return of all those already there. He was, however, appeased by the appearance of Strongbow himself, who surrendered all his possessions in Ireland to the king, to be holden at his good pleasure. He was restored to favour, and appointed seneschal of this new lordship, with the exception of Dublin and the other fortified cities, which the king retained in his own hands. Henry soon afterwards went over to Ireland with a train of 500 knights, and a large body of soldiers. Landing at Waterford, he proceeded without molestation to Dublin, where he received the homage of a numerous assemblage of the native chieftains, whom he entertained in a pavilion hastily constructed of wicker-work without the walls, as the city then contained no building suitable for their accommodation. He also held a great council or parliament at Lismore, in which the English laws were received and sworn to. At the same time a synod of the clergy at Cashel adopted the rules of doctrine and discipline of the English church for their future regulation. After spending the Christmas in Dublin, and dividing the districts that acknowledged his authority among the chief leaders of the adventurers by whose valour they had been acquired, he returned to England early in spring, to allay the commotions which threatened to break out there.

His absence gave rise to dissensions amongst the English leaders, which led to revolt amongst the natives, who had so lately submitted. To aid the efforts of the Irish, Roderic made another attempt to regain his lost dominions, and to expel the strangers. He invaded Meath, which had been given by Henry to an English baron of the name of De Lacy, with such fury, that Raymond le Gros, the favourite general of the English, who was then celebrating his marriage with the sister of Strongbow, was forced to quit Wexford the morning after his nuptials, in order to make head against the Irish. But they, content with the devastation committed in Meath, had already retired across the Shannon, and Raymond turned his arms against Limerick, which city he took by storm with little difficulty. Roderic, convinced of his inability to cope with success against the superior power of England, sent deputies to the king, proposing to do homage, and pay a stipulated tribute, in return for which he was to hold the kingdom of Connaught, and all his other lands and sovereignties, as fully, in other respects, as before the arrival of the English.

On the death of Strongbow, who died and was buried in Dublin, leaving behind him an only daughter, the heiress of his princely domains, the government of Ireland was committed to William Fitz-Andelm, a nobleman allied to Henry by blood; but the complaints arising from his indolent and corrupt administration became at length too loud to remain unnoticed. He was therefore removed, and John, the king's favourite son, was appointed lord of Ireland, at the early age of twelve years. On his arrival at Waterford, at the head of a train of young and arrogant noblemen, the native chieftains hastened to pay their respects and do him homage; but when they approached to testify their allegiance according to the custom of the country, by saluting him with the lip, the prince's English attendants repelled them with insolence, plucked them by their beards, and treated them with every mark of studied indignity. The high-minded natives quitted the court, and their cause was espoused by all who heard their tale. The alarm of war was spread throughout every part of the country. The castles already built by the English on their newly-acquired territories in Meath were stormed and razed, some of their owners killed, and others driven from their settlements. John was recalled, and the government intrusted to De

History. Lacy, who was soon afterwards assassinated by one of the natives whilst superintending the erection of a fortress which he was building, sacrilegiously, according to the opinion of the times, on the ruins of an abbey dedicated to Columbkill at Durrow. He was succeeded in the government by De Courcy, a nobleman celebrated for his gigantic size and prowess. He had been given such parts of Ulster as he could conquer; and having established his head-quarters at Down, he maintained himself there for some time in a kind of subordinate sovereignty, against all the efforts of the neighbouring princes, and even made an attempt to extend his conquests into Connaught, in doing which, though he failed in the main object of his ambition, he established his power in the neighbourhood of Armagh. The death of Henry II. made no change in the government of Ireland. Richard, intent on his schemes of foreign conquest, permitted John to retain the title and authority conferred on him by his father. The only event which varied the scene of intestine commotion in Ireland during this reign, was the death of Roderic, the last sovereign of all Ireland. The latter years of his life were embittered, in addition to the loss of his independence, by the rebellious conduct of his own sons, which at last compelled him to seek, in the retirement of monastic seclusion, the tranquillity he had vainly sought for on a throne. He died in the monastery of Cong, in 1198, in extreme old age.

John, in the early part of his reign, paid little attention to the affairs of Ireland, which was now much distracted by the feuds carried on between De Lacy, son of him who had been killed at Durrow, and De Courcy. In this struggle the artful management of the former gained him the advantage over De Courcy's blunt and boisterous ferocity. He accused him of having imputed to John the murder of his nephew Arthur, in consequence of which, De Courcy was summoned to the court in London; and when he treated the mandate with contempt, he was treacherously seized by his enemy De Lacy, while performing a religious penance unarmed in the church of Down, and sent prisoner to England, where he was long kept in confinement. A proceeding as unworthy as this which exposed De Courcy to the royal indignation, brought John a second time to Ireland. The lady of William de Braosa, who had received a large grant of land in Thomond, or North Munster, on being required to send her children to the English court as hostages for her husband's allegiance, refused to obey; alleging as a reason, that she would not intrust her children to the care of the murderer of his own nephew. The insult was unpardonable, and John went over in person to avenge it. Upon his arrival in Dublin, upwards of twenty chieftains attended to do homage; but he performed no military act worthy of notice. The unfortunate De Braosa was forced to fly to France, leaving his wife and family behind, who were seized by the tyrant and sent to England, where they died of the severity of their treatment in prison. During his short stay, John paid much attention to the internal management of the country. He ordained that the laws of England should be introduced, with all their judicial forms, a copy of them being left under his great seal, in the exchequer of Dublin. He also divided the districts which acknowledged his authority, and which were afterwards distinguished by the name of the Pale, into the twelve counties of Dublin, Meath, Kildare, Louth, Carlow, Kilkenny, Wexford, Waterford, Cork, Kerry, Tipperary, and Limerick. In the remainder, which comprehended two thirds of the island, the king's supremacy was merely nominal. Connaught, which Roderic in his treaty with Henry had specially reserved to himself, after suffering dreadfully by the contentions of that monarch's sons, and by the irruptions of the English leaders, who endeavoured, by their interference in these family quarrels, to obtain some footing in it for themselves, fell ultimately into the hands of Cathal, surnamed Croove-derg, or the Bloody-handed. But the influence of the De Burghos, a branch of the family of Fitz-Andelm, proved too powerful for him. After many a desperate struggle with the intruders, in which his undisciplined valour enabled him to cope at times successfully with the well-marshalled followers of the English chieftain, he was compelled to surrender two parts of the country to the king of England, in order to secure to himself the peaceable possession of the remainder; at the same time acknowledging himself a vassal, and binding himself to a yearly tribute of an hundred merks. On the departure of John, who continued but a short time in the country, the government was intrusted to John de Grey, bishop of Norwich, who conducted it with prudence and vigour; and afterwards by Henry de Loundres, archbishop of Dublin, the most remarkable act of whose administration was the erection of a castle in Dublin, now the acknowledged capital of the English territory. History.

Immediately after the accession of Henry III. the Irish transmitted to England a list of the encroachments made on their rights in the preceding reign, with a petition to be taken under the royal protection. Henry sent them in answer a copy of the Magna Charta, whereby they were to be placed on the same footing as English subjects. This charter was confirmed by others of a similar tendency, transmitted by the same monarch. He also gave O'Brien, king of Thomond, a grant of that territory, to be held by English law, in lieu of the Irish tenure by which he had hitherto possessed it. The change was considered of such value as to be worth the payment of a thousand merks, and an annual sum of an hundred and thirty. But the king's promise of impartial protection to the Irish was grossly violated in the instance of Cathal Croove-derg, who was now deprived of the third part of his kingdom that had been allowed to remain with him by John, this portion being granted, together with all the rest of Connaught, to Richard de Burgho. Cathal died soon after this unjust deprivation of his property. His subjects, assisted by O'Neill, prince of Tyrowen, placed his brother Tirlogh on the throne; but he was removed by the lord-deputy, and Aedh, a son of Cathal, substituted in his place. Aedh being shortly afterwards killed in a skirmish, the lord-deputy again removed Tirlogh, whom the people of Connaught had reinstated, and placed Feidlim, another son of Cathal, upon the throne. But a title held under a tenure so precarious and degrading could not be satisfactory. Feidlim, therefore, crossed over to England, and threw himself on the protection of the king, by whom he received a special assurance of security in the possession of his territories, which enabled him to retain them unmolested till his death.

Towards the conclusion of his reign Henry made a grant of Ireland to his eldest son Edward; with a proviso, however, that it was to be always connected with and dependent upon the crown of England. The country derived no benefit from the arrangement. Edward was drawn away to pursue schemes of more brilliant promise in the Holy Land, and Ireland was suffered to continue under the management of subordinate officers. Its state was at this time truly miserable. In addition to the struggles of the Irish chieftains to regain their patrimonial rights of property and independence, the districts which acknowledged the English rule were torn to pieces by the hostilities of rival barons. To such a pitch did this state of anarchy increase, that in a contest between the De Burghos and the Fitzgeralds, the latter faction seized upon Richard de Rupella, the lord-justice of Ireland, and threw him, with several of his adherents, into prison, from which it required the authority of a parliament to liberate him.

The neglected state of the country during the reign of Edward I., whose attention was absorbed by the nearer and more pressing affairs of Scotland and Wales, increas-

History. ed the turbulence and audacity of the English barons. A dispute between Sir William de Vesci, the lord-justice, who had married an heiress of the Pembroke family, and John Fitzthomas, one of the heads of the Fitzgeralds, was carried to such a pitch, that each accused the other of high treason; and the affair was brought before the king in person, to be decided by the law of duel. On the day appointed for the combat, Vesci was not forthcoming. He had fled to France. The king transferred his lands in Ireland to his accuser, which contributed considerably to the future aggrandizement of the Fitzgerald family. So grievously was the great body of the Irish pressed down by the arrogant tyranny of these feudal lords, that they offered the king six thousand merks for a charter from him to be governed by the laws of England. This reasonable request, which implied nothing more than the enforcing of the previous charters of John and Henry to the same effect, was neutralized by the opposition of the barons, whose oppressions it was meant to curb. A second application of a similar nature during this reign met with a similar fate. The conduct of Edward to one of the lords-justices, De Ufford, whom he called over to explain why such quarrels were permitted during his administration, proves that the king was not over anxious to probe this malady to the bottom. De Ufford's defence of himself was, that "he deemed it expedient to suffer one knave to destroy another, to save expense to the king." Edward was satisfied with this evasive answer, and sent him back to his government. The wars of the barons were still tolerated; and the Irish, who wished for the protection of English law against their tyranny, were still forced to purchase it by special charters of denization, by the fees of which the officers of the court were enriched. These charters were mostly the consequence of intermarriages with some of the great English families.

The accession of Edward II. afforded a prospect of the restoration of the royal authority, and the suppression of the exorbitant power of the English barons. The king, compelled to part with his favourite Gaveston, sent him into Ireland as lord-lieutenant, as into a kind of honourable exile. On his arrival, Gaveston obtained some advantages over the Irish septs in the neighbourhood of Dublin; but, however flattering the appearances arising from this change of administration, they proved delusive. Edward, unable to endure longer his favourite's absence, recalled him, and the country fell back into the anarchical sway of the barons. The royal mandates were set at nought, and private wars carried on without restraint or control. Frightful as were the state and prospects of the country, a fresh ingredient of misery was now thrown in. Robert Bruce, king of Scotland, elated with the victory of Bannockburn, resolved on a measure which, if successful, would have added considerably to the security of his own kingdom, and to the weakening of his most formidable enemy. He proposed to detach Ireland from England, and to connect it with Scotland, either as an ally or a dependency. With this view, and also to give employment abroad to an ambitious and ardent relative, he proposed to his brother Edward the conquest of the country. The offer was accepted. The first attempt on the northern province failed, because the means were insufficient for the magnitude of the object. But Bruce was not to be discouraged by a single check. The attempt was soon afterwards renewed with enlarged resources. In the summer of 1315, Edward Bruce landed in the north of Ireland, at the head of six thousand men, where he was joined by numbers of the discontented Irish. De Burgho, earl of Ulster, aroused by the danger which threatened his possessions, aided by Feidlim, king of Connaught, marched to oppose the invader. Their combined force was defeated at Coleraine, and Bruce, following up his victory, reduced Carrickfergus; penetrated into Meath, where he defeated, at Kenlis or Kells, a second army sent to oppose him; advanced still further to Skerries, where he encountered and routed Sir Edmund Butler, the lord-justice; and returning to Dundalk, through want of provisions, was there crowned king of Ireland. His affairs were now singularly prosperous. His brother came to his assistance from Scotland, but was forced, through the scarcity of provisions, to return, leaving with him a part of his troops. Feidlim joined his party, and was followed by O'Brien of Thomond, and several lesser chieftains. The English barons now began to be sensible that the tenure of their possessions was at stake. They collected a numerous body of troops, which were sent, in the first instance, into Connaught, to put down Feidlim. A sanguinary battle ensued at Athenree, in which the Irish prince was slain, and with him terminated the last hope of the restoration of the monarchy of Ireland. Bruce, after refreshing his troops, marched to Dublin. To guard against his assaults, the citizens set fire to their suburbs, with such precipitation, that one of the churches was involved in the conflagration; and intrenching themselves within their walls, they presented such a face as deterred the besiegers from continuing the siege. Bruce therefore proceeded to Kildare, which he ravaged, and thence penetrated through the passes of Ossory into Munster, spreading havoc and desolation on all sides. Want of provisions, and the intelligence, on one hand, of another army having been collected against him, under the command of Roger Mortimer, sent from England as lord-justice, and on the other, of new supplies from home, led by his brother in person, induced him to retrace his steps towards Ulster. By forced marches he retreated unmolested into Meath. He was followed by the English, now under the command of Sir John Bermingham. Both armies met at Faugher, near Dundalk. The Scotch army was the more numerous, but it was much exhausted by fatigue and famine; the English were well equipped and armed, and in a high state of organization. It is said that Edward Bruce, on hearing that his brother was advancing, pressed on the engagement, in the hope of securing to himself the undivided honour of victory. The result was deserving of the arrogance which led to an act so ill advised and precipitate. After a sanguinary struggle, the Scottish army was totally defeated. The body of Bruce was found, after the engagement, in the midst of heaps of slain, lying under that of an English knight of the name of Maupas, who had pressed forward to the honour of being captor of the Scottish general. Robert Bruce, on hearing of the result, immediately returned home, and made no further attempt upon the country. History.

The expulsion of the Scotch gave little relief to the people, who still continued to groan under the feudal oppressions and interminable quarrels of their rulers. On the accession of Edward III. they addressed themselves again to the throne, in order to procure a general charter of admission to the rights of British subjects. The petition was favourably received; but being referred, like former applications of the same kind, to the Irish parliament, through the lord-justice, it was, like these, rejected. The Irish, disappointed in their hopes of good government, broke out into acts of insurrection. The king, unable to restore tranquillity by energetic measures, had recourse to others, the evil effects of which were long felt. The greater part of Leinster had been parcelled out into five palatinates, in favour of the five grand-daughters of Strongbow, on whom this princely inheritance had devolved in failure of male issue. Meath and Ulster had also been granted in like manner. The number of these exempt jurisdictions, in which the superior lord exercised most of the prerogatives of royalty, was now increased,

History. by erecting the county of Desmond, or South Munster, into a palatinate in favour of Maurice Fitzthomas, a branch of the Fitzgerald family; and another was shortly after erected in Tipperary, for James Butler, created Earl of Ormond. In consequence of the great privileges bestowed on these noblemen, the king's authority was proportionally contracted, and a few powerful chieftains were enabled, under colour of asserting their rights, to overawe or control, by their combination, the wholesome exercise of the powers of the constitution, or to convulse the country to its centre, by their mutual contests for superiority. This ruinous system was carried still further. The chief governor, unable to collect men in numbers sufficient to cope with the insurgent Irish, applied for military aid to the Earl of Desmond. The request was readily acceded to, and ten thousand men were sent him; but as the deputy was deficient in the means of paying or feeding such a body, the troops were allowed to live on the country at free quarters, or, as it was then called, on coygne and livery, which consisted in the taking of man's meat, horse's meat, and money, of all the inhabitants, at the will and pleasure of the soldier, who had no other means of subsistence. This extortion was originally Irish, for they used to lay Bonaught, as they called it, upon the people, and never gave their soldiers any other pay. But under the English it was still more intolerable, as with them the oppression was not temporary or limited either in time or place, but, because there was everywhere a continual war, either offensive or defensive, and every lord of a country, and every marcher, made war and peace at his good pleasure, it became universal and perpetual, and was, indeed, the heaviest oppression that ever was inflicted on any kingdom, Christian or heathen.

The effects of this feeble policy proved the reverse of what its devisers may be supposed to have expected. Internal turbulence and discord increased. To heighten the confusion, William de Burgho, who united in his own person the government of the two palatinates of Meath and Ulster, and had also the greater part of Connaught, was assassinated at Carrickfergus by his own domestics. His only daughter was carried to England for protection. O'Neill of Tyrowen, to whose family the northern palatinate of De Burgho had formerly belonged, seized on the opportunity to recover by force a considerable portion of the inheritance of his forefathers. The estate in Connaught was also seized on by two of the younger branches of the De Burgho family, who, conscious of the illegality of their claim according to the rules of English law, renounced their allegiance, assumed the Irish name of M'William, distinguishing themselves from each other by the surnames of Eighter and Oughter, or the Hither and Further M'William; the former holding the lands in Galway, the latter those in Mayo, and both, conforming to the laws and tenures of the Irish, set the authority of the king's justice at defiance. But the act which tended most to destroy the English power, by unhinging the connection between the parent country and the colony that had sprung from it, was an order that all public officers whose property existed wholly in Ireland should be displaced, and their places supplied by persons born in England, and having lands in that country. This act gave rise to the distinction between the English by blood and the English by birth, causing those of the former class, through irritation at the insulting degradation by which they were deprived of their fair share of the honours and emoluments earned by the blood of their ancestors, not only to attach themselves to the native Irish by the ties of marriage and community of interests, but to exceed them in the intensity of hatred to the new intruders; and hence they were said to be more Irish than the Irish themselves. The effects of this unjust and impolitic ordinance were not long in showing themselves. A common History. interest united the descendants of the old settlers into a general combination. Alarmed at the spirit which they indicated, the lord-justice, Sir John Morris, deemed it expedient to assemble a parliament at Dublin, whereby a less dangerous vent might be afforded to the expression of the grievances of the discontented. But the injured party adopted another and a more spirited course. Not content with absenting themselves from parliament, they held another assembly, totally independent of it, at Kilkenny, under the auspices of the Earl of Desmond, in which they drew up a remonstrance, to be presented to the king, which exhibited a striking view of the aggressions of the government, and the grievances which had excited general discontent. The king's answer was gracious and condescending. Assurance was given them of immediate relief from the more gross grievances, and of inquiry into all. His anxiety to procure aid for his continental expeditions appears to have been one cause of the readiness with which these concessions were granted; for we are informed that the Earls of Desmond and Kildare attended him with numerous followers into France, and the latter distinguished himself greatly at the siege of Calais. But the spirit of self-interested monopoly which gave birth to this distinction, though repressed, was not extinguished; and fresh occasion was soon given it to blaze forth from a quarter whence it might least have been apprehended. Lionel, afterwards Duke of Clarence, Edward's second son, had married the heiress of the late Earl of Ulster, and thus became entitled to the lordships of Ulster and Connaught. To add weight to the enforcement of his claim, which he was about to assert in person, the king invested him with the lord-lieutenancy of Ireland. But, born and educated in England, he carried over with him all his English prejudices and prepossessions. Surrounded by men of English birth, and taught by them to look on the ancient settlers, not only as unworthy of his confidence, but as disaffected to his government, he forbade, by proclamation, any of the old English, or of the king's subjects of Irish birth, to approach his camp. This imprudent measure deprived him of the only aid which could render his operations against the common enemy of the English government effectual. Left, amongst strangers to the country, to traverse unknown districts, and to contend against an enemy of whose movements and mode of action he was wholly ignorant, he found himself enclosed in a position in which advance was impossible and retreat perilous, and from which he was extricated solely by an appeal to those whose services he had at his first landing so haughtily and unwisely rejected. After a short stay he was recalled, but returned in a few years, improved in the knowledge of the science of governing a country of habits dissimilar to those of his own. On his second visit he directed his attention to the general reformation of the parts of the island that yielded a willing obedience to the royal authority. A parliament was summoned at Kilkenny, the result of whose deliberations was an ordinance, since known by the name of the Statute of Kilkenny, which forms one of the great political epochs in the history of the country.

By this statute it was enacted, that marriage, fostering, or gossipred with the Irish, should be deemed treasonable; and conformity to the rules of Irish law was subjected to a similar penalty. The use of Irish names, language, or apparel, by any person of English birth or descent, was punishable by forfeiture of lands or imprisonment. Penalties were also imposed on those who permitted their Irish neighbours to graze on their lands, who presented them to ecclesiastical benefices, who admitted them into religious houses as members, or who gave encouragement to the Irish bards, musicians, or story-tellers. The execution of this statute was enforced by the anathemas of the church against its

History. violators. Whatever might have been the effects of an enactment so rigorous towards uniting the English settlers more closely among themselves, it is evident that it severed completely any links of the bond of mutual charity and community of interests that existed between them and the Irish. The presence of an English nobleman of royal birth, connected by marriage with the descendant and representative of a family now nearly Irish through length of residence, might have led to the introduction of a system of generous equity towards the natives of the country, the former rightful possessors of the soil. But the wording of this statute pronounced the Irish to be irreclaimable. The opportunity for the amalgamation of conflicting interests was lost; and ages passed over without another such presenting itself for a renewal of the experiment. The Duke of Clarence was again recalled, and the administration of the government left, as before, to deputies. The low condition to which the country was now reduced may be inferred from the fact related as to Sir Richard Pembridge, warden of the Cinque Ports, who, on being appointed to the lieutenancy, refused to undertake the office, in consequence of the distracted state of the country; and it was adjudged that his refusal was strictly legal, inasmuch as residence in Ireland, even in the elevated station assigned to him, was looked upon as but an honourable exile, to which no freeman was to be subjected, except in case of abjuration for felony, or by act of parliament. So far was the English power reduced towards the close of this reign, that, as the authority of the English law had extended during the time of John over the twelve counties already named, and over the greater part of Connaught, it was confined, in the thirtieth year of the present reign, to the four counties of Meath, Louth, Dublin, and Carlow; and of these the greater part was border-land, governed by march law, which was little more than another word for the arbitrary will of the lord of the marches. The last effort made by Edward to restore the English government, was a mandate directing a stated number of bishops, knights, and burgesses to attend the king in his parliament in England, to assist in enacting laws for Ireland. The proceedings of this parliament are lost, but the existence of writs to the several counties, cities, and boroughs, directing them to defray the expenses of the persons sent over, proves that it had assembled. About the same time the trade with Portugal was thrown open to the Irish, but the disorders of the country were too deeply rooted to admit of the people availing themselves of the privilege.

In the beginning of the reign of Richard II., Robert de Vere, earl of Oxford, was appointed lord-lieutenant of Ireland by the joint consent of the king and the English nobility; the latter party wishing thus to break the connection of favouritism that bound him to the former. But after an equipment, fitted out on a princely scale, the project failed. He had proceeded as far as Wales, when Richard, who accompanied him to the water's edge, found his attachment too violent to bear the separation, and brought him back to London. Commissioners were afterwards deputed to inquire into the state of the country, but with no beneficial result. At length Richard resolved to visit this part of his dominions in person. He landed at Waterford with an army of four thousand men-at-arms and thirty thousand archers; but after nine months spent in an empty display of regal pageantry, during which he received the submission of seventy-five native Irish or degenerate English chieftains, and granted pardons to others, whom an apprehension of ill treatment kept at a distance, he returned to England. The only stipulation for restoring tranquillity made during his visit was, that the province of Leinster should be evacuated by the Irish; but when the condition was to be enforced, after the removal of the terrors of a royal army, the requisitions of the government were followed only by excuses and delays, and ultimately by insurrection, in the course of which Roger Mortimer, earl of Marche, whom Richard had left behind him as his lieutenant, was killed at Kenlis, in a skirmish against the O'Byrnes, whom he had driven from their mountain fastnesses in Wicklow. History.

Mortified and irritated by a result so contrary to the anticipations entertained from his expensive armament and pompous reception in Ireland, Richard undertook a second military expedition thither. He landed again in Waterford, and after spending some time there and at Kilkenny, in an idle display of royalty, he proceeded to Dublin, in the full confidence that now, as previously, his journey thither would be but a progress of pacific parade. In this expectation he was buoyed up by the appearance of several of the Irish lords, who, presenting themselves with halters round their necks, fell at his feet and implored forgiveness with the most abject humility. But on entering into the woods and defiles of the marches of Leinster, his reception was very different. M'Murchad, the principal chieftain of the province, who, notwithstanding the pensions he had received, and the submissions he had entered into, was still the inveterate enemy of the English, rushed out unexpectedly from the cover of his woods, at the head of three thousand chosen men, so well appointed, and with such a display of valour, as to stop the advance of the royal army for some time; and though it ultimately forced its way to the capital, such were the losses sustained by famine, hardship, and battle, that Richard had to wait for a reinforcement from England before he could resume hostilities. In the mean time the news of the successes of the Duke of Lancaster compelled him to hasten his departure, in order to oppose this new enemy. The unfortunate and disgraceful termination of his reign belongs to English history.

The intestine commotions in Ireland were aggravated in the reign of Henry IV. by invasions of the Scotch, who assisted the Irish of Ulster in driving the English from this province, and acquired some settlements there, whence they were never afterwards wholly removed. Henry's second son, Thomas, duke of Lancaster, was sent over as lord-lieutenant. His government was vigorous, and in some degree effective. The native Irish of Wicklow were checked; the degenerate English in Meath and Uriel were compelled to submit; and M'Murchad, who still maintained himself in the western parts of Leinster, in defiance of the government, was defeated in a severe and well-contested battle. The citizens of Dublin fitted out several naval expeditions against the Scotch and Welsh; and though, in their first engagement with the former enemy, they suffered a total defeat on the coast of Ulster, they afterwards revenged the insult by carrying the war into the islands and coasts of Scotland, and by their depredations in Wales, whence they brought back in triumph a shrine of St Cubin, and lodged it with much ceremony in Christ Church, as a proud monument of their victory. But this favourable change was merely temporary. The lord-lieutenant was wounded, and his forces beaten back, under the very walls of Dublin; and he soon afterwards quitted the country altogether. The residents in the border counties were now reduced to the degrading necessity of purchasing peace and protection from the neighbouring Irish chieftains, by the payment of a stipulated tribute called black rent.

The arrival of Sir John Talbot, Lord Furnival, in the succeeding reign, a man distinguished for his military talents, gave hope of a change for the better. By his activity and valour he compelled several of the neighbouring Irish chieftains, not only to desist from their incursions, but also to do homage and give hostages. Yet though bound to keep the peace, they still retained their independence,

History. and the English pale was not enlarged. The lord-lieutenant, likewise, having brought with him no supplies either of men or money, had no means of maintaining his position, except the oppressive and ruinous system of coygne and livery. The English settlers were thus reduced to a state of extreme degradation and distress. Looked upon by the Irish as aliens and intruders, they were treated by the new comers from England as slaves, and considered by the English in general as in nowise better than the natives. In the beginning of this reign, the parliament at London, in consequence of the swarms of needy adventurers from Ireland, whom the devastations of their own country had driven to seek an asylum abroad, passed an act to oblige all Irish to quit the kingdom. Even the students who resorted to London for education, though expressly excepted from the severe provisions of the statute, were contemptuously excluded from the Inns of Court, from a prejudice as impolitic as it was unjust, since it not only precluded them from an intercourse tending to conciliate their affections to England, but debarred them from the means of acquiring a knowledge of the laws, which were the only effective means of preserving the connection between the countries. Indeed the continuance of such connection was preserved at the present period, more by the ignorant prejudices of the native princes themselves, than by the exertions of the government. Contented to rule over their petty septs, their aversion to the English was scarcely more violent than that entertained by them against the neighbouring tribes of their own race. They united in the most cordial attachment with the old English in their revolts; and their insurrections, far from being excited by a general desire of exterminating the whole body of their invaders, were usually occasioned by some local dispute or act of private oppression.

In the beginning of the reign of Henry VI. the two Anglo-Irish families of Desmond and Butler began to assume the high political position which they retained long after. James, the first Earl of Desmond, obtained the leadership of the family and the title, to the prejudice of his nephew, who had degraded himself in the eyes of his followers by marrying a peasant's daughter. The uncle was secured in the estate by authority of parliament, and also constituted governor of the counties of Waterford, Cork, Limerick, and Kerry, over which he exerted an almost royal jurisdiction. The Earl of Ormond, the head of the Butler family, after having been removed from the chief government of Ireland by the machinations of his enemies, was protected against their further efforts by the personal kindness of Henry VI., which laid the foundation of a lasting attachment to this monarch on the part of the earl and his descendants. A change now took place in the government, more important in its effects than any hitherto recorded. Richard duke of York, descended from an elder brother of the prince through whom the reigning family derived its claim to the throne, was universally beloved. The contrast between him and his inglorious sovereign was too glaring to remain unnoticed. It was therefore resolved to remove him out of England; and he was appointed lord-lieutenant of Ireland, with extraordinary powers. His administration presents one of the few bright gleams of Irish history. It was long quoted as the time when peace and prosperity flourished, when faction was repressed by even-handed justice, and when the natives, the English by blood, and the English by birth, coalesced in an honest exertion to improve the country. Aware, on his arrival, of the bitter jealousy which existed between the rival families of the Butlers and Geraldines, and although he knew that the former was attached by gratitude to his rival, he scorned to be swayed by any suspicions on that account; but, on the birth of his son, afterwards the unfortunate Duke of Clarence, by engaging the heads of both families to be sponsors at the infant's baptism, he bound each to himself and to the other by the tie of gossipred, a relationship respected to a degree of veneration amongst the Irish. Being called away to England to clear himself from some imputations on his loyalty, he intrusted the administration to the Earl of Ormond, who was succeeded by Sir Edward Fitz-Eustace, a knight of great military fame, by whom the O'Connors of Offaly were defeated, and the sept of the O'Neills, who had presumed to insult the city of Dublin by plundering some of the ships in the bay, and carrying off the archbishop, were so roughly treated at Ardglass, as to check for a long period any efforts of the northern toparch against the pale. In the mean time the Duke of York, though successful in his first effort to seize the English crown, was totally defeated at Bloreheath, and forced to fly into Ireland, where he was received more like a sovereign prince than a discomfited traitor. The parliament passed an act for his protection, and decreed that whosoever should attempt to disturb him, under pretence of writs from England, should be deemed guilty of high treason. An agent of Ormond, who ventured to violate the law, was executed. On the duke's subsequent change of fortune, numbers of his Irish adherents followed him to England. The palatinate of Meath, in particular, was almost deserted by the English settlers, who hastened to enrol themselves under the banner of the white rose. He appeared in London with this gallant train; but the war being unexpectedly renewed, he was encountered at Wakefield by an army four times more numerous than his own, which consisted but of five thousand men, mostly Irish, and fell in the unequal contest, together with the greater part of his devoted followers. The exhaustion thus produced was nearly fatal to the English interests in Ireland. Towards the close of Henry's reign, the Irish or rebellious English had conquered or subjected to tribute the greater part of the counties of Limerick and Tipperary, together with those of Kilkenny and Wexford, and almost the whole of Carlow, Kildare, Meath, and Uriel, so that little was left, of which the English could claim the undisputed possession, excepting the county of Dublin. The only method to secure peace was by the purchase of the protection of the heads of the Irish septs, who, gratified with such acknowledgment of their superiority, looked with contemptuous disregard on the movements of the Saxons, as the English were called by them.

History. The attachment of the Geraldines to the house of York was rewarded by Edward IV. on his attainment of the royal dignity, by appointing the Earl of Kildare to the lord-lieutenancy. He was shortly afterwards superseded by the Duke of Clarence, the king's brother, who appointed the Earl of Desmond his deputy, in return for having crushed an effort made by the Butlers in favour of the house of Lancaster. But his continuance in power was short-lived. On the king's marriage with Elizabeth Grey, he had incautiously thrown out some reflections upon the meanness of her birth. Tiptoft, earl of Worcester, was soon afterwards sent over as lord-deputy, and, in a parliament summoned at Drogheda, he caused an act to be passed against the Earls of Kildare and Desmond, for allying themselves by marriage, and fostering with the Irish enemy. Kildare, though arrested, was fortunate enough to effect his escape. Desmond, relying either on his innocence or his influence, came forward to justify his conduct, and was immediately seized and executed without even the formality of a trial. This monstrous outrage did not long go unpunished. Kildare justified himself so effectually before the king, that he was not only restored to his titles and estate, but appointed chief governor; and Tiptoft, being recalled into England, suffered, in a new revolution, the same fate which he had inflicted upon Desmond. The defence

History. of the confined limits of the pale was now intrusted to a military order established by authority of parliament, under the name of the Fraternity of St George. It consisted of thirteen leaders of the first consequence in the four counties of Dublin, Meath, Kildare, and Uriel, who had under them forty knights, as many squires, and an hundred and twenty mounted archers. The appointment of a force so inadequate to preserve the peace even of the contracted limits it was intended to protect, evinces in the strongest manner the reduced state of the English power after the termination of the desolating conflict between the rival roses.

The short and distracted reign of Richard III. allowed no time to attend to the state of Ireland. His successor, for what reason it is not known, suffered the government to continue in the hands of the Fitzgeralds, the avowed friends of the house of York. The evil consequences of this policy, or negligence, were not long in showing themselves. Lambert Simnel, who had been set up by the king's enemies on the Continent to personate the Earl of Warwick, son of the late Duke of Clarence, was sent by them to Ireland, as the place most favourable for the design. He was received by the Earl of Kildare, then lord-lieutenant, as the lawful sovereign; proclaimed king; publicly crowned in Christ Church, with a crown taken for the purpose from a statue of the Virgin Mary; and borne thence to Dublin Castle on the shoulders of Darcy of Platten, according to a form used in the inauguration of the native Irish kings. A parliament convened by his writ, under the title of Edward VI. granted subsidies, and enacted severe laws against those who refused to recognise his right, amongst whom the chief were the families of Butler and Bermingham, and the citizens of Waterford. Fortunately for the peace of the country, the arrival of a body of German auxiliaries from Flanders, under the command of Martin Swart, inspired the partisans of Simnel with such an overweening confidence in their own strength, that they determined to transfer the seat of war to England. Thither Simnel went, attended by the flower of the Irish nobility, and a numerous following of the natives. He was met at Stoke, in Nottingham, and defeated by Henry with immense loss, as the Irish, whose light arms could make no impression on the compact and iron-bound ranks of their adversaries, refused quarter, defending themselves singly, even when routed, until they fell overwhelmed by numbers. Simnel, when taken prisoner, was punished, not by severity, but degradation. He ended his life as a scullion in the royal household. The actors in this hasty and ill-digested movement were not treated harshly. Even the city of Dublin was pardoned, on its humble submission. But, in the hope of securing the future allegiance of the great residents, Sir Richard Edgecombe was sent over as a special commissioner, with a train of five hundred men, to receive their submission, and administer the oath of allegiance. On his arrival at Kinsale, his apprehensions at first prevented him from landing; and he received the homage and oaths of Lord Thomas Barry, a principal nobleman of the district, on board his ship; but afterwards landed, and was received in Cork, Waterford, and Dublin, in a manner befitting his mission. The Earl of Kildare hesitated for a time, but at length joined with the others in tendering this proof of submission to the ruling power.

Another claimant of the throne now appeared in the person of Perkin Warbeck, who was, or pretended to be, the Duke of York, second son of Edward IV. He landed at Cork, where his identity was acknowledged. On his arrival there he wrote to the Earls of Desmond and Kildare. The former recognised him at once; but before the latter could decide on the part he ought to take, the adventurer had removed to the French court, whither he had been invited for the purpose of more effectually annoying the English king. Henry now sent over into Ireland Sir Edward Poynings, a knight of distinguished ability, accompanied by several English lawyers to fill the offices of judges; those then on the bench, who owed their elevation to party influence, being notorious for their incapacity. History.

The administration of this governor forms a new era in the history of the country. A parliament assembled by him enacted several useful laws, two of which were peculiarly influential in breaking down the exorbitant power of the nobility. By one of these, all the statutes hitherto passed in England were made law in Ireland; by the other, it was enacted that no parliament should be held until the reasons for holding it, and the statutes to be proposed in it, should be approved by the privy council of England. Warbeck made a second attempt upon Ireland, in which he was openly assisted by the Earl of Desmond; but after an unsuccessful attempt on Waterford, he was forced to quit the country, and take refuge with the king of Scotland. The enemies of Kildare were not remiss in seizing this opportunity to crush him; and the Butlers importuned the lord-deputy to imitate the example of Tiptoft, and consign him at once to the executioner. But Poynings rejected the cruel and impolitic suggestion, contenting himself with sending the earl to England to answer in person the allegations brought against him. This proceeding, as just as it was merciful, led to a conclusion wholly opposite to the anticipations of his enemies. When warned by the king to choose able counsel to defend himself against the heavy charges advanced against him: "Yes," said Kildare, "I choose the ablest in the realm; I take your highness as my counsel against these false knaves." Charge after charge was alleged against him, and answered; amongst others, that of having burned the church of Cashel. On hearing this brought forward, Kildare interrupted the speaker: "Spare your evidence," said he; "I did burn the church, but I thought the bishop had been in it." This extraordinary plea raised a laugh amongst all present. His accusers in a rage exclaimed, "All Ireland cannot rule this earl." "Is it so?" replied Henry; "then this earl shall rule all Ireland;" and he sent him back as lord-deputy. The event justified Henry's sagacity. Kildare repaid his sovereign's confidence by a government of unremitting zeal, energy, and fidelity. The boundaries of the pale were gradually extended; several septs, to whom tribute had hitherto been paid, were forced to submit. He marched a gallant army into Connaught, against Ulick de Burgho, the head of the degenerate English in that province; more, it must be acknowledged, to gratify private resentment than to promote the interests of his royal master. The armies met at Knocktow, near Galway. The victory of the deputy was sullied by the ferocity of his troops, who refused to give quarter, and continued the massacre until night forced them to desist. This victory reduced the whole of Connaught to obedience. The O'Neills and the O'Briens were the only septs of any consequence who still refused to tender their allegiance.

The Earl of Kildare was continued in the government by Henry VIII., who testified his approbation of his services by appointing his son Gerald his successor. The young earl, with the characteristic valour of the family, inherited a more than ordinary share of their pride and imprudence. Too haughty to court the favour of Wolsey, then in the zenith of his greatness, by meanness and subserviency, he incurred that proud prelate's hatred, which was heightened by the artful suggestions of his rival the Earl of Ormond. Through the machinations of this nobleman he was removed, and summoned to England to account for his conduct. Here, strengthened by a marriage with the daughter of the Marquis of Dorset, he was enabled to baffle the efforts of the cabal formed against him.

History. He attended Henry at his celebrated interview with Francis I., and, by the splendour of his suite, and the brilliancy of his equipage, contributed largely to the splendour of "the Field of the Cloth of Gold." On his return home, the struggle between the rival families attained to such a height, that commissioners were sent from England to investigate the case. Their report, when laid before Henry, induced him to remove from the head of affairs Pierce earl of Ormond, better known in the chronicles of the times by the name of Red Peter, the deputy to the Earl of Surrey, then lord-lieutenant, and to substitute his rival in his place. The decision proved eventually fatal to this nobleman. Inflated with an opinion of his own greatness, he acted so as to excite a suspicion of aiming at the assumption of independent power in Ireland. His enemies pressed the charge against him, and a peremptory order was issued for his immediate attendance at court. Unwilling to quit the seat of power, conscious most probably that his conduct would not bear a strict investigation, he endeavoured, through his wife's relations, to evade obedience; but finding all his efforts ineffectual, he ultimately repaired to London, after having supplied all his castles with arms and ammunition from the royal stores, a measure tending most powerfully to confirm the prejudice raised against him. On his arrival there he was forthwith thrown into the Tower.

That the royal anger against the earl had not been very violent, is evident, notwithstanding the harsh treatment thus inflicted on him, from the fact that he was permitted to commit the government during his absence to some person for whose conduct he should be responsible. By a step still more unaccountable than any of those that had involved him in suspicion, he intrusted the administration to his eldest son Thomas, a stripling scarcely twenty-two years of age, who, to the rashness of youth, and a natural violence of temper, added an insolent contempt of his rivals, and a boyish confidence in the irresistible power of the Geraldines. The news of his father's imprisonment could not fail soon to arrive in Ireland. Common fame, aided by the artifices of the enemies of the family, swelled it into an assertion of his execution. The young lord lent a credulous ear to these falsehoods, and, as impetuous as he was credulous, instantly had recourse to means of vengeance as desperate as they were chivalrous. Attended by a retinue of an hundred and forty followers equipped in a style of gaudy display, which, even in those times of courtly splendour, earned for him the title of "the Silken Knight," he proceeded to St Mary's Abbey, on the northern bank of the Liffey, where the privy council were assembled; and there, throwing down the sword of state, he solemnly renounced his allegiance, and declared himself the mortal enemy of the English government. All the other members of the council gazed on him in silent astonishment. Archbishop Cromer, then primate and chancellor, alone interfered, and remonstrated with the fiery young man on the madness of the act he was committing. The appeal to his better judgment was interrupted by the family bard, who, unconscious, through his ignorance of the language, of what was going forward, commenced a rhapsody on the glories of the Geraldines, the treatment of their chief, and the vengeance which it claimed. Passion prevailed over prudence. The voice of age and wisdom was drowned in the clamours of his attendants, and the young lord tore himself from the chancellor, rushed out of the council board, and, without premeditation or preparation, plunged into a war against the whole power of England.

Baffled in an attempt to surprise the castle of Dublin, Lord Thomas ravaged all the district of Fingal, in its northern neighbourhood, during which Alen, archbishop of Dublin, one of the determined enemies of his family, was taken prisoner. When brought before him, his hasty expression, "Away with the English churl," was translated by his rude Irish followers into a mandate for execution, and the wretched man was immediately butchered. He then renewed his attempt to seize the castle, but was prevented, and eventually driven from the city by the citizens, who even burned part of the suburbs, to prevent them from affording shelter to his troops. From being the aggressor, he was now forced to act on the defensive. Maynooth Castle, his strongest fortress, was invested, and, after a resistance of fourteen days, was captured by the treachery of a foster brother of Lord Thomas, who, after having been paid the pecuniary remuneration of his treason, received a more adequate recompense by being hanged by the orders of the English deputy. The irregular army of the insurgents began to dissolve on the intelligence of this disaster, and their leader was driven to a desultory warfare in the fens and mountains, from which he was inveigled by a solemn assurance of pardon given by the English general Lord Grey, and confirmed by the communion of the holy sacrament. Grey was rewarded for his services by the office of lord-justice. His first act of government was one of atrocious perfidy. In spite of his previous solemn promise, he sent his prisoner to London, where the first news the wretched youth received was, that his father had died, not by legal execution, but through grief at his insane rebellion. This act of Grey was followed by a similar one, if possible of deeper guilt. Henry breathed the most furious revenge against the whole family of Kildare, and sent orders to have the five uncles of the young lord seized. To effect this, the lord-deputy invited them to a banquet, where, in the midst of the pretended hospitality, they were arrested, forced on board ship, hurried to England, and executed along with the real instigator of the rebellion. A brother of Lord Thomas, a boy about twelve years of age, who was also included in this decree of blood, after having been sheltered for some time, at no small risk, by his aunt, the widow of M'Arthy, a Munster chieftain, was conveyed to France, and, when Henry had the meanness to claim him as a subject, he escaped to Flanders. Thence, when pursued by the same spirit of despicable malignity, he fled to Germany, and finally found shelter in Rome, under the protection of Cardinal Pole, who, in defiance of Henry's protestations, received and educated him as his kinsman, and, by his favour and support, enabled him to recover his birthright, and restore the otherwise extinct honours of the house of Kildare.

History.

A period now arrived in which religion, hitherto little noticed in the political events of the country, was forced to assume a character as dissonant to its real nature as prejudicial to its true interests. Henry determined to extend to Ireland the reformation he had with so little opposition established in England. Commissioners were sent over to procure an acknowledgment of the king's supremacy, who, though opposed by Cromer, the archbishop of Armagh, a strenuous champion for the religion at that time established by law, succeeded in obtaining it. A parliament, assembled at the special suggestion of Browne, the first Protestant archbishop of Dublin, exhibited a subserviency to the royal wishes as great as even the despotic character of Henry could require. It pronounced the king's marriage with Catherine of Aragon null; declared the inheritance of the crown to be in the king's heirs by Anne Boleyn; and as the passing of this declaration was followed by an account of that unhappy lady's condemnation and death, and the king's subsequent marriage with Anne Seymour, it altered the succession anew to correspond with the new change in the king's disposition. It also acknowledged the king's supremacy in the fullest manner, forbade appeals to Rome, renounced the authority of the Romish see, and decreed the suppression of most of the monastic institutions.

History. his daring adherents had seized a prey of cattle for his sustenance. They were traced into a wooded valley, where, attracted by a light, his pursuers were led to a hovel, in which they found only a feeble old man. On being assaulted and wounded, he called out for mercy, and told them he was the Earl of Desmond. This was the signal for his death. The soldier repeated his blow, and slew him. His head was forwarded to the queen, who ordered it to be fixed upon London Bridge.

The government of Sir John Perrott, who succeeded Lord Grey, presents one of the bright spots in the history of the country. His first act was to publish an amnesty, and to denounce the military slaughters and spoliations which were encouraged by too many of the commanders. He took care to secure all parties in their persons and properties, to administer justice to all alike, and to reform the gross abuses in the public departments. Nor were his endeavours unsuccessful. The natives vied with each other in tendering proofs of loyalty. The old lords of the pale suspended their feuds, and came up to attend his court in Dublin. A parliament was assembled, which, though with some reluctance, passed an act for the attainder of the deceased Lord Desmond, together with an hundred and forty of his followers, and confiscated his immense estate to the crown. Having thus reduced the south to order, he turned his attention to Ulster. Hugh, the eldest son of Matthew, Lord Dungannon, was entitled to the honours and estates belonging to the earldom of Tyrone. He had been educated in England, and had served with honour in the queen's army. He now applied for his seat in the House of Lords, and for the restoration of his property. Perrott granted him the first of these requests, and referred him to the queen as to the second. He therefore presented himself at court, not, like his predecessor, in the wild attire and equipage of an Irish dynast, but as a British courtier. He was received with marked partiality, and soon restored to his possessions. The close of Perrott's government was stained by an act unworthy of him. O'Donnell, the chieftain of Tyrconnel, was suspected of meditating a revolt. Perrott undertook to stifle the attempt without difficulty or expense. To effect this, he caused O'Donnell's eldest son to be inveigled on board a ship sent into Lough Swilly, on pretence of trafficking in wine, and had the young man brought up to Dublin, where he was kept for some time in close confinement. But such had been this governor's general conduct, that even an act so unjustifiable did not deprive him of general confidence. On his recall, being aware of an impending Spanish invasion, he assembled such of the lords and chieftains as were most likely to be swayed from their allegiance by the appearance of a foreign force, pointed out to them the consequences which must result from the apprehended invasion, and persuaded them to give hostages in proof of their determination to adhere to their sovereign. He then quitted the country, followed by the blessings and prayers of thousands. The conduct of his successor, Sir William Fitzwilliam, whose sole object appeared to be the accumulation of wealth, enhanced the feelings of regret for his departure. After the defeat of the Spanish Armada, several of the ships belonging to it were lost on the northern coast of Ireland. Reports were rife as to the quantities of money acquired from the wrecks by the chieftains residing in the neighbourhood. Fitzwilliam seized upon some of them, on the mere suspicion of their being in possession of these treasures, and kept them for years in close confinement. He afterwards imprisoned M'Mahon, the head of the sept that held Monaghan county, on a charge of treason, for having employed a military force to collect his revenues, an usual custom in the Irish districts, and brought him to trial before a jury of soldiers, by whom he was at once condemned and consigned to immediate execution. These and similar severities excited the spirit which they professed to repress. Young O'Donnell, who had been treacherously entrapped by Perrott, found means to escape from Dublin Castle, and took refuge in the mountains of Wicklow, whence, after a year's residence, he made his way, through extraordinary difficulties, to his own country, where he was most active in fomenting the spirit of discontent amongst his neighbours. History.

About this time the university of Dublin was founded, on the site of a suppressed monastery. The project was first conceived by Sir John Perrott, but it was not acted upon until the time of his successor. It was the only successful effort since the arrival of the English at imparting to the country a knowledge of the higher branches of learning.

O'Neill, ever since his restoration to his estate, had been preparing means for the part he afterwards acted. Amongst the stipulations in his favour on his restoration, was the privilege of being attended with a certain number of armed men. These he frequently changed, so as to have in a short time a large number of his followers trained to the use of arms. When he conceived himself sufficiently prepared to set the English power at defiance, he threw off the mask, and openly laid siege to the fort of Blackwater, built some time before for the avowed purpose of keeping him in check. Sir Nicholas Bagnal was sent to relieve it. The opposing armies met near Armagh. The numbers on each side were nearly equal, but fortune turned the scale of victory. In the heat of the engagement, the explosion of a magazine threw the queen's forces into confusion. The death of Bagnal, who, whilst raising his visor, was shot through the brain, rendered the confusion irremediable. The victory of the Irish was decisive, and fifteen hundred of the enemy fell in the field. The fort of Blackwater immediately surrendered, and Armagh was evacuated by the queen's troops.

Elizabeth at length determined to make one irresistible effort to crush an adversary now become truly formidable. She sent the Earl of Essex into Ireland as lord-lieutenant, at the head of twenty thousand men; a number deemed more than sufficient to accomplish her object in a single campaign. Essex had orders to proceed directly against Tyrone; but he took a course diametrically opposite. He directed his march southwards through Munster, where he found an impoverished and depopulated country, and an enemy that eluded every effort to bring them into decisive collision. In passing through Leix, his cavalry suffered heavily from the repeated desultory attacks of O'More, who cherished all his ancestor's hereditary hatred of the English; whilst another division of his army was defeated by the O'Byrnes of the mountains. In another quarter Sir Conyers Clifford, who was sent into Connaught to create a diversion in favour of the main body, was routed and killed in the Curlew Mountains, by O'Ruark, prince of Breffney, as the county of Leitrim was then called. These repeated losses so diminished the numbers and broke the spirit of the English, that when Essex moved northwards to effect his main object, he found his means inadequate to the attempt. An interview was proposed and accepted, which was followed by a truce for six weeks, in consequence of which the English army returned to its quarters in Leinster.

The anger of Elizabeth at this termination of her expensive expedition was extreme. Essex, to ward off its effect, took the desperate expedient of returning unbidden to court, to justify himself in person. The act was as unfortunate as inconsiderate. He was arrested, imprisoned, and, on a still more frantic effort to excite the citizens of London against the queen, was tried and beheaded.

Sir Charles Blount, Lord Mountjoy, was sent to Ireland in the place of Essex. His love of literature had excited

History. an opinion of his effeminacy. O'Neill exulted openly at the appointment of a man "who would lose the season of action whilst his breakfast was making ready." He was soon to learn that the graces of polite literature are by no means incompatible with the qualifications of a warrior. At the commencement of Lord Mountjoy's proceedings, an occurrence took place which excited in his mind strong doubts of the honesty of the Earl of Ormond, who had still the chief command of the army. This nobleman having allowed himself to be trepanned into a conference with O'More, the chieftain of Leix, on pretence of treating as to terms of submission, was seized and long detained prisoner, as Mountjoy was not over hasty in paying a large ransom for a man who, he shrewdly suspected, had been the secret cause of his own calamity. The proceedings against O'Neill were conducted with much policy. The inferior chiefs were bribed to join in the confederacy against him. Rival claimants were set up against his friends. The lands of those who adhered to him were mercilessly devastated. Pardon was granted to the insurgents only on the condition of betraying or murdering a relative or friend. A strict adherence to these practices soon wasted O'Neill's strength. He persevered in his resistance, however, in the hope of succours from Spain. These at length arrived, but fell far short of what his expectations had anticipated, or the greatness of the emergency called for. Two thousand men, under the command of Don Juan d'Aquila, were all that Philip of Spain would or could spare towards this effort to crush his rival, or at least to dismember her empire. To complete the series of ill-combined arrangements, the invading force landed at Kinsale, in the south of Ireland, whilst the ally whose interests it was sent to maintain was shut up in the northern extremity of the island. The Spaniards, as soon as they landed, were blocked up in Kinsale by the combined forces of the lord-deputy, and Sir George Carew, president of Munster. Don Juan wrote in the most urgent terms to O'Neill and O'Donnell to come to his relief. They advanced at the extraordinary speed of forty miles a day, through a country already desolated by the protracted continuance of a war of extermination. At the same time that they arrived near the scene of action, the landing of a second Spanish armament at Castlehaven, joined to the intelligence that this was to be followed by still further succours, induced several of the southern chieftains to declare themselves openly in favour of the Spaniards; and Mountjoy now found himself blocked up in turn, between the garrison of Kinsale on the one side and the Irish army on the other. Under such circumstances, delay would have been ruin. Famine and disease, already active in his camp, must soon have accomplished the annihilation of his army. The impatience of the Spanish general, and the want of concert among the Irish, saved him. O'Neill was prevailed upon to hazard an attack upon the English lines. In this he was anticipated. Mountjoy, aware of his intention, marched to meet him with part of his forces, leaving the remainder to keep the besieged in check. The enemy were taken by surprise, and, after a short resistance, the main body of the Irish was broken and scattered. O'Donnell, who commanded the rear, fled without striking a blow. O'Neill, after some ineffectual attempts to rally his men, still much superior in numbers, gave up the attempt in despair, and hurried back to the north. The Spanish general, finding himself deserted, and, as he thought, betrayed, by his new auxiliaries, surrendered upon terms. The war of desolation was now carried into the northern province. The forts of Charlemont and Mountjoy were erected to curb the Irish in that quarter. The open country was desolated. Large tracts were converted into deserts, where the miserable remnant of the population endeavoured to support nature by feeding on grass, or the filthiest garbage. O'Neill's friends and adherents gradually fell off. He at length applied to be received into mercy. Mountjoy, at this time aware of the precarious state of Elizabeth's existence, was equally anxious to terminate the struggle. After receiving from O'Neill an abject submission on his knees at Mellifont, he admitted him to pardon, and encouraged him with the hope of restoration to his title and estate. Scarcely had the ceremony been concluded when the news of Elizabeth's death arrived. O'Neill, on hearing of it, burst into a flood of tears, occasioned, as he said, by his regret for a princess whose kindness he had so ungratefully repaid, but, with more probability, by the reflection that an earlier intimation of the event might have enabled him to take advantage of it for procuring terms less degrading. The war could not have been much longer continued. It had worn itself out; the resources of the country were completely exhausted; the population was reduced to the number of from six to eight hundred thousand; the finances were in the most ruinous state; and the debasement of the coin, an expedient adopted by Elizabeth to parry off the ruin, ultimately served only to aggravate the distress. History.

With the exception of an effort made in the cities of Waterford and Cork to restore the old forms of worship, which was speedily put down with the effusion of but little blood, the submission of Tyrone restored the general tranquillity to such a degree, that Mountjoy felt justified in proceeding to England to present himself before his new sovereign, leaving Sir George Carew in his place as lord-deputy. He was accompanied by O'Neill and O'Donnell, the former of whom was confirmed in his title of Tyrone, and the latter created Earl of Tyrconnel. Before his departure he published a general amnesty, and received into the protection of the English law the whole of the Irish people hitherto exposed to the ill-defined rule of their respective chieftains. But the dawn of tranquillity was darkened by the apprehension of fresh convulsions. An anonymous letter was found in the council-chamber of the castle, hinting at the existence of a conspiracy carried on by some of the great Irish lords against the state. On the alarm being given, the Earls of Tyrone and Tyrconnel, actuated either by a consciousness of guilt, or by an apprehension that they were specially marked out as the objects of persecution, left the country, and took refuge in Spain. Their flight was considered as sufficient proof of their guilt. They were attainted, and their immense possessions forfeited to the crown. In one district of the north the flame of insurrection broke out openly. Sir Cahir O'Dogherty, proprietor of Innishowen, who had hitherto espoused the cause of the English, disclaimed his allegiance, seized by treachery the fort of Culmore, and thence proceeded to attack the town and fort of Derry, which he took by storm, putting the whole garrison, with the commandant, to the sword; but after continuing his ravages for five months, his followers were routed, and himself slain, in an engagement, by Sir Arthur Chichester, the lord-deputy, who found his presence necessary for the complete suppression of the insurrection.

The death of this chieftain and the flight of the two earls having placed nearly the whole of Ulster in the king's hands, he resolved to remodel the province, by removing the ancient possessors, and introducing a colony of English and Scotch settlers in their stead. The tract on which the experiment was to be made comprehended the counties of Tyrconnel, since called Donegal, Tyrone, Derry, Fermanagh, Armagh, and Cavan, spreading over upwards of half a million of acres. The lands were to be portioned out into estates varying from one to two thousand acres, the proprietors of which were bound to build substantial residences in them after the English fashion, and to people them with English and Scotch tenantry. The city of London was peculiarly active in promoting this plan. A company of merchants and undertakers there, under the name of

History. the Irish Society, contracted for large tracts of land, which they still hold under this tenure. The remainder was portioned out amongst private individuals, either English or Scotch, who thus became the founders of most of the principal families now residing in these counties. The order of baronets was instituted in order to promote the execution of this favourite project of James. The number of its members was limited to two hundred, each of whom purchased his rank by the payment of a sum adequate to support thirty men on the new plantation for three years. About the same time, the county of Wicklow, heretofore the property of the septs of the O'Byrnes, and O'Tooles or O'Tothils, was made shire-ground, after the natives had been dispossessed by a summary process, somewhat similar to that employed in the settlement of the northern counties.

In order to secure the permanence of these changes by positive law, a parliament was convoked, after a lapse of twenty-seven years. It was the first to which members from all the counties of Ireland were sent. To secure a preponderance in favour of the crown, a number of new boroughs was created, in the charters of which the right of election was placed in hands which secured subserviency to the ruling power of the day. Notwithstanding this precaution, the political aspect which this assemblage presented was by no means promising. In the upper house, which consisted of but four earls, five viscounts, sixteen barons, and twenty-five bishops, the numbers of the latter order gave the crown an irresistible preponderance. But in the House of Commons the parties were more equally balanced. The election of a speaker served as a trial of strength. The court party proposed Sir John Davis, the attorney-general, an Englishman, and author of the celebrated tract on the Causes why Ireland had never been completely subdued. The country party set up Sir John Everard, an Irish lawyer of respectable family. The election went in favour of the former, by a majority of a hundred and twenty-seven votes to ninety-seven. The defeated party, not content with protesting against the unfair construction of the house, took advantage of the absence of the majority, who had left the apartment for the purpose of being counted on the division, put their own speaker in the chair, and were proceeding to pass resolutions, when the excluded members returned, and, failing in an attempt to eject Everard from the chair, placed their own nominee in his lap. The scene of disgraceful tumult which followed was at length terminated by the secession of the minority, after they had protested against all the acts that should be passed, as informal and unconstitutional.

A commission, issued for the discovery of defective titles, at the head of which was placed Sir William Parsons, a name of no small notoriety in the series of subsequent events, began now to excite alarm. During the long continuance of civil war, the loss of family documents, the neglect of the performance of feudal services, the ignorance of the great proprietors, and the uncertainty of the law fluctuating between English and Irish tenure, brought most persons of property within its fangs, and excited the alarm of all. By means of it the king established a claim of right to upwards of an additional half million of acres. The chief profit of these confiscations accrued to the members and dependents of the government, who employed agents, technically called discoverers, to scrutinize titles and discover flaws, receiving as their reward a portion of the lands charged with being concealed or illegally withheld from the crown. Their success in other parts led them to project the confiscation of the whole of Connaught. The king's claim rested on a case of the most flagrant iniquity. The lands of this province had been surrendered by their proprietors to Sir John Perrott, and restored to them by grants from the queen, to be held under the provisions of English law. Having neglected to enrol their patents in that reign of turbulence and internal commotion, they surrendered them anew to James, and took out new patents, for the enrolment of which a sum of three thousand pounds was paid. The officers of chancery, either through negligence, or from a worse motive, omitted to execute the process of enrolment, and the king, towards the close of his reign, was preparing to take advantage of the *laches* of his own servants, and to seize on Connaught, in order to have it parcelled out anew, as he had done with Ulster. The injured party, aware of their adversaries' power, prepared to avert the ruin which impended over them, by the proffer of ten thousand pounds. Whether the necessities of this extravagant monarch would have led him to the acceptance of that sum for the fulfilment of his part of an equitable contract, cannot now be decided. His death left the question at issue to be handed down to his successor, as one of the ingredients of discontent in the cup of bitterness that he was condemned to drain to the very dregs. History.

Charles I. began his reign by sending a large force to Ireland, both to provide against the danger of foreign invasion, and to curb internal disaffection; but, through a deficiency of pecuniary means to support the troops, he had recourse to the exertion of his prerogative, and quartered them on the counties and principal towns, obliging the inhabitants to supply them, not only with lodging, but with money and provisions. The murmurs against this oppressive impost were loud and frequent. A meeting of the principal Catholic recusants and great landed proprietors having assembled in Dublin, proposed to Lord Falkland, the lord-lieutenant, to grant the king a voluntary assessment of an hundred and twenty thousand pounds, on a guarantee of security in their rights and properties. The proposal was accepted by the king, who sent over the document containing the required concessions, ratified by his signature, in order to their being confirmed by the ensuing parliament. The principal articles in this covenant, which was known by the name of The Graces, were—that the king's claim to lands should be limited to sixty years; that the Connaught proprietors should receive new patents; that the exactions of the soldiery should be restrained, the fees of the king's officers and the powers of his courts defined, the powers of the ecclesiastical jurisdiction limited, and a general pardon granted for all past offences. When the parliament which was to give the sanction of law to these favours had met, an informality in the writs for assembling was alleged as a reason for not having then confirmed them; and as no new writs were issued, nor any steps taken to convoke another parliament, the people, who had advanced their money on the security of this promise, entertained strong doubts of the king's sincerity. The recall of Lord Falkland served to confirm these suspicions. The lords-justices who were appointed on his departure executed the laws against recusant Catholics with great severity. They caused the celebrated place of penance in Lough-derg, called St Patrick's Purgatory, to be dug up and desecrated; and on being resisted by a tumultuous mob in an endeavour to prevent the Carmelite friars of Dublin from publicly performing their religious rites, they seized upon fifteen religious houses, and dispossessed the Catholics of their college in Backlane, giving it to the Dublin university, which kept it open for some time as a Protestant seminary. These measures only augmented the spirit of discontent, to repress which Charles sent over Lord Wentworth, afterwards Earl of Strafford. This nobleman, from being one of the most active leaders of the popular party in the English parliament, became at once the most violent assertor of the king's arbitrary measures. Equally proud and daring, he took no pains to conceal or palliate his desertion. "You see, gentlemen," said he to some of his former political friends, "I have quitted you." "We see you have," replied one of these sturdy republicans;

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"but, with God's blessing, we will never quit you while you have a head on your shoulders." His policy on his arrival was to treat Ireland as a conquered country, and to beat down opposition, from whatever quarter it might arise, by the stern arm of power. His arbitrary conduct made no distinction of persons. The Earl of Kildare having left the country without his permission, for the purpose of laying a complaint against his overbearing conduct before the king, was forced to make an abject submission to the person against whom he complained. Lord Mountnorris, for having used an unguarded expression, which could be distorted into a threat against the lord-lieutenant, was seized, tried by a court-martial, and sentenced to death, and escaped punishment only by the universal outcry raised against such a stretch of power. One Irish nobleman only had courage sufficient to oppose this conduct. Strafford, on the meeting of parliament, had issued orders that the members should lay aside their swords when they took their seats. The Earl of Ormond, who had just come of age, on being stopped at the entrance of the House of Lords, and required by the usher of the black rod to give up his sword, answered, that if that officer must have his sword, it should be through his body, and passed on to his seat. On being summoned before the council to answer for this daring insult on the viceregal authority, he defended himself by saying that he had received the investiture to his earldom *per cincturam gladii*, and was ordered by the writ of summons to attend parliament *gladio cinctus*. The answer, as spirited as it was unexpected, staggered Strafford. He felt that such a spirit in so young a man must either be crushed at once, or otherwise directed. He had the prudence to adopt the latter course; and Ormond, at the age of twenty-four, was admitted into the Irish privy council. The imperious and harsh measures of the lord-lieutenant had, however, the effect of putting down all opposition in parliament. Six subsidies, amounting to three hundred thousand pounds, were granted, and no steps taken to secure to the people, by the sanction of parliament, those graces which the king had pledged himself to grant, and for which they had paid so highly. In some respects Strafford's government was laudable. He reformed the army, so as to render it efficient without being burdensome to the people; he encouraged the linen manufacture, using at the same time every means to depress that of wool; he promoted a spirit of commerce, and guarded the coasts with great vigilance against the annoyance of pirates. Amongst the worst acts of his government, was his project to subvert all titles to estates in Connaught, in order to plant a new Protestant colony in that province. Taking with him a large body of soldiers to overawe the juries, he held courts of inquest to investigate titles. His measures were effectual in four counties. In Galway, the jurors having presumed to give a verdict against the crown, were summoned before the court of the council chamber in Dublin, and the sheriff fined a thousand pounds for returning an improper jury. The exigencies of Charles's affairs induced him to call over Strafford to England, where, after some time, he was impeached by the House of Commons. The principal charges against him rested upon his conduct whilst in Ireland. Several articles were certainly groundless, others exaggerated, but more than sufficient remained to justify the sentence which brought his head to the block, and fulfilled the ominous prediction of the party he had deserted when in the zenith of his prosperity.

Whilst general discontent in Ireland was fermenting through the duplicity of the king, the arbitrary conduct of his officers, the suggestions of his enemies in England, and their bloody triumph over his great agent, a secret conspiracy was forming to rescue the country by force of arms from its present oppressed state, and to restore the property of it to those whom the late changes had ejected. The deviser and main-spring of the plot was Roger Moore, a descendant of the O'Mores of Leix, who had been dispossessed in the reign of Mary. In conjunction with a son of the Earl of Tyrone, who, on escaping to Spain, had obtained the command of a regiment in the Spanish service, he set about procuring the means to accomplish this daring measure. Returning to Ireland, he gained over several of the heads of the old Irish families. The death of Tyrone checked, but did not prevent, his proceedings. Application was made to another branch of the family, Owen Roe O'Neill, then in the service of the king of France, from whom the conspirators received assurances of military aid when matters should be ripe. The seizure of the castle of Dublin was to be the first overt act, and the 5th of October was fixed on for the attempt. The timidity of some of the parties caused its postponement. Roger Moore, after having visited his friends in Ulster, on whose exertions, owing to the severity with which they had been dispossessed in the late settlement of that province, he placed most dependence, came up to Dublin to superintend the attack, which was now fixed on for the 23d of the same month. The lords-justices, Sir William Parsons and Sir John Borlase, were till this moment unaware of the conspiracy, and unprepared for resistance. On the evening of the 22d, information of its existence was given, through Owen Conolly, a Protestant, who had been invited to join in it. Parsons paid little attention to his statement, but Borlase took the alarm, placed guards on the castle and principal avenues, and seized M'Mahon and Lord M'Guire. Moore had sufficient notice of the discovery to make his escape. Dublin was thus saved; but the insurrection broke out with irresistible fury in the north, where Sir Phelim O'Neill, one of the Tyrone family, a man of mean capacity but violent passions, took the lead, by surprising the castles of Charlemont, Dungannon, and Mountjoy. Tanderagee, and the border town of Newry, soon afterwards fell into the hands of the insurgents. Fermanagh was seized upon by a brother of Lord M'Guire, and Monaghan by the M'Mahons. So well organized was the conspiracy, that within eight days' time the Irish found themselves masters of the counties of Tyrone, Monaghan, Longford, Leitrim, Fermanagh, Cavan, Donegal, and Derry, together with some parts of Armagh and Down.

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In the mean time the lords-justices were engaged in taking measures for their own security in Dublin. All strangers were ordered to quit the city. Parliament was prorogued. The sheriffs of the counties of the pale received orders to provide for the security of their respective districts. The Catholic lords of the pale attended the counsel, declaring their readiness to assist in the defence of the country. The lords-justices, suspicious of their motives, yet unwilling to irritate them by an expression of doubt, furnished a small supply of arms to those most exposed to danger. After the first burst of an explosion so general and so unexpected, the progress of the insurgents failed to keep pace with their primary exertions. The Protestants in Down took refuge in Carrickfergus. In Fermanagh, Enniskillen set the attempts of the insurgents at defiance, and Lord M'Guire's castle was taken by storm. Sir Phelim O'Neill was driven with disgrace and loss from Castlederg, was defeated in Donegal, forced to retire from before Newry, and again routed at Lisburn, then called Lisnegarvey, with such slaughter that the number of the slain is said to have trebled that of the garrison. These reverses were attended with consequences truly dreadful. The Irish, exasperated by defeat, carried on their hostilities without mercy. The inhabitants of Lurgan, who had surrendered on terms, were seized, and the town plundered. Lord Caulfield, who had been taken

History. in Charlemont, was murdered, with fifty others. Prisoners, whilst removing from one place of confinement to another, were attacked on the road and massacred, or driven into the nearest river. These excesses were not confined to the one side only. The garrison of Carrickfergus fell upon the Catholic inhabitants of the neighbouring peninsula of Island Magee, and forced a number of them over the rocks into the sea. Sir Charles Coote, who was sent out from Dublin to oppose the insurgents, carried on a war of extermination against all suspected of favouring them. That these atrocities did not stain the rebellion at its commencement, but grew out of its progress, is evident from the fact, that no mention of a massacre is made in any of the proclamations issued by the lords-justices, even so late as the 23d of December, three months after its commencement; the protestation of the Irish parliament, which met on the 17th of November, is also silent on the point; nor does any state paper emanating from the Irish government afford grounds for the charge. The parliament, on assembling, sat but for two days. Its only acts were a protestation against those who had taken arms, and the appointment of a committee to confer with their leaders. Alarmed at this act of concession, it was prorogued by the lords-justices; and the conference was broken off in the most indignant manner by O'Moore, when he found himself and his friends stigmatized in it by the name of rebels. The lords-justices now proceeded to deprive these noblemen and gentlemen of the pale of the arms furnished to them in the first paroxysm of terror. Exposed thus undefended to the attacks of the insurgents on the one hand, and to the suspicions of the government on the other, they held meetings with the leaders of the insurrection, first at the hill of Crofty, and afterwards at that of Tarah, in consequence of which they determined to embody themselves as a force distinct from the Ulster Irish, under the command of Lord Gormanstown and the Earl of Fingal, with the professed purpose of confining their operations to self-defence. The lords-justices were alarmed. They now sent to invite the discontented lords and gentry to Dublin, to confer with them on the state of the country. These excused themselves, on the plea that they would not venture within a city under the control of Sir Charles Coote, whose sanguinary speeches at the council board, and massacres throughout the country, had already rendered him peculiarly obnoxious. They also drew up an address to the king, complaining of the injurious conduct of the lords-justices, by which they had been driven to the necessity of arming themselves in their own defence; and they published a manifesto to the same purport, for general circulation. The latter document produced a decisive effect. The insurrection, hitherto confined to Ulster and a small portion of Leinster and Connaught, at once became general. At the commencement of the year the authority of the lords-justices was confined to Dublin and Drogheda, the latter of which was in a state of siege. In Connaught, the town of Galway was retained in its allegiance through the influence of the Marquis of Clanricarde, the king's steady friend. In Munster, the cruelties of Sir Warham St Leger, president of the province, which equalled those of Sir Charles Coote in Leinster, drove even those hitherto well disposed into insurrection.

The arrival of supplies of men from England produced a change, and encouraged the lords-justices to exert themselves to crush their enemies. The means adopted by them were those of extreme severity. The prisoners of the lower orders brought into Dublin were summarily executed by martial law; those possessed of lands were tried by the regular course of law, in order to secure the confiscation of their property. Bills of indictment for high treason were found against all the Catholic nobility and gentry in Meath, Wicklow, and Dublin, and against many in Kildare. Several persons of imputed guilt were put to the torture to extort confessions. The Earl of Ormond, who had the command of the army, received instructions not only to kill all rebels and their adherents, but to burn all the places where they had been harboured, and to destroy all the male inhabitants capable of bearing arms. Nor were these merely denunciations, circulated for the purpose of producing obedience through terror. Sir William Cole's regiment alone boasted, that, besides killing two thousand five hundred men in battle, they had starved and famished, of the vulgar sort, whose goods they seized on, seven thousand. The Earl of Ormond was despatched into the county of Kildare to relieve and secure the castles which still held out for the government. After executing his commission, he defeated at Kilrush a large body of the Irish under Lord Mountgarret; but being unable, through want of supplies, to follow up his advantage, he was forced to content himself by thus securing a safe retreat to Dublin. History.

On the other side, the arrival of Owen Roe O'Neill gave fresh vigour to the cause of the Irish in Ulster. A Scotch force, which had been sent thither under the command of Lord Leven, remained inactive. Lord Leven, after an empty display, quitted the country, leaving the command to General Munroe, who, following the example of his predecessor, remained quiet in his quarters, whilst the forces of O'Neill were daily augmenting, by the accession of numbers of the natives, and by supplies of officers, military stores, and money, from the Continent.

The insurgents now began to find themselves sufficiently powerful to give form and regularity to their proceedings. A general assembly of delegates from all the provinces was convened at Kilkenny. Their first act was a declaration, in which, after professing their determination to adhere to their allegiance to the king, they disclaimed the authority of the Irish government in Dublin, administered as it was by a malignant party in conjunction with the king's enemies in England. They appointed for the execution of their edicts subordinate councils in the provinces, from which there was to be an appeal to the supreme council of the Catholics of Ireland, a permanent body, consisting of twenty-four members, chosen by the general assembly. Having thus organized their civil constitution, they provided for their military operations by giving Owen Roe O'Neill the command of their forces in Ulster; General Preston, who had lately brought a supply of arms and ammunition from France, in Leinster; Garret Barry in Munster; and Colonel Burke in Connaught. Lord Castlehaven, who, on the first breaking out of the war, had made a tender of his services to the government, but had been refused, having afterwards appeared in Dublin to justify himself from a charge of treason, was thrown into prison, whence he contrived to escape after a confinement of twenty weeks, and was appointed to the command of the Leinster cavalry.

The good effects of system soon showed themselves. Munroe was defeated in Ulster, and the united forces of Lords Muskerry and Castlehaven were successful in Munster. Connaught was wholly in obedience to the confederates; and though Preston had allowed himself to be defeated near New Ross, Lord Ormond found himself too weak to reap any decisive advantage from his victory. Yet, notwithstanding these favourable appearances, the leaders of the confederates, aware of the great superiority of their opponents, and not firmly united amongst themselves, were anxious to put an end to hostilities. But the English parliament obstinately refused to negotiate with those whom they styled rebels and murderers. The Earl of Ormond at the same time undertook to continue the war on the part of the crown, provided the lords-justices furnished

History. him with a supply of ten thousand pounds. After much delay, a cessation of arms was acquiesced in by both the belligerent parties, for which the confederates agreed to advance to the amount of thirty thousand pounds for the king's service, one half in money, and the remainder in cattle.

The great object of the cessation of hostilities was to procure from the king a permanent settlement of the country. Both parties sent in their proposals. In these the Catholics asked for freedom of religion, seminaries for the education of their children, a free parliament, from which all who had not property in Ireland should be excluded, and an amnesty for the past. The Protestants, on the contrary, called for the strict execution of the penal laws, the total disarming of the Catholics, the vesting of all estates hitherto forfeited in the crown, and the distribution of them when so vested amongst English settlers exclusively. Charles gave no decisive answer to any of these proposals. He pleaded the difficulties of his situation, and referred them to Ormond, whom he had appointed chief governor instead of Parsons and Borlase, and had raised to the dignity of a marquis. Ormond procrastinated. The mean motives of avarice and personal aggrandizement are charged against him for his indecision in such an emergency. But be the cause what it might, the opportunity for a pacific settlement was let slip, and lost for ever.

The first eventful change was the desertion of the confederate party by Lord Inchiquin, who, on being refused the office of president of Munster by the king, declared for the parliament, and became the bitter enemy of his former associates. Still, however, the confederates had the advantage in several minor encounters, for military operations were not wholly stopped by the armistice. At this period, whilst they refused to furnish the king with supplies either of men or money until their interests were more fully secured than by the temporary stipulations of a truce, and whilst Ormond, on the king's part, resisted every attempt at a permanent peace, the pope's legate, Rinuncini, archbishop of Fermo, arrived, and in his master's name protested against any pacification which did not secure the public establishment of his religion. Charles, pressed by the exigencies of his situation, and unable to overcome Ormond's reluctance, employed another agent. He sent over the son of the Marquis of Worcester, Edward Lord Herbert, better known by the title of Earl of Glamorgan, to which he was soon afterwards promoted, who, through his influence with the confederates, succeeded in persuading them to make a double treaty, the one public, the other private; which latter contained articles insisted on by the Catholics, but deemed to be such as, if generally known, would increase the prejudice against the royal cause in the minds of the English. The secret clauses were, a provision that the members of each religious persuasion should pay their tithes to their own clergy, and that the churches should remain in the hands of their present possessors.

Rinuncini, who, while on his way to Ireland, had obtained from the queen an assurance of terms even more favourable than those of the private treaty, objected to both of them; he also insisted on the publication of the former. His wish was accomplished by an accident. Sir Charles Coote, the second of the name, for the former had been killed in a skirmish soon after the breaking out of the war, having defeated, near Sligo, a body of men commanded by the Archbishop of Tuam, found amongst the baggage of this prelate a copy of the secret articles. The document was immediately transmitted to the English parliament, which lost no time in publishing it throughout all parts of the country. Charles at once denied its authenticity. He declared that Glamorgan had exceeded his powers, and caused him to be arrested on a charge of treason, and examined before the Irish privy council. His duplicity gained him but little credit even at the time, and documents preserved in the public libraries of England have since furnished incontestible proofs of his insincerity. Glamorgan was soon liberated upon bail. The transaction destroyed all remaining confidence between the confederates and the king. Ormond refused to ratify the secret articles. Rinuncini, also, who had private information of the progress of a treaty at Paris between Charles and the pope, insisted on delay. In the mean time, the king's affairs became desperate; and Ormond, when it was now too late, consented to relinquish his objections to the repeal of the penal laws, and concluded a treaty with the confederates. But the want of confidence excited by the king's conduct caused delays in carrying the terms of the treaty into effect, which ended in the utter ruin of the royal cause. Rinuncini, still averse to a compromise which withheld from the Catholic church the enjoyment of any of its former privileges, made party with Owen Roe O'Neill, who, through the aid of the nuncio's money, was enabled to undertake offensive operations, and defeated Munroe at Benburb, a village on the Blackwater. Rinuncini, elated with his success, entered Kilkenny, appointed a new confederate council, and imprisoned the members of the old one. Ormond, in despair, resigned the sword of state, and retired to the Continent; and though he returned again armed with full powers as lord-lieutenant, and though a new general assembly of the confederates, convoked at Kilkenny, had declared themselves favourable to terms in which both parties might be led to acquiesce, and were violent in their protestations against the stubborn resistance of the nuncio, the adoption of any decisive measure was postponed, until all were aroused from their lethargy by the appalling news of the demand made by the parliamentary army in England to bring the king to trial. Then, indeed, the confederates agreed to the terms proposed by Ormond. The leading points were, the free exercise of religion, and the retaining of the churches then in possession of the Catholics until the king's pleasure should be known. Twelve individuals appointed by the general assembly, under the name of the commissioners of trust, were made guardians of the treaty, and vested with powers to levy soldiers, raise money, and perform all acts of supreme authority. The treaty was signed on the 17th of January 1648. But it was then too late. Before the news of its ratification could arrive in London, Charles had forfeited his life upon the scaffold.

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Previously to the death of the king, no less than five armies were maintained in Ireland, each acting for a different object. The Marquis of Ormond commanded that of the king, for the purpose of restoring him to his government. The parliamentary forces, under Colonel Jones, had possession of Dublin; and in the south he was supported for some time by a force under the Earl of Inchiquin. General Preston commanded the troops of the confederate Catholics in Leinster. Owen Roe O'Neill, who had attached himself to the nuncio, and therefore was equally opposed to the king, the parliament, and the confederates, had the command of all Ulster, except a small portion of its eastern extremity, where Munroe was at the head of an army which favoured the Scotch. All these elements of intestine commotion were again thrown into action by the king's death. Rinuncini, indeed, finding that this event, which he was charged with having hastened by his obstinacy and violence, had alienated the whole of the Catholic population, quitted the country privately. Ormond then endeavoured to gain over O'Neill, but failed; he afterwards made overtures to Colonel Jones, with whom he was equally unsuccessful, his proposals being met with the retort that his suspicious conduct had been the cause of exciting the apprehensions of the king's

History. insincerity, which prevented any of the parties in Ireland from coalescing with him sincerely, and thus led to his destruction. Having at length, from his own resources, collected an army sufficient to take the field, he invested Dublin, with the intention of reducing it by famine. But an advanced post at Baggotsrath having been successfully assaulted by a sortie from the garrison, which followed up its success by an attack on the marquis's head-quarters at Rathmines, the whole besieging army was seized with such an unaccountable panic that it dispersed in all directions, leaving the general so utterly deserted, that when he wrote to Jones respecting the prisoners who had fallen into his hands, this officer's taunting reply was, that he did not know where to find his lordship in order to wait upon him on the business.

Before the marquis could recover from the effect of this defeat, news was brought him of the arrival of Oliver Cromwell in Dublin, with a select and well-appointed army of ten thousand men. After a short delay in that city to refresh his troops and to regulate the civil affairs of the country, Cromwell proceeded to besiege Drogheda, which Ormond, suspecting his intention, had provided with a good garrison, and abundance of military stores. After having made a practicable breach, the assault was given, but the besiegers were twice repulsed. On the third attack, led on by Cromwell in person, his troops forced their way into the town, and the garrison were overpowered. In the heat of action Cromwell put the whole garrison to the sword; and in this terrible severity he took the surest method to hasten the termination of what threatened to be a long and bloody conflict. The merciless but well-timed stroke broke the power of his adversaries, and by their intimidation saved the country from the bloodshed of a protracted struggle. From Drogheda Cromwell proceeded southwards to Wexford, which being well garrisoned and provided, was expected to make a long resistance, so as to give time to Ormond to collect his forces from other quarters. But it was betrayed by the treachery of the officer placed in command of the castle, and, when taken, treated with the same stern cruelty as that which had before marked Cromwell's triumph at Drogheda.

The effect of these terrible examples of severity in paralyzing opposition, was increased by the orders given by Cromwell to his troops to abstain from any wanton injuries on the peaceable peasantry, and to pay them in full for all their supplies; a system directly contrary to all former practice, according to which, the soldier, whether friend or foe, was ever the peasant's terror.

The only hope for the royalist party now rested in the cordial union of Ormond and O'Neill. Both were sensible that a junction of their forces was absolutely requisite to counteract the movements of Cromwell. To effect this object, O'Neill moved southwards with his army, but was seized on his march with a defluxion of the knees; a complaint attributed at the time to a pair of poisoned boots prepared for him by an agent of the confederates. Unwilling to retard the movements of the armies, he had himself conveyed in a litter, but sunk under the accumulated pressure of disease and fatigue, and died at Clough-outer Castle.

The commissioners of trust were so much alarmed at the treatment of Drogheda and Wexford, that they were with difficulty prevented, by the remonstrances of Ormond, from abandoning Kilkenny. The want of confidence which he experienced, both from the leaders of the confederates, and the inhabitants of several of the large towns in the south, tended much to embarrass him. The city of Waterford absolutely refused admission to his troops, even at a time when a passage through it was required to make a successful assault on the retiring army of Cromwell. This general commenced the campaign in 1650 by a movement on Kilkenny, which was to have been betrayed into his hands. But the plot being discovered, and the traitor executed, he was forced to lay regular siege to the place. It made a very gallant defence. After a breach had been effected, the besiegers were repulsed in two attempts, and Cromwell was preparing to retire, when he received secret information that the town magistrates were anxious to surrender. A third assault was then made, with as little success as the former; but Ireton having come up with a fresh supply of men, and the garrison having been informed that no assistance could be afforded them from without, the town surrendered on terms highly honourable to its defenders, who, on marching out, were complimented by Cromwell for their gallantry, and told, that had it not been for the treachery of the town's people, he must have raised the siege. History.

Clonmel still held out against the parliamentary army. The garrison was commanded by Hugh O'Neill, another branch of the family which had signalized itself in the wars of Ireland. The first assault was repelled with such slaughter that the infantry refused to advance a second time, and Cromwell was compelled to bring forward his own favourite regiment of cavalry. These succeeded in entering the breach, but met with an opposition so fierce and so unexpected, at a retrenchment thrown up within, that the greater part of the storming party lay dead or wounded on the spot, and the remainder evacuated the place. In the two assaults Cromwell lost two thousand of his best soldiers. Not daring to venture on a third, he changed the siege into a blockade. The Marquis of Ormond, aware of the importance of the place, made every exertion for its relief. Assisted by the Catholic bishop of Ross, he collected a numerous but tumultuary body of men in the western part of Cork. These were attacked and routed, and the bishop taken. His life was promised to him, provided he would prevail on the garrison of a neighbouring fort, which greatly annoyed the besiegers, to surrender. On going thither, he exhorted the garrison to persevere in their defence, and, on his return to the camp of Cromwell, was executed. O'Neill having defended the town as long as his ammunition lasted, withdrew his troops by night unobserved; and Cromwell, unaware of the movement, gave the people very favourable conditions, to which he was the more inclined, as the intelligence of Charles II. having taken refuge in Scotland, and the hostile indications from that quarter, rendered his presence in England necessary to his party. Immediately after the surrender of Clonmel, he proceeded to Youghal and embarked for England, leaving the army in charge of his son-in-law, Ireton.

All rational hope of successful resistance to the parliament was now at an end. Ormond prepared to quit the kingdom. The commissioners of trust for some time opposed his intention, conscious of the confusion which must arise from such a public avowal of his despondency. But with the Catholic clergy it was otherwise. They suspected that he was secretly negotiating with Cromwell. His former conduct afforded plausible grounds for such a suspicion; and during the siege of Clonmel he had procured passes from that general for himself and Lord Inchiquin to go to England. A synod of the bishops, held at Jamestown, resolved upon sending a deputation to him, calling upon him to quit the country, and transfer his powers to some trustworthy person, who enjoyed the confidence of the nation. A second resolution denounced excommunication against all who should hereafter adhere to him. Whilst the relics of those who professed attachment to the royal cause were wasting their strength and ruining their prospects by these proceedings, Ireton was engaged in extending his authority by the reduction of

History. one place of strength after another. Ormond, as a last resource, convened a general assembly at Loughrea; but the party of the clergy was too powerful. Finding all means ineffectual to induce them to recall their hostile declaration, he embarked in a frigate provided for him by the Duke of York, transferring his powers as lord-lieutenant to the Marquis of Clanricarde. An extraordinary negotiation was now commenced with the Duke of Lorraine, by which it was proposed, that on the advance of a large sum of money, and a proportionate supply of military stores, he should be declared protector of the royal cause, and receive some towns as cautionary securities. But the rapid progress of Ireton baffled all these projects. Limerick was reduced, partly by the effects of a pestilential disease, partly by treachery. Amongst the victims of the plague was Ireton himself. After his death, Galway surrendered to Ludlow, his successor. A last desperate attempt at resistance was made in Connaught by Clanricarde, aided by Sir Phelim O'Neill, who now again began to make himself conspicuous. It was defeated, and Clanricarde fled to one of the islands on the coast. Sir Phelim was taken prisoner, and ultimately executed as a traitor. The nuncio's party sent ambassadors to offer the crown of Ireland to the pope, the kings of France and Spain, and the Duke of Lorraine; but none of them would accept the worthless bauble. Clanricarde still endeavoured to maintain a mountain war amidst the glens and wastes of western Connaught. It was but the expiring effort of unbending loyalty. At length a letter from Charles, recommending him to provide for his own safety, released him from the shackles of the self-imposed bonds of loyalty. He applied to Fleetwood, Cromwell's deputy, for a pass to retire to England. It was granted, and he submitted to the parliament on an assurance of not being called upon to perform any act inconsistent with his duty to his sovereign. Shortly afterwards, a proclamation from the English parliament announced the termination of what was called the rebellion in Ireland.

The victors had now only to share the spoil. The greater part of the nobility and gentry of Ireland, and of the army, had expatriated themselves; the estates of the confederates were deserted. It remained to apportion them amongst the friends and followers of the parliament, in such a manner as would best secure a zealous attachment to the new order of things. The ordinance of the English parliament to this effect decreed, that all who had been concerned in the rebellion previously to the 10th of November 1641, all Jesuits and priests, all who, not being themselves in arms, had slain English soldiers, and all who, being now in arms, did not lay them down within twenty-eight days, should be excepted from pardon. The Marquis of Ormond, the Earls of Inchiquin and Roscommon, and Bramhall, Protestant bishop of Derry, were also specially excepted. All persons who had borne a command against the parliament were to be banished during pleasure, to forfeit two thirds of their estates, and to be assigned lands to the value of the remaining third wherever the parliament should appoint. All Catholics who had resided in Ireland at any time during the war, and had not manifested their constant good will to the commonwealth of England, were to forfeit one third of their estates. All others residing in Ireland, as before, who had not been in arms for the parliament, or manifested their good will towards it when an opportunity offered, were to forfeit one fifth.

A high court of justice, somewhat of the nature of a court-martial, being composed of parliamentary officers, who acted in the double capacity of judges and jurors, and whose decisions were not regulated by any settled rules of evidence, sat on the cases of delinquency. Yet, after the severest scrutiny, the number of those subjected to the penalties of the first clause of the instructions was very small. Lord Mayo in Connaught, and Colonel Bagnal in Munster, were condemned, as it was thought, unjustly. Lord Muskerry was saved by the evidence of the numerous English settlers, who pressed forward to vouch for the protection and security they enjoyed under his control. In Ulster, Sir Phelim O'Neill was the only victim. Although offered not only pardon, but restoration of property, if he could produce substantial proof that he had had a commission from Charles to commence the insurrection, he disclaimed the fact, and died maintaining the contrary. Of others, not quite two hundred could be found who came within the strictness of the clause, so much had the accounts of the atrocities committed at the breaking out of the insurrection been magnified, or so completely had the actors in it been swept off by the desolation of the hostilities that succeeded. History.

The disposal of the forfeited lands was regulated according to the principles of an act of the English parliament, by which those who at the commencement of the war had subscribed L.200 towards the reduction of Ireland were to have 1000 acres in Ulster; those who had subscribed L.300, the same number in Connaught; and those who had subscribed L.450 and L.600, a like quantity of land in Munster and Leinster. The holder of the lands thus granted was bound to pay a yearly quit-rent to the crown, of one penny an acre in Ulster, three halfpence in Connaught, two pence in Munster, and three pence in Leinster. The soldiers who had served in Ireland since the landing of Cromwell there in 1649, were entitled to a share of the lands in lieu of their arrears, on the same terms as those who had advanced money, and who were distinguished by the name of adventurers. Those who had served previously to that date were to look for payment to the residue of lands which might be over and above after the former division had been made; a kind of security which was found to be very deficient. In order the more effectually to secure the new possessors in their properties, the Catholics who should be found entitled to retain any part of their estates under the provisions of the act above specified, were to surrender such part if in any of the other provinces, and to receive an equivalent, or, as it was called, "to be reprized," by waste lands in Connaught, which new allotments were assigned in the parts of the province situated at least a mile from the coast. No Catholic was, under any condition, to be suffered to remain in a town, or within a certain space around it. By the latter part of this provision, it was intended to cut off the Irish from any communication with foreigners, as by the former the broad boundary of the Shannon separated them from any contact with the residents in other parts of the kingdom. Commissioners of delinquency sat at Athlone, to decide upon the qualifications of the Roman Catholics; others, appointed to arrange the details of settlement of those transplanted to Connaught, held their court at Loughrea. A third body of commissioners met in Dublin, to receive and hear claims. Under their direction a survey was made by the celebrated Sir William Petty, of all the forfeited lands, which, notwithstanding the lapse of time, and the state of the country when executed, is found to be singularly correct in its details. The confiscation comprehended by much the greater part of the surface of Ireland, and threw the property, and consequently the influence, of the country into the hands of a new class of men. Private soldiers, or desperate adventurers, now became the lords of extensive tracts, once enjoyed by the native families of ancient descent, or by the Anglo-Irish nobility. It also produced another change, of less striking character at first, but of overpowering influence on the future destinies of the country. The land was likely to be useless for want of cultivators. The continuance of a warfare, in which mercy was deemed a symptom of timidity or

History. of treachery, had swept away the peasantry in multitudes. Numbers had been transported as slaves to the plantations; many had emigrated as soldiers or colonists. The plan of peopling the wilds of Connaught by transplanted Catholics was almost totally relinquished. Hands were wanting on the new estates; the tenants were therefore retained, but they were treated with all the jealous severity arising from a consciousness of weakness, and an apprehension that advantage would be taken of it. They experienced the harshness of slavery, without the enjoyment of that protection which the selfishness of ownership in some degree spreads over it.

The government of Ireland was intrusted by Cromwell to his son Henry, who proved himself worthy of the choice. He visited most parts of the island, so as to make himself personally acquainted with its resources and capabilities. He checked the frauds attempted to be committed by the commissioners in the disposal of the forfeited lands, repressed the violence of the soldiery, and afforded the protection of the law to the ill-used peasantry. He had even devised plans on an extended scale for the improvement of the country, which the short duration of his power prevented him from executing. Impressed with the necessity of diffusing knowledge as the surest foundation for the solid advancement of the people, he purchased the library of Archbishop Usher, in order to bestow it on a second college which it was intended to found in Dublin. Amongst other plans for the consolidation of the interests of the two countries, it was intended that Ireland, instead of being governed by a domestic parliament, should send representatives to that of England. The number fixed upon was thirty. But the death of Cromwell, and the resignation of his son Richard, put an end to all these well-intended projects. On the announcement of this latter event, the English parliament, aware of Henry Cromwell's abilities and popularity, and apprehensive of an attempt on his part to maintain himself in the government, sent over Sir Hardress Waller to seize upon the castle of Dublin; but the precaution was unnecessary. Cromwell retired without opposition, remaining in privacy in his house in the Phœnix Park until he had provided himself with the means of removing to England, having administered the government with so much disinterestedness during a period in which he had the means of amassing unlimited wealth, that he could not at once defray the expenses of his passage over.

The thoughts of the new settlers, who were now transformed from needy adventurers and soldiers into landed proprietors, began to turn upon the means of securing the properties so unexpectedly acquired. The agitation consequent on the death of Cromwell, whose overruling master-mind had hitherto kept all parties subservient to his views, began to take a turn decidedly favourable to the restoration of royalty. The great leaders of the parliamentary party perceived this, and prepared to shape their course accordingly. Lord Broghill, who had already changed from a royalist to a republican, was the first to retrace his steps. He was followed by Sir Charles Coote, the most sanguinary of the parliamentary leaders. The towns of Youghal, Bandon, and Kinsale, which had been amongst the first to revolt to Cromwell, were now led by Lord Broghill to declare for the king. Coote secured Galway and Athlone. The same party, after a short struggle, seized upon Dublin Castle. Sir Hardress Waller, who had taken possession of it for the parliament, was sent a prisoner to London; and Ludlow, who, upon the alarm of the change of sentiment in the parliamentary party in Ireland, had been sent over to take the chief command, on arriving in Dublin Bay, was prevented from landing, and forced to return to England. A convention was assembled in Dublin. The council of state in England ordered its dissolution. The order was set at defiance. The king's declaration at Breda being presented to the convention, was accepted by acclamation, and Charles was proclaimed with every demonstration of joy in all the great towns. Thus, the restoration of the son in Ireland was effected by the same persons who had been mainly instrumental in bringing his father to the block. History.

The sudden change of public opinion gave Charles irresistible influence in Ireland. All parties looked to him. Above all, the Catholics, whose attachment to his father had been the great cause of their sufferings, and of the ruin of their property, anticipated an immediate restoration of their estates. So sanguine were they, that many proceeded to take forcible possession of them, and to eject the new proprietors. The Protestants raised the cry of a new rebellion, employed agents in London to resist their claims, and had influence sufficient to obtain clauses in the act of indemnity, excluding from it all who had at any time aided the Irish, and prohibiting the restoration, upon any terms, of lands already disposed of by the parliament or convention. Nor was it without the greatest difficulty that an exception could be carried in favour of the Marquis of Ormond and other Protestants. Every severe ordinance against the Catholics was strictly enforced. The commoner sort were prohibited from quitting their place of residence without permission. Assemblies of the Catholic gentry were forbidden. A proclamation was issued for apprehending Irish rebels, and for assuring all adventurers and soldiers in the quiet possession of their grants.

At length the king's declaration, which was to form the basis of the new settlement of the landed property of the country, was published. This document, after vesting all the confiscated property in the king, confirmed the adventurers and soldiers in the lands already granted to them. The officers in the king's service before 1649, distinguished by the name of "Forty-nine Men," were to receive their arrears in lands at the rate of twelve and sixpence in the pound, and an equal dividend of whatever should remain of their security. Protestants whose estates had been given to adventurers were to be restored, and the present holders "reprised," that is, given other lands of equal value. Innocent Papists were also to be restored, and the holders reprised; those restored to property within corporate towns were to be reprised in the neighbourhood, as no resident Catholics were to be permitted in those places. Such Catholics as had accepted lands in Connaught were to continue bound by that act. Those who had joined the king in his exile, and served under his banners, were to be restored when the present holders were reprised; such persons were called "Ensign-men." Additional grants were made to Ormond and Inchiquin, who had been restored by the English parliament. Monk, now Duke of Albemarle, and some others, received grants. The king's brother, James, duke of York, had several of very great extent. Thirty-six of the Irish nobility and gentry, to be specially named by the king, were also to be restored under the title of "Nominees." Those who had any share in the trial and execution of the late king were specially excluded from the benefit of this arrangement. Lands belonging to corporations were to be restored, and the possessors reprised. The qualifications which entitled a Roman Catholic to claim the benefit of the clause respecting "innocent Papists," were so worded as to render the chances of an acquittal almost impossible. None were to be restored as such, who, at the time of the cessation in 1643, had been of the royal party, or had lived within the quarters of the confederates, except the inhabitants of Cork and Youghal, who had been forcibly expelled from those towns, and driven by the fanatics into the enemy's lines; who had acted with the confederates before

History. the peace of 1648, or had adhered to the nuncio or the papal power against the royal authority, or, when excommunicated for such adherence, had submitted and obtained absolution. Whoever derived his title from persons guilty of those crimes; whoever claimed his estate on the articles of peace, thus acknowledging his concurrence in the rebellion; whoever had held correspondence with the confederates, sat in their councils, or acted under their commission; whoever had employed agents to treat with any foreign power to bring forces into Ireland, or had been a tory, the name given to the marauding parties which harassed the country; were also excepted. Few Roman Catholics could hope to escape being included in some one or other of those sweeping clauses.

The principal subjects which engaged the attention of the Irish parliament that met after the Restoration, were the established church, and the settlement of property. Ormond, to whom the management of Irish affairs was principally intrusted, contrived, by postponing the consideration of the question of the lands, to secure the adoption of the former. Although the House of Commons was almost exclusively composed of those who had a few years before been most zealous in pulling down the church and abolishing the liturgy, it now not only readily assented to the revival of both, but concurred in censuring the solemn league and covenant, and in condemning their former oaths of association. They also procured an order from the lords-justices to adjourn the law term, and close the courts of justice, in order to prevent the reversal of outlawries, or the ejectment of adventurers and soldiers before their titles could be secured by statute.

The act of settlement, the next object of parliamentary attention, was framed according to the spirit, and nearly according to the letter, of the declaration published by the king. The principal alterations were respecting reprisals, and what was called the doubling ordinance. The commissioners of the court of claims had been guilty of gross partiality respecting these. They rejected the claims of the nominees, and the ensign-men, on the plea that there were not lands sufficient to reprise the present possessors, a defalcation caused by the clandestine disposal by themselves of these lands to their own friends. Through the exertions of the House of Lords, a clause was inserted for the revocation of these fraudulent grants. The doubling ordinance was still more pregnant with injustice. The English parliament having found that the sums subscribed by the original adventurers had fallen short of the amount required to finish the war, and being in want of further supplies, passed a law, that whosoever advanced one fourth more than his original share, should be entitled to as much land as if he had actually doubled his subscription; and that if any adventurer refused to make such advance on his original share, any other person, on paying it, should reap the benefit of the doubling clause, provided he repaid to the adventurer the sum at first subscribed. With great exertions, and by the determined interference of the Earl of Kildare, it was at length determined that the adventurers should receive lands for the money actually advanced by them, and no more. The Irish parliament, however, could only frame heads of a bill to this effect, which was liable to be modified by the king and privy council in England. Thither, therefore, all parties interested sent agents to defend their respective claims. London became the scene of controversy, intrigue, cabal, and even violence. The Irish called for the fulfilment of the articles of the peace of 1648. Ormond, who hated the Catholics even more than he did the regicides, persuaded the king that such fulfilment would be detrimental to his favourite scheme of maintaining an English interest in Ireland. Richard Talbot, afterwards Lord Tyrconnel, the advocate of the Irish, finding reason and justice ineffectual, challenged Ormond. The latter made his complaint to the council; Talbot was committed to the Tower, and detained there till he made an humble submission. The bill, with all its clauses, received the royal assent, and was sent back to Ireland, where it was adopted by both houses of parliament. History.

But the passing of the act was not sufficient to render it operative. Every one was dissatisfied with it. Even the adventurers, whose interests were best guarded by it, exclaimed against it most loudly. They considered the rejection of the doubling ordinance as the deprivation of so much of their justly purchased property. The land granted to the nominees, the number of whom had been increased by the king, was looked upon as so much cut off from the common fund whence they were to be repaid. The restoration of church property was peculiarly galling to their religious prejudices. The Protestant officers felt that their security was greatly diminished by large grants lavishly made to some of the king's special favourites. The Catholics complained that, so far from having justice done to their services, their agents were not even admitted to plead their cause before the council.

Ormond, now elevated to the rank of a duke, was sent over as lord-lieutenant to calm these effusions of anger, and to settle in the most amicable manner the conflicting interests of the parties. The first proceedings were those of the commissioners of innocency, who soon found that the number of those who could clearly establish their innocence, even before a court cautiously and carefully composed of Englishmen and Protestants, was inconveniently great, and excited the most serious alarm amongst the other party, who felt that every acquittal abstracted so much from the fund to which they themselves had to look for a settlement. Out of a hundred and eighty-seven cases adjudicated in the first three months, a hundred and sixty-eight were pronounced innocent, and but nineteen condemned. The House of Commons called upon the lord-lieutenant to make the qualifications more rigorous. The more violent of the old parliamentary soldiers laid a plan for a general insurrection. Ormond was steady. He put down the conspiracy, and executed a few of the ringleaders. He refused to make any change as to the qualifications. But he contrived to effect, by an evasion, what a regard for consistency of character had made him reject in public. Upwards of four thousand cases had been entered, and, from the number already decided, and the character of the decisions, it was felt that by much the greater proportion of the Catholic proprietors would be restored to their estates. To prevent such an occurrence, the time of the sitting of the court was limited to a fixed number of days, during which not more than one fourth of the claims could by any possibility be heard. It then closed, and thus upwards of three thousand ancient and respectable Irish families were stripped of their fortunes, without even the form of a trial before a court specially constituted to do them justice. The injured parties applied to the king; but he refused to listen to them, and they were irremediably ruined. Though their claim was rejected, however, its justice was recognised by a concession, and the lord-lieutenant was permitted to select twenty out of the three thousand, to be restored to their estates as objects of special favour.

To remedy, in some degree, the defects of the act of settlement, a bill was brought into parliament, chiefly by the instrumentality of the Duke of Ormond, which made a few alterations in some of its most obnoxious provisions. This is known by the name of the act of explanation. The two together form the tenure under which by much the greater part of the landed property of Ireland is held; they have therefore been quaintly, and with more regard to their binding force than their justice, styled the Mag-

History. na Charta of the Protestants of Ireland. To account for the Duke of Ormond's conduct towards his former friends, to whom during the war he owed so much, and his master every thing, and his sacrifice of their interests to the bitter enemies both of himself and the king, it may be sufficient to mention, that his estates, which, before the breaking out of the civil war, had yielded but about L.7000 per annum, now brought him in a yearly income of upwards of L.80,000, in addition to the pecuniary grants made him for losses during the disturbances. The acts which ruined so many of the adherents to the royal cause secured him in the undisturbed enjoyment of this princely income.

Notwithstanding the apprehensions arising from the still uncertain state of title, the condition of the country began to improve with a rapidity alarming to the English, who were now suffering through a decline of their domestic trade, which prejudiced persons imputed in a great degree to the excessive importation of Irish cattle. To prevent the supposed ill effects of this, acts were passed prohibiting the Irish from sending cattle or provisions into England after the first of July, which exclusion was afterwards extended to all periods of the year. So strong was the prejudice, so powerful the alarm, that when the Irish parliament, through a wish to alleviate the sufferings of the people of London after the great fire in that city in 1666, sent them a free gift of thirty thousand oxen, the only wealth of the country at the time, the well-intended donation was rejected, as an attempt to evade the prohibition under the mask of benevolence. The king endeavoured to alleviate, though he was too weak and too timid to prevent, this impolitic act of injustice. He issued an act of state, permitting the Irish to export to foreign countries all commodities of their own growth and manufacture; and the Duke of Ormond, on his part, encouraged the woollen manufacture, for which the country was peculiarly fitted, from its capability of rearing sheep, and its water-power for machinery. He brought in foreigners acquainted with the processes of the manufacture, established a board of trade in Dublin, and encouraged factories on the Suir. His attention was also directed to the improvement of the linen manufacture. But his laudable efforts were thwarted by his enemies at court, who persuaded Charles to recall him. Lord Robarts, who was appointed in his place, rendered himself so offensive to all parties, that he was soon removed, and his place supplied by Lord Berkeley, who was also as speedily withdrawn, in consequence of his being active in procuring a commission of inquiry as to frauds practised on the Catholics in the adjudication under the act of settlement. The government of Lord Essex, his successor, was equally short-lived; and it was found necessary to restore Ormond, as the only person sufficiently acquainted with the state of parties in Ireland, to manage the country without danger of a sudden explosion.

Shortly after his return to office, the Popish plot occurred. The devisers of this execrable contrivance endeavoured to involve the Irish in a share of the guilt. Charges were made against Talbot the Catholic archbishop of Dublin, Lord Mountgarret, and Colonel Peppard, as being principals in it. On investigation, the first of these imputed conspirators was found to be labouring under a complication of disorders, beneath which he soon afterwards sunk; the second was bedridden through age; and the third was entirely unknown. The Duke of Ormond, more probably through a conviction of the necessity of yielding something to popular clamour, issued two violent proclamations. The one required the relations of tories to be answerable for them, and also that the priests of parishes in which a robbery or murder had been committed should be transported, unless the offender were delivered up to justice within a fortnight; the other prohibited Catholics from entering Dublin Castle, or any fortified place, and caused all fairs to be held without the walls of cities and corporate towns. But restraints, however rigorous, were not sufficient. The bigotry of the time called for a victim. Plunket, the Catholic archbishop of Armagh, was accused of being the instigator of a plot to raise seventy thousand men to overturn the government. He was sent to London, tried there for a crime committed in Ireland, denied either time or means to bring over witnesses, condemned as a traitor, and executed at Tyburn, professing his innocence to the last. The only subsequent act of Charles's reign, of consequence enough to merit notice, was a second attempt to deprive Ormond of his power. And it proved successful. Partly from a plea of his advanced age and increasing infirmities, partly from a necessity avowed by the king of removing from office several of his friends, the sword was taken from him and assigned to his relative Lord Rochester. History.

All the political arrangements consequent on the accession of James II. indicated a settled and systematic determination to disturb, if not wholly to nullify, the provisions of the act of settlement. Talbot, afterwards Earl of Tyrconnel, was placed over the army, which he immediately began to new-model, by cashiering and disbanding most of the Protestants, and bringing Catholics into their places; and by disarming the militia, which consisted chiefly of Protestants, under the plea that they were suspected to have been connected with Monmouth's rebellion. These apprehensions were still further increased by the promotion of Tyrconnel to the chief government. The first overt act was made against Dublin College, by nominating a Catholic to the professorship of the Irish language, which was defeated on the ground that no such professorship existed. An attempt made to appoint a Roman Catholic to a fellowship was frustrated by the gross incapacity of the person recommended.

The king's attempts against the Irish corporations were more successful. In order to carry into effect all his changes, the sanction of an Irish parliament was necessary; and to effect this, it was equally necessary to secure a majority in the boroughs, in which the Protestant interest had hitherto been almost exclusively predominant. Tyrconnel caused all the charters of these bodies to be seized into the king's hands, on the plea of violation or non-performance of conditions, and granted new charters, so arranged as to throw the whole of the borough influence into the hands of the Catholics. A few of the corporate bodies still hold under these charters; but the great majority of them having been passed after the abdication, are considered as of no authority in the courts of law.

On the landing of the Prince of Orange in Torbay, Tyrconnel received orders to send over four thousand men to England. So little prepared was he at the time to meet the exigency, that he found it necessary to withdraw the garrison from Londonderry in order to make up the number. But he soon became sensible of his error. The Protestants in the northern counties had already been roused to a movement of self-defence, in consequence of an anonymous letter sent to Lord Mount-Alexander, warning him of the intention of an immediate insurrection to extirpate them. Just at the time, a Roman Catholic regiment, lately raised by the Marquis of Antrim, had been ordered to Derry in room of the troops sent to England. The appearance of the men, now approaching the town, noway tended to diminish the feelings of alarm already excited by the previous warning. The first division of the newly-arrived regiment was within a few hundred paces of the town, when several young men, said to be apprentice boys, hurried armed to the gate, shut out the soldiers, hastened to the walls, pointed the guns, and

History. threatened them with destruction if they attempted to force their entrance.

This decided act of the people of Derry was followed up by all the northern Protestants. The town of Enniskillen was secured in a similar manner, and armed associations were formed throughout every part of the province, to maintain the Protestant religion, and secure the dependency of Ireland. The first act of these bodies, after providing themselves with the means of resistance, was to apply to William. But he had already opened a treaty with Tyrconnel, to whom he sent General Hamilton, then prisoner with him, under a promise, that if he failed in gaining over Tyrconnel, he himself should return. Hamilton's conduct on the occasion was inexcusable. Instead of using arguments to persuade Tyrconnel to submit, he encouraged him to persevere in the cause of James, and remained with him instead of redeeming his parole, and proved his zeal in the cause he had thus faithlessly adopted, by heading a body of troops in Ulster, by which the whole province, with the exception of Derry and Enniskillen, was brought again under its allegiance to its former king.

James soon afterwards landed at Kinsale with a small body of French forces, having declined the aid of a more powerful armament, from a wish to be indebted for his restoration to the unassisted loyalty of his own subjects. On arriving at Dublin, he was welcomed with loyal addresses from all ranks and classes, amongst which the Protestant clergy were not less forward than others in their professions of zealous attachment. Finding himself at the head of what he considered as an unanimous people and a large army, his first movement was the reduction of the city of Derry, which, instead of listening to terms offered by Tyrconnel, resolved upon an obstinate resistance; expelled the governor set over the city by the king, upon a well-founded suspicion of intended treachery on his part; marshalled themselves in regiments; chose for leaders in this desperate attempt, George Walker, a clergyman of the established church, who had already signalized himself by raising a regiment of a thousand Protestants, and Major Baker; and, turning their guns against James, who, from a mistaken reliance on his personal influence, had approached the walls, compelled him to retire. The sword was now drawn between king and subject. The men of Derry had not only renounced their allegiance to their sovereign, but defied his power and insulted his person. James, convinced of the irresistible force of the numbers brought against the place, and of the futility of their means of resistance, their numbers not being more than seven thousand men, and these undisciplined and badly armed, the place unprovided with military stores, or even sufficient quantity of provisions, and the defences by no means adequate to resist the advances of a well-organized besieging force, returned to Dublin, leaving the conduct of the siege to Marshal Rosen, who had been a German officer in the French service. After some feeble attempts at gaining the town by storm, Rosen adopted the surer though more tedious method of blockade. The inhabitants were soon reduced to extreme privations, yet still they adhered to their determination of holding out. After upwards of two months suffering, they were cheered by the appearance of a fleet sent by William to their relief; but, after an empty display of assistance, Kirke, who commanded it, sailed away to Lough Swilly, where he employed his time in sending supplies to Enniskillen, which stood less in need of them. Still the garrison persevered in its defence. Rosen, enraged at their obstinacy, ordered all the Protestants in the neighbouring districts to be driven under the walls, in order to expedite the extremity of famine. The townsmen, in retaliation, prepared to hang up all the prisoners on the town walls. An express order from James forced the besieging general to relinquish this inhuman device for augmenting the horrors of war. The wretched sufferers were allowed to return home, and the town's people adroitly seized this opportunity of recruiting their strength, by taking in some of the younger and more vigorous, and sending away in their stead those exhausted by the hardships of the siege. After the garrison had been reduced to the necessity of subsisting on food loathsome to humanity, Kirke made a second attempt for its relief. A frigate and two provision ships sailed up the river, broke the boom thrown across it to obstruct their passage, and entered the town uninjured. The Irish army, whose hopes of success had rested wholly on the effects of famine, raised the siege in despair. The town's people, though reduced to half their original number by the casualties of war and sickness, had the hardihood to issue out in pursuit of the retiring army; but their temerity was punished by a severe check. About the same time the Enniskilleners gained a signal victory at Newtown-Butler, over a body of the enemy three times their number. History.

The military career of James in Ireland was neither creditable nor fortunate; his political efforts during the short period of his Irish government remain to be canvassed. A parliament was assembled in Dublin, in which the Protestant party, as might have been expected, was considerably outnumbered by the Catholics. One of its first acts was the attainder of about two thousand Protestant noblemen and gentlemen, adherents of William, whose estates were to be forfeited, unless they surrendered before a certain day, and who, if found guilty, were to be excluded from the benefit of a royal pardon; an act almost equalling in the extent of its powers, and the severity of its inflictions, the rigours of the act of settlement. The other measures of this parliament were of a different character; one was an act for establishing liberty of conscience, and repealing all such as were contrary thereto; another, connected with religious observances, directed that all should pay their tithes to the pastor of their own persuasion. A bill was also brought in to repeal the act of settlement, which was carried after much opposition from the Protestant bishops, and some of the lords. Another to prevent appeals to England was also carried, though with much difficulty. Two more, the one to repeal Poyning's law, the other to establish inns of court in Dublin, were opposed by James himself, who, still fondly clinging to the hope of a restoration to his seat of dominion in England, was averse to whatever had a tendency to diminish the dependency of Ireland. His conduct with respect to the circulating medium is the most unjust, as well as the most impolitic, of his measures. Parliament had voted him a subsidy of twenty thousand pounds a month. He doubled this sum by a royal ordinance. The money, notwithstanding votes of parliament and kingly proclamations, came in slowly. James erected a mint in Dublin, where he had large quantities of base metal coined into pieces of large nominal value. The plan, as a financial project, proved a complete failure, bringing discredit on the deviser, and inflicting injury on the friends of his cause, who were the ultimate sufferers by the depreciation.

Whilst James was neglecting his military operations in the north of Ireland, and injuring his credit and resources by his financial mismanagement in Dublin, his antagonist William, now freed by the death of Dundee from the apprehension of a Scotch invasion, was making extensive preparations for carrying on the war in Ireland. In the summer of 1689, his favourite general Schomberg landed near Carrickfergus, with a well-appointed army of ten thousand veterans. After taking that town, which surrendered on honourable terms, he moved southwards to Dundalk, where the scarcity of provisions, and the ap-

History. proach of the Irish army under James, obliged him to halt and encamp. His position was low and unhealthy, his camp ill supplied with provisions. His men sunk rapidly, through sickness and inaction. James, though much urged to it by his officers, could not be prevailed upon to hazard an assault. After remaining some time opposed to each other in a state of inaction, Schomberg took advantage of the arrival of some fresh troops to change his position, and retrace his steps towards Carrickfergus, where he was more secure against the necessity of combating to disadvantage with a superior force.

Next year William resolved to take the field in person. He landed early in June at Carrickfergus, and being joined by Schomberg with the remains of his shattered forces, advanced southwards in the same direction that had formed the line of march in the last campaign. His forces now amounted to six and thirty thousand men, the greater part veterans, who had proved themselves on the Continent. James's army had been in the mean time furnished with a supply of five thousand Frenchmen; but these were raw and undisciplined, and procured by an exchange of an equal number of Irish, the flower of his army. After retreating before his rival from Dundalk to Drogheda, he at length took up a position on the south side of the Boyne, where, contrary to the advice of all his officers, he determined to make a stand, and to set his chance of dominion on the hazard of a battle. William, whose disposition and circumstances equally urged him to bring the contest to an immediate decision without hesitation, prepared to force the passage of the river. Whilst engaged in reconnoitring the enemy's arrangements, he received a wound on the shoulder from a piece of artillery levelled at him from the opposite bank, but not sufficient to prevent him from appearing at the head of his troops in the ensuing day's engagement. The next morning his army, headed by himself, moved to the attack in three divisions. Crossing the river where the water in some places came up to their breasts, his troops gained the opposite bank, notwithstanding a galling fire from the infantry, by which they were lined, and repeated charges of the Irish cavalry led on by General Hamilton. Schomberg was killed, as is supposed by a chance shot from his own soldiers, in the confusion of one of these desperate assaults. Callimote, the leader of the French Protestants in William's army, also fell during the passage. Walker, likewise, the clerical defender of Derry, fell here. When his death was reported to William, the only remark made by the cold Dutchman was, "The fool; what business had he there?" The Irish, after some vain efforts to drive back the enemy into the river, in one of which Hamilton was taken prisoner, finally broke and quitted the field, thinking only of making good their retreat.

Whilst William was thus actively engaged in asserting his title to his newly-acquired throne, James was standing aloof on the hill of Donore, an idle spectator of a struggle which involved the fortunes of himself and all his adherents. On seeing the discomfiture of his army, he immediately fled to Dublin, and thence to Waterford, leaving directions to have the bridges broken down after him, to check his pursuers. William, adopting the same system towards him as when he had driven him from England, allowed him to continue his flight unmolested. Proceeding to Drogheda, he forced it to surrender on a threat of military execution in case of resistance, and thence continued his march without interruption to Dublin, holding out offers of protection to the peasantry, who accepted his protection, but declaring that he would leave the leaders, of what he chose to call a rebellion, to the chances of war. The main body of the Irish army retreated to Limerick and Athlone, placing the strong line of the Shannon between themselves and their victorious enemy. An attempt made upon Athlone by General Douglas was unsuccessful, History. After being baffled in an attempt to force a passage there, and in another at Lanesborough, lower down the river, he was forced to desist and retire to Dublin. A similar attempt made by William upon Limerick met with the same termination. Relying for success on the dissensions that existed between the French and Irish officers in James's army, he advanced to that town, carrying with him only a field train of artillery. On being apprized of his error by the formidable aspect of defence presented by the garrison, he sent for his battering train from Dublin, which, when within seven miles of his camp, was attacked and totally destroyed by a sortie of General Sarsfield. William, however, was not of a temper to be easily discouraged. With two pieces which had escaped the fate of the others he effected a breach, and proceeded to attempt an entrance by storm; but the breach was defended so gallantly that he was forced to retreat and raise the siege, after having suffered a loss of two thousand of his best men. The urgency of his affairs in England obliged him to go thither, leaving the command of the army to his generals, Solmes and Ginckel. The war was carried on during the winter, chiefly from a suggestion of the Earl, afterwards the celebrated Duke, of Marlborough, who proposed the taking of Cork and Kinsale, so as to secure the command of the southern coast. The suggestion was adopted, and its execution intrusted to the proposer of it. The fortifications of Cork were in a state of great dilapidation; the place was in a hollow, commanded by the surrounding mountains. After a short resistance, the only remarkable feature of which was the death of the Duke of Grafton, one of the natural sons of Charles II., the town surrendered on condition of protection to persons and property. But it was with much difficulty that the commanding officers enforced the observance of these terms. As soon as the troops had entered, a tumult was excited, the governor was wounded, the Earls of Tyrone and Clancarty narrowly escaped, and the houses of many Catholics were plundered. Kinsale, which was afterwards invested, presented more difficulty. The garrison abandoned the town, and confined their defences to two castles. One of these, the old castle, was soon stormed; but the other held out until its garrison procured permission to march out with their arms and join the main body of the Irish. Ginckel, after the capture of these places, attempted to carry the war into the west of Cork and Kerry; but his troops were foiled in the mountain passes, and forced to return with loss. Whilst the military operations were proceeding thus languidly, the civil officers of King William were more active and successful in securing their own interests, by the confiscation of the property of the adherents of King James. The forfeitures made by them comprehended a million of acres, the property of three thousand nine hundred and twenty-one sufferers, and were valued at three millions three hundred and twenty thousand pounds. The injustice of inflicting such a penalty on adherence to the cause of a rightful sovereign can only be surpassed by the means of its enforcement. The Irish gentry who possessed estates were indicted for high treason in their respective counties, and the causes then removed by *certiorari* into the King's Bench in Dublin. Thus, in most cases, the accused persons were deprived of the means of making their defence. In many, they were ignorant even of their accusation, until they found themselves stripped of their patrimony by the sentence of the court. At the same time rumours of plots and conspiracies were set afloat, and proclamations issued in consequence, assessing the Catholic inhabitants of peaceable counties for injuries to Protestant property in others, excluding from protection those who had sons in the enemy's quarters, prohibiting assemblages of more than ten Catholics, and subjecting to transportation the

History. parish priest of places where such assemblages were held. These proceedings drove the great body of the Catholics to desperation. They saw no hope but in the subversion of a government whose establishment was to be secured only by their utter ruin.

Military operations recommenced vigorously at the beginning of summer. St Ruth, who had been sent from France to take the chief command, determined to make a stand at Athlone, which he strengthened with some works. Ginckel directed his main force against it. His first assault failed. After a delay of nine days spent in preparations, a second attempt was made with still less effect. Not only were his troops repulsed, but his works were burned. St Ruth, intoxicated with his success, withdrew the greater part of his men from the defences, in spite of the warnings of his Irish officers. Ginckel, aware of the inconsiderate movement, took advantage of it, and forced the passage of the Shannon by surprise, whilst St Ruth was celebrating his victory by balls and entertainments in his camp at some distance. The Irish general then retired to Aghrim, on the borders of Galway, there determined to make a final stand, on a position chosen by himself. He was soon followed thither by the English, who attacked the position with undaunted intrepidity. For some time the contest was doubtful; but the death of St Ruth, who fell by a cannon-ball in the heat of the action, decided its fate. Whether from jealousy or contempt, this foreigner had avoided communicating his plans to the Irish generals who were to execute them. His sudden death, therefore, left the army without a head. All was confusion; and Ginckel, taking advantage of this state of things, pressed on and obtained an easy, but not a cheap victory. In the preceding struggle, upwards of two thousand of his men had fallen. The loss of the Irish, which occurred mostly in the rout, exceeded seven thousand.

The remains of the Irish army fell back upon Limerick. This city was now the only place of any importance that held out. Galway had surrendered upon favourable conditions. The garrison of Banagher, on declaring their determination to return home after surrendering, were supplied by their conqueror with the means of proceeding thither. Ginckel, who had remained some time inactive in Galway, hoping that terms of accommodation would be offered, as Tyrconnel was now dead of an illness said to be caused by disappointment, and the lords-justices who succeeded him were inclined to make terms, provided the interests of the general body of the Catholics were secured by them, at length opened the trenches before Limerick. At first the operations of the besiegers proceeded but slowly. Having, however, made themselves masters of a pass across the Shannon, through the treachery of Colonel Clifford, the officer who commanded there, they were enabled to invest the town on all sides. This advantage was followed by an assault on one of the gates, which was urged with so much ardour, that the officer there thought it necessary to raise the drawbridge with so much precipitation that upwards of a thousand of the garrison were left on the outside, exposed to the besiegers' fire. The greater part of these unfortunate victims were killed either by the enemy or in attempting to swim the river; a few were captured. The act itself was condemned as over hasty. The officer who gave the order for it was a Frenchman, and his conduct was imputed to bad motives. The bad feeling that had long subsisted between the strangers and the native troops was thus greatly exasperated. The latter, conceiving that their countrymen had been wantonly sacrificed, determined to seek for peace. Their resolution was encouraged by Ginckel, and a cessation of arms for the purpose of adjusting the terms of a treaty was the consequence. The news was immediately forwarded to the lords-justices in Dublin, just in time to prevent the publication of a proclamation, offering to the Irish in arms terms as liberal as they could have hoped for after a victory; granting, in fact, to the Catholics all the privileges they had heretofore enjoyed, and all they have since obtained. The lords-justices hastened to the camp, and in two days after their arrival the articles of Limerick received the signatures of both the contracting parties. History.

By this treaty it was stipulated that the Roman Catholics should enjoy the exercise of their religion, as during the reign of Charles II.; to which was added a promise that the king would endeavour to procure further security for them on this point, as soon as parliament should be assembled. It was further agreed, that all the inhabitants of Limerick, and those in arms for King James in the counties of Limerick, Clare, Kerry, Cork, and Mayo, should enjoy their estates, and be suffered to pursue their respective avocations unmolested; that the Catholic gentry should be allowed the use of arms, and should not be called upon to take any oath but that of allegiance; and, finally, that all the soldiers who were unwilling to submit to these conditions should be conveyed to the Continent at the expense of the English government. Two days after the signing of this treaty, a French fleet arrived on the coast with a large supply of reinforcements and military stores. But it was then too late. Nothing now remained in order to terminate the war, but the execution of that part of the treaty which permitted the Irish soldiery to choose between residence at home and service under a foreign but friendly power on the Continent. The Irish guards set the example; they all volunteered for the service of the king of France, seven individuals only excepted. Two regiments of Ulster Irish returned home in a body. Of the remainder of the Irish army, but one thousand horse and fifteen hundred foot remained. The generous self-devotion of those who sacrificed their country for their principles was but ill rewarded. On the arrival of the troops in France no quarters were assigned to them. The regiments were broken up, the officers reduced to lower grades, and the generals excluded from court. After some time, however, the value of their services was acknowledged, and the Irish brigade, during the succeeding continental wars, long maintained the highest character for fidelity to the cause it had embraced, and for the intrepidity it manifested under every circumstance of difficulty and danger.

A parliament was convened shortly after the ratification of the treaty. It was the first that had assembled after a lapse of twenty-six years of intestine commotion. Composed as it was of a great majority of Protestants, it testified little inclination to co-operate with the king's wishes, in adhering to the strict fulfilment of the articles of Limerick. The king evidently wished them to be maintained in the spirit as well as in the letter. The feelings of the leading party in parliament were sufficiently indicated in a sermon preached by the Bishop of Meath before the lords-justices, which inculcated the detestable doctrine that Protestants were not bound to keep peace with Papists. The first open breach that occurred between the government and the House of Commons was caused by the introduction of two money bills. According to the system of Ireland under Poyning's law, no bill could be brought into parliament until it had received the approbation of the king through the privy council. According to the principles of the British constitution, all money bills should originate with the House of Commons. The party opposed to the king took their stand upon the latter ground. One of the two bills was rejected altogether, and the other suffered to pass solely in consideration of the present exigency of affairs, and the pressing necessity of raising a supply for the king's service. Lord Sidney, in retaliation, suddenly prorogued the parliament, after reprehending the House of Commons sharply for what he styled an undutiful and ungrateful in-

History. vasion of the royal prerogative. This act increased the general discontent, as several measures of importance then in progress were left unfinished.

A new parliament, assembled in 1695 by the Lord-deputy Capel, opened with an assurance from the throne, that the king was intent upon the firm settlement of Ireland upon a Protestant interest. Such a declaration was hailed with joy by the prevailing party. In order to support the king in this measure, a committee was appointed to consider what penal laws were in force. The following were found to be the principal: 1. An act subjecting all who maintained the supremacy of the church of Rome to the penalties of a *præmunire*, and requiring the oath of supremacy as a qualification for every office. 2. An act imposing fines on absence from the parish churches on Sunday. 3. An act authorizing the chancellor to appoint a guardian to the child of a Catholic. 4. An act to prevent Catholics from being private tutors, without license from the bishop. Having ascertained the actual state of restrictions on the Catholics, as they had existed previously to the treaty of Limerick, the parliament proceeded, not to secure them in the privileges guaranteed to them by that instrument, but to increase the number of penalties and restrictions, contrary to its spirit and tenor. The following statutes, passed by this parliament, formed the commencement of the system of restrictive legislation now known by the name of the penal code, which, when wound up to its acmé of intolerant severity, by the successive enactment of laws, each surpassing its predecessor in severity, was described by Burke as the acmé of refinement in political persecution. These acts were, 1. to deprive Catholics of the means of educating their children, either at home or abroad, except under Protestant teachers, and to prevent them from being guardians even to their own children; 2. to disarm the Catholics; 3. to banish Catholic priests and prelates. Having passed these acts in direct violation of the treaty, they proceeded to confirm those articles, or so much of them as might consist with the safety and welfare of the king's subjects in these kingdoms. The bill took care that the precautionary proviso should not be a dead letter. It abrogated the articles which provided for the security of the Catholics from disturbance on account of their religion, which confirmed them in the possession of their estates and the exercise of their profession, which allowed them the use of arms, and which required the oath of allegiance only as a test of their loyalty. The bill passed the House of Commons with little difficulty. But in the House of Lords, where several of the Catholic peers still had seats, it was strenuously resisted; and when carried, a protest against it was entered on the journals by thirteen peers, six of whom were bishops. This mutilated ratification of the treaty was followed up by three other penal laws: 1. To prevent the intermarriages of Protestants and Catholics; 2. to prevent Papists from being solicitors; and, 3. to prevent them from being gamekeepers.

The spirit of religious intolerance that gave birth to these acts was not the only evil that checked the prosperity of the country. The commercial spirit of monopoly of the English manufacturers, who had long viewed with a jealous eye the increase of the woollen manufacture in Ireland, to which the cheapness of living and the excellency of the pasturages afforded peculiar advantages, prevailed on the king to make a solemn assurance that he would do all that in him lay to discourage that manufacture, adding as a mitigation of a declaration so iniquitous, that every encouragement should be afforded to the linen manufacture. The former part of the promise was rigidly adhered to, the latter was disregarded. Every attempt to establish the linen manufacture in the south of Ireland failed, chiefly from the opposition given by the clergy to the introduction of an equitable modus for the tithe of flax. History.

Whilst parliament was thus employed during the reign of William, in undoing the bonds of the treaty of Limerick, the court of claims appointed to investigate and dispose of the lands forfeited by the adherents of James was equally active in its invasion of their property. Amongst the chief sufferers by the decisions of this court was the Earl of Clancarty. It appeared doubtful whether his noble estate should be included amongst the forfeitures. The point was decided by a declaration of the grand jury of the county of Cork, which resolved that its restoration would be prejudicial to the Protestant interest. It was therefore sold, under a decree of the court. A subsequent attempt made in his favour in the reign of George II. was not only equally unsuccessful, but all attempts at a repetition of it were crushed by a vote of the House of Commons, that any lawyer who pleaded in his behalf should be deemed an enemy to his country.

The annals of Ireland during the reign of Queen Anne are merely a record of the exertions of the Irish parliament to rivet and extend the penal laws. By an act passed in 1703, the father of a Papist who conformed to the established religion was incapacitated from disposing of his property by sale, mortgage, or bequest; and a Papist was prohibited from being guardian to his own child, who, on conforming, was to be taken from his parent, and given in charge to a Protestant. Papists were rendered incapable of holding lands for more than thirty-one years; and if the profit rent of such land was found to exceed one third of the actual rent, the benefit of the lease was to be transferred to the Protestant who made the discovery. They were also prevented from inheriting the lands of their Protestant relatives, and their own lands were to be gavelled after death amongst their children. The most extraordinary provision of this monstrous act, was the requiring the oath of abjuration, and the sacramental test, to be taken as a qualification for office and for voting at elections. The cause of its insertion is singular. The English government was at this time negotiating with the emperor of Germany for the toleration of Protestantism throughout his dominions. To press the enactment of severe laws against the Catholics at home at such a period, exhibited an inconsistency as absurd as it was iniquitous. An effort was therefore made to dissuade the Irish parliament from proceeding with the bill, but to no purpose. Knowing, therefore, that the majority of the lower house consisted of Protestant dissenters, the clause requiring the taking of the sacramental test was inserted by the English council, in the hope that the rigid puritans would reject the whole bill rather than saddle themselves with the disqualification. But they were mistaken. Bigotry prevailed over self-interest; and the Puritans of the day acquiesced in the passing of a law, which deprived the conscientious members of their own persuasion of the right of exercising the most valuable privileges of freemen, rather than suffer their Catholic countrymen to participate in them.

This act was followed up by resolutions calling upon all the civil officers of the government to enforce its provisions, and declaring that the prosecuting and informing against Papists was an honourable service to the government. But this law, and these resolutions, were not deemed sufficient. In 1709 another act was passed, imposing additional restrictions upon the Catholics, by which they were prohibited from holding annuities for life; requiring the father of a conforming child to give in to the chancellor a strict account of the value of his property, in order to apportion a due share thereof to his support. Jointures were secured to conforming wives. Papists were forbidden to be assistants in schools. Popish priests

History. who conformed were allowed a stipend of L.30 a year, that of a Protestant curate being L.50; and rewards were offered for the discovery of popish prelates, priests, and teachers, at the rate of L.50 each for the first of these classes, L.20 for the second, and L.10 for the third. A subsequent statute excluded Catholics from acting as sheriffs, and from sitting on grand juries, and even proceeded as far as to enact, that in trials arising out of statutes for strengthening the Protestant interest, the plaintiff might set aside a juror on the ground of his being a Papist. The example of the parliament was followed by the corporations. Bye-laws were enacted, excluding Catholics from every profitable branch of trade. The result was, that all the Catholic gentry possessed of the means of emigration quitted the country, as did all the merchants of respectability, carrying with them, to fructify in other and in hostile countries, the property which might have enriched that of their persecutors.

The system was now nearly complete. The Catholics were excluded from every opening to political power. They were not exterminated, because the land would have been valueless to the new proprietors, without the assistance of labourers sufficient to extract its produce. The effects of the system soon began to appear. The son of James II. made an attempt to recover his father's dominions in the beginning of the reign of George I. The new proprietary took the alarm. On the first rumour of his intended project against Scotland, a number of Irish Catholic gentlemen were thrown into close confinement. The government, however, ashamed of this unnecessary ebullition of terror, soon afterwards caused them to be liberated, even without payment of the customary fees. The alarm was futile. The Irish had not the means, nor even the inclination, to renew the contest. Their spirit was broken by the grinding degradation of the restrictions thrown around them. Yet, to make assurance still surer, these restrictions were increased by the addition of new clauses to the penal code, mostly of minor importance, by one of which Papists were excluded from voting in vestries for the assessment of money for repairing or rebuilding parish churches.

The Irish Protestants were equally active in asserting their own liberties, as in extinguishing those of the Catholics. An attempt made by the English House of Lords to exercise the right of ultimate jurisdiction in cases of disputed property, to the prejudice of the peers of Ireland, was stubbornly resisted; and though the dispute was cut short for the time by an English act, declaring that the British parliament had full power and authority to make laws to bind the people of Ireland, the acquiescence of the latter proceeded, as future events fully proved it, from a consciousness, not of the defect of right, but of power to assert it. In its resistance to another act of British interference the country was more successful. The coinage, particularly of copper, was deplorably defective both in quantity and in value. An application for a domestic mint, a right often before allowed and exercised, was rejected, and in lieu of it a patent was granted to an English brassfounder of the name of Wood to coin copper to a large amount. The pride of the Irish took fire, and the circumstances of the case elevated the feeling into patriotism. Amongst the opponents of Wood's patent, Jonathan Swift, the celebrated dean of St Patrick's, was most eminent. In a series of letters, published under the name of the "Drapier," he denounced the scheme as illegal and ruinous. One of the letters was deemed libellous, and a large reward was offered for the discovery of the author. But the fidelity of the dean's partisans bore him harmless; the storm passed over without injury to him. The invidious patent was recalled; and his grateful country has embalmed his memory in the immortality of patriotism.

The state of the Catholics was now brought down nearly to the lowest point of depression. An address of congratulation to George II. on his accession, presented to the lord-lieutenant by Lord Delvin, on their part, was suffered to remain unnoticed, except so far as to render so faint an effort an apology for still further restraints. A bill was brought in for excluding Papists from voting at elections. By another, lawyers and attorneys married to Papists were prevented from practising. Even converts could not hold the office of justice of the peace if their wives and children continued to be recusant; and persons plundered by privateers in the service of a popish nation were to be reimbursed by a levy on the goods of Roman Catholics only. A vote of the Commons, declaring any person who took legal steps for the recovery of his tithes of dry cattle, commonly called the tithe of agistment, to be an enemy to the country, threw the greater part of the burden of maintaining the Protestant clergy from the rich proprietor, whose land was wholly under pasturage, upon the Roman Catholic cotter, who was obliged to raise some grain on his little patch of ground for the subsistence of his family. History,

Whilst the Irish parliament were thus vigilant in cutting off from the Catholics all means of regaining political power, they were no less so in preventing any encroachment of the English government upon the rights they themselves possessed. The relations of these two latter parties towards each other after the Revolution were peculiar. The members of the House of Commons held their seats, not, as in Great Britain, by septennial election, but during the pleasure of the crown. Their tenure was therefore generally regarded as tantamount to a life estate, subject only to a dissolution on the demise of the crown. Hence they were virtually unrestrained by popular control. On the other hand, as the lord-lieutenant came over to Ireland but once in two years, to hold a parliament for granting the supplies, the management of the country rested with the lords-justices nominated to hold the reins of government in his absence, who were selected from among the most powerful of the great Protestant families. Their influence, in questions between the two countries, was therefore often directed to thwart the measures of the English cabinet, particularly when these seemed to interfere with their own aggrandizement. The operation of the penal laws, whilst it enslaved the Catholics, pauperized the country. The great mass of the population was deprived by them of the main stimulus to industry, the hope of improving their condition by their own exertions. The great proprietors found their land becoming of less value, from the neglect of agricultural improvement. The supplies for the service of government were therefore granted with a niggardly and reluctant spirit. The English cabinet hoped to cut the knot that thus linked them to the Irish parliament. An attempt was made to obtain a vote for the supplies for twenty-one years. The Irish aristocracy immediately took the alarm. However acquiescent in the general tenor of their votes, they now rallied, and the insidious attempt was rendered abortive by a majority of one.

The depression of the country, arising from the treatment of the Catholic part of the population, was endeavoured to be remedied by the extension of education, the formation of patriotic societies, and the execution of public works. To educate the Catholics, it was necessary they should first be converted, because by the penal code domestic education according to the principles of their own faith was prohibited. Schools were therefore opened, in which the pupils were taught the elements of literature and the useful arts, and were also clothed and fed at the public expense. Being established by letters patent from the crown, these obtained the name of charter schools.

History. Their professed object was the diffusion of useful knowledge: but as their primary process was based upon Protestant instruction, and as this, to be effective, required a total severance of the parental tie which linked the Catholic peasant to his family, the effort failed. The second element of national regeneration was attempted by the formation of a society, in imitation of the Royal Society of London, under the name of the Physico-Historical Society, for the improvement of agriculture, husbandry, and the useful arts, which afterwards merged into the Royal Dublin Society. The last-named element of improvement, the execution of public works, gave rise to the measure of inland navigation. But none of these were effective to the extent proposed by those who set them on foot. The great object was not merely to give Protestantism the ascendency, but to eradicate Catholicism; to realize, in fact, what was imagined by a fiction of law, when, in a case where a Catholic came into a court of justice, he was gravely told that the law did not recognise the existence of a Papist. Education, whether of the primary rudiments or of the higher departments of science, gave knowledge, and knowledge revealed the extent and gloom of degradation. Useful works required workmen, and thus circulated capital amongst the Catholic population, to which the undertakers were compelled to have recourse for the mechanical parts of such undertakings. A state of society so anomalous, in which universal liberty was the avowed principle, yet slavery, unmitigated by the protection which sordid interest extends to the preservation of individual property, was the practice, could not but be most precarious. The ruling party, aware of the danger of explosion, at length found itself compelled to give vent to the under-workings of the re-action against oppression, by a partial change of system. That of ever-increasing compression, painful and hazardous at all times, was found, in periods of general agitation or impending warfare, impracticable. The threatened invasion of England by the young Pretender was the crisis which led to a change of domestic policy towards the Catholics. Ireland, as the weakest point of the empire, was looked upon as the most exposed. The Irish population was numerous and discontented. Their deficiency in the means and the organization of war could be instantaneously supplied by the wealth of France, and by the long-proved skill and valour of their countrymen, the Irish brigades in the French service. To ward off the apprehended danger, Lord Chesterfield was sent over in the spirit of conciliation. To the Catholics, worn down by the action of half a century of increasing oppression, the slightest relaxation of the highly strained engine of oppression became comparatively a blessing. An accidental circumstance afforded the new governor an opportunity to evince the sincerity of his professions. Hitherto the Catholics had held their assemblages for religious worship in the most secluded and secret places. The rewards offered by the laws for the detection of their priests, or of those who attended their ceremonies, compelled them to the strictest secrecy. The floor of a building in one of the confined streets of Dublin, where mass was celebrated, gave way, and caused the death or mutilation of a number of the wretched beings, congregated to worship their God at all hazards, in the way in which they had been trained. Lord Chesterfield, with the tact which has immortalized him as a first-rate character in the annals of fashionable life, seized the opportunity of declaring openly that he would not be a party to a system of religious prevention, liable to the hazard of such results; and the meetings of Catholics for the purpose of religious worship were consequently winked at. Still, however, the spirit of the penal code remained unrestricted; and operative laws were passed during the government of this, the first of the tolerating lord-lieutenants, not only annulling all marriages between Protestants and Catholics, if celebrated by a Catholic priest, but also rendering the clergyman who performed the ceremony liable to capital punishment. The threatened storm from abroad blew over. The invasion of the young Pretender forms no part of Irish history. The Irish Catholic remained unmoved in his habits of passive obedience. The Irish Protestant returned to his parliamentary controversies with the ruling powers in England. Where there existed such a consciousness of overwhelming superiority on the one side, acting upon a spirit of domineering independence, checked by an internal conviction of weakness, the weakness of division, on the other, collisions between the English cabinet and the Irish ascendency party could not fail to be frequent and acrimonious; much less could such collisions fail to throw to the surface some of those restless spirits which political convulsions have shaken from their orbits of ordinary movement. A contest between the Irish privy council, which then exercised the most important parts of the legislative functions of government, and the corporation, stimulated Charles Lucas, a Dublin apothecary, to assert the rights of the latter. Though unsuccessful, he was not unrewarded. The death of the two representatives for Dublin gave rise to a contested election, an event of rare occurrence under the then existing constitution of the Irish parliament. Lucas was elected, under the pledge of vindicating, in the House of Commons, the perfect independence of the Irish legislature. This doctrine, first broached by Molyneaux shortly after the Revolution, in a treatise called the "Case of Ireland," was viewed with alarm by the English party in the House, and with jealousy by that of the Irish aristocracy. By the one it was viewed as a severance of the connection of sovereignty and dependence between the two countries, by the other it was felt to sap the foundations of their own domestic omnipotence. Passages of libellous tendency were extracted from Lucas's publications. The House of Commons declared him an enemy to the country, and passed a vote for his prosecution. He evaded the coming storm only by retiring to the Continent. On a subsequent vacancy, however, he was re-elected, and took his seat as one of the representatives of the people, which he retained till his death. The Irish parliament, arrogant where it felt secure in its own power, was tamely submissive under circumstances wherein an assertion of its just rights would have been truly creditable. A surplus revenue remained in the Irish exchequer. The English council insisted on the king's right to dispose of it at pleasure. The Irish Commons equally insisted on their absolute control over the public purse, without any interference from other quarters. The bill acknowledging the necessity of the royal consent to the appropriation of the surplus income was rejected by the Commons. The English council cut the matter short. The money in dispute was drawn out of the treasury by a king's letter, and the Commons passively acquiesced in the spoliation and insult.

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In this state of torpid tranquillity, ruffled only by apprehensions of internal commotion, or by the agitation of partisan quarrels between the rival factions of court and country which divided the dominant party, Ireland continued to advance for nearly seventy years after the Revolution, until at length the elements of activity were roused by the reality of an actual invasion. In the year 1759, a fleet was fitted out in the French ports, for the avowed purpose of landing a large armament in Ireland. A small squadron under M. Thurot, supposed to be an advanced section of the main fleet, and intended to cause a diversion of the defending forces, landed in the north of Ireland, and took possession of the town and castle of Carrickfergus, with little opposition. After holding it a few days, the French commander, checked by the appearance of the general and

History. determined resistance which was gathering around him through all the northern counties, deemed it expedient, instead of proceeding to the assault of the wealthy and undefended town of Belfast, which lay at but a few miles' distance, to re-embark. Any further repetition of his predatory incursions was prevented by the destruction of his little armament in the channel, in an engagement, in which Thurot himself lost his life.

The alarm excited by the threatened invasion afforded an opportunity to the Catholics to call the attention of the government to their sufferings. An address, framed by a committee of their body, was presented to the lord-lieutenant, making a tender of their allegiance at this critical period. Its favourable reception brought forward others of the same kind from every part of the country, and thus was the first impulse given to the movement for the repeal of the penal code. Another opportunity of echoing the sentiments contained in these addresses presented itself on the accession of the new king, George III. It was eagerly seized on, and the address was received with equal favour as the former. The state of the country required some vital change in its internal administration. The revenue was declining, and the peasantry were every year becoming more destitute and discontented. The wretched sufferers, attributing their misery to the exaction of tithes and the enclosure of lands hitherto left open in commonage, banded themselves together in large bodies at night, and destroyed the new enclosures; whence they at first received the name of Levellers, but were afterwards better known by that of Whiteboys, from their wearing white shirts over their clothes, to be known to one another in their nocturnal expeditions. From the invasion of property they proceeded to the attack of persons obnoxious to them, particularly tithe proctors, treating with wanton and barbarous cruelty those who fell into their hands. The government, instead of probing the evil to the bottom in order to effect a cure by the removal of the cause of irritation, retaliated by a series of severe and arbitrary laws, known by the name of the Whiteboy Acts, many of which are still in force. Attempts were made to connect those insurrections of desperate misery with the political movements of France. Rumours were circulated that the Whiteboys were encouraged by money from that court, and that their combination was the explosion of a plan for restoring the Pretender. A parish priest of the name of Sheehy, who had made himself obnoxious to the gentry in his neighbourhood by his exertions to shield the peasantry from their oppressions, was arrested on a charge of treason; and, though acquitted of that crime after a patient and long investigation by a jury in Dublin, he was, on his return home, again arraigned on a charge of murder, universally known to be false, and executed. The situation of the British government in Ireland at this time was extremely irksome and invidious. In order to carry on the public business smoothly, it became necessary to conciliate the great landed proprietors, who, through their borough influence, had the control of the House of Commons. They were to be gained over partly by allowing them a large share in the disposal of all places of trust and profit, and partly by indulging their enmity to the Catholics, who were still suspected of being cemented in a secret union for the recovery of their forfeited estates. The party which thus virtually ruled the country by playing the British government and the Irish people against one another, was known by the name of the Undertakers. They had a double object; the one to make the crown, as far as Ireland was concerned, dependent on themselves; and the other to check the spirit of liberty in the people, and at the same time to throw on the government the odium of the measures of which they themselves were the instigators. To break down this petty aristocracy, which had intruded itself between the prerogative of the crown and the rights of the people, the British cabinet resolved, in the early part of George III.'s reign, History. that the lord-lieutenant, who had hitherto visited the country only once in two years for the purpose of holding a parliament and passing the supplies, leaving the management of the country during the intervening period to two or three lords-justices chosen from among the leaders of the Undertakers, should reside permanently in Dublin, so as thus to be the immediate and ostensible organ of government patronage and influence. At the same time, to put a stop to the outcry against the mismanagement of the public income, which was attributed to the people's want of a sufficient check over their representatives, the duration of parliaments, which hitherto had terminated only on the demise of the crown, was limited to eight years, so that, as the parliaments then sat only ever second year, there should be four sessions between each dissolution. Lord Townshend, a nobleman of moderate political, but of great convivial endowments, was selected as the most fitting person to effect the change. He succeeded with much difficulty, some loss of character, and great expenditure of the public money. But the people felt no benefit from the change. The places and pensions, hitherto bestowed on the dependents of the Undertakers, were now lavished with augmented profusion on the creatures of the lord-lieutenant. The disappointed borough holders of the old parliaments felt their power in the House of Commons increased by the curtailing of the period of legislation. They threw themselves into the ranks of opposition, to thwart the measures of the government which they could no longer direct. The parliament was the arena for the struggle between the two parties, and the real interests of the country were disregarded. The severity of the Whiteboy Acts caused a temporary cessation of insubordination in one part of the country, only to give vent to it in another. The disturbances in the south had been imputed to Catholic conspiracy, aided by foreign influence. A similar systematized spirit of outrage now displayed itself in Ulster, which was chiefly inhabited by a Protestant population, that had already testified its loyalty during Thurot's invasion. The real cause of disaffection was the same in both parts of the country. High rents, and the rapacity of the agents of absentees, drove the people into insurrection. The assembled multitudes here took the name of Hearts of Steel. For their suppression, the legislature passed an act that offenders should be tried in counties different from that in which the crime was committed. The extreme severity and injustice of the law counteracted its operation. Dublin juries, disgusted at a measure so arbitrary and unconstitutional, acquitted the prisoners, and the law was soon repealed. Emigration to the American colonies was the consequence of the depressed state of the peasantry, and of the severity with which they were treated. The war with those colonies, by closing this vent for the discharge of the popular discontents, caused them to accumulate at home. It also increased their amount by the addition of other grievances arising out of the change from peace to war. America had been the great mart for Irish linens, now the only thriving branch of the national manufactures; it was also the great market for Irish provisions. The war closed the trade, and an embargo laid on provisions in favour of some great English contractors put a stop to their export. The country was also deprived of its portion of the regular troops, which the increasing emergency of the struggle with the revolted provinces called away. The sufferings of the people were intense; and the alarm of danger was shortly afterwards increased by the well-founded apprehension of an invasion from France, now the avowed ally of the Americans. To allay the spirit of discontent which was rapidly pervading all ranks, two measures were proposed, the one in England, the removal of the restric-

History. tions imposed there, as unwisely as selfishly, on Irish commerce; the other the relaxation of the penal code in Ireland. The commercial jealousy of the mercantile interest in England prevented the former; the latter succeeded so far as to allow Catholics to hold lands by lease for a long term of years. This boon, though it might excite the hope of more extended liberality, could avail little toward relieving the pressure of immediate distress. Want at home, and danger from abroad, stared the country every year more fully in the face. The landed and commercial interests called on the government for protection. The Earl of Buckinghamshire, then lord-lieutenant, a man of moderate abilities, returned for answer that the government had none to give. The people, urged on by the exigency of the crisis, resolved to arm themselves. Volunteer associations were not hitherto wholly unknown in the country. The military spirit of the nation had shown itself on many preceding occasions, in the readiness with which numerous bodies of men, assuming a self-formed and self-taught military organization, united together on occasions of local or temporary danger. The invasion of Thurot gave rise to some in the north, the outrages of the Whiteboys led to others in the southern counties. But such instances were temporary and local. The impulse now given to the public spirit, by the desponding reply of the government to the appeal for protection, was universal and permanent. The organization commenced in Belfast, to which the lord-lieutenant's answer had been more specially directed. The constituted authorities had told them they were not to look to them for protection, but to themselves. They took the hint, and formed several companies of self-armed, self-disciplined, and self-officered soldiers. The surrounding towns followed the example; and the government, acting in the spirit of its own suggestion, supplied these new-raised levies with arms. The flame of military ardour spread with unexpected rapidity through all parts, and the number of well-disciplined corps soon became so great and so formidable as to dispel all thought of invasion on the one side, and all apprehension of it on the other. The same spirit caused a re-action against the monopolizing restrictions of the British legislature. The people of Ireland entered into a very general combination to confine themselves to the use of their own manufactures. The sudden check to industry thus produced in England caused the supporters of the measure to reflect on its inexpediency; and the military display could not fail to attract their respect.

The people of Ireland now began to expect from their volunteer associations what, according to the principles of the constitution, should only be looked for from the legislature. These bodies were not backward in meeting such expectations. Assemblages of volunteer corps in Dublin and elsewhere passed resolutions that the king, lords, and commons of Ireland alone were competent to make laws to bind the people of Ireland. The political feeling thus excited increased the number of military associations; and, whilst in the parliament the old system of corrupt influence carried all before it by numerical majorities, the volunteers of Ulster, in the consciousness of their strength, held a meeting at Dungannon, declarative of the necessity of a thorough reform of the state of the representation, and of a combined exertion of the whole volunteer force of Ireland to procure it. The effervescence of patriotism was increased by the unsettled state of the administration in England; Lord North had resigned, and the death of Lord Rockingham put a premature end to his short-lived administration. The result as to Ireland was the dissolution of the parliament, against which the feelings of the nation were so highly excited. A new parliament was about to meet; and at the same time a meeting of delegates from all the volunteer corps in Ireland was to assemble in Dublin, to urge on the favourite measure of parliamentary reform. History.

At this time several individuals had raised themselves to the highest pinnacle in the scale of patriotism. The most remarkable was the Earl of Charlemont, who, after spending his youth amidst the elegancies of Italian refinement, devoted his maturer years to the service of his country at home. Next to him were Grattan and Flood, both members of parliament, both eager to establish the independence of their common country on sure grounds, yet fatally adverse to each other as to the foundation on which it was to be laid; the former considering a simple repeal of all English laws interfering with Irish rights as a sufficient disavowal of the assertion of supremacy, the latter requiring an open and explicit disclaimation on the point. Grattan was successful, and the country voted him L.50,000. The breach between the rival patriots was irremediable. Grattan remained at home to continue the struggle for securing the newly-gained rights of his country. Flood soon afterwards retired to England, where a seat in the British legislature flattered him with a more enlarged sphere for the display of his powers. But he failed, and was no longer named as a patriot or statesman.

The meeting of the new parliament and of the volunteer convention took place simultaneously. The first and only act of any consequence adopted by the latter, was a resolution as to the necessity of a reform in parliament; which having been immediately afterwards introduced by Mr Flood into the House of Commons, was there rejected by a large majority; and the convention, partly through an apprehension among many of its members, of dangers from a collision between two representative bodies, both emanating from the same source, and both claiming to be the constitutional organ of their constituents, and partly through a manœuvre of some of its leaders, quietly adjourned, and never afterwards assembled.

Assemblages of large bodies of armed men, unconnected with and beyond the control of the government, could not fail to alarm the ruling powers. The union of these bodies into a deliberative meeting, for the avowed purpose of influencing the legislature, was still more alarming. The first effort of the volunteers to attain this position had been baffled. The meeting of delegates was dissolved; but it might, and there was every reason to suppose that it would, be re-assembled. To prevent such a recurrence by violent means was dangerous. The volunteer body was numerous. It counted upwards of 100,000 men, embracing the greater part of the wealth and respectability of the country, in its ranks; its numbers and discipline were yearly increasing. The consequences of a hostile collision with such a body, particularly at the close of an unsuccessful war, commenced with the avowed determination of crushing the spirit of independence in the American colonies, were fraught with great hazard. An attempt was therefore made to break up the strength of this body by internal divisions. The Catholic question effected this. The volunteers were almost exclusively Protestants. The extension of rights to a portion of the population, so long held in a state of passive degradation, was viewed by many of them with a jealous eye. They looked upon every new concession to the Catholics as so much abstracted from themselves. Still, however, the Catholic cause was gaining ground.

The extension of a free trade to Ireland had afforded the means of accumulating property. It was eagerly seized on by the Catholic merchants and traders. The lately conceded permission to hold land on long leases gave the holder of such property a fixed position and weight in the country. New laws, framed in the spirit of the increasing liberality of the age, extended their rights. They were permitted to purchase, hold, and dispose of land, by will

History. or otherwise, as freely as Protestants. The penal acts prohibiting the celebrating or hearing of mass, keeping horses above the value of five pounds each, instructing their own children, or acting as teachers, were repealed; as were those taxing them for the losses sustained from privateers, obliging them to pay Protestant watchmen, excluding them from residence in particular towns, and some other petty and irritating restrictions. Still they were far from being on a political equality with their Protestant countrymen; and at the very time that the severity of the code was thus relaxed as to property, new laws were passed still further contracting their political rights. By one of these they were debarred from admission into the Inns of Court; by another the English act of William III. excluding them from sitting in parliament, was formally enacted in Ireland. The passing of it attracted but little notice, as the act of William had been hitherto passively acquiesced in by the Catholic body.

Whilst the government was successfully busied in sowing the seeds of disunion amongst the volunteers, it paid little attention to conciliate the people by economy or good management. The reckless system of lavish and profligate expenditure introduced by Lord Townshend, to break down the monopoly of the Undertakers, was persevered in to secure majorities in the House of Commons. A feeble effort made by the Duke of Buckingham to retrench and restore order into the finances only led to his recall. Yet it was soon found that a government resting on majorities thus purchased depended on a very frail security. The mental derangement of the king in 1789 showed the futility of such reliance. The English cabinet wished to restrict the Prince of Wales in the discharge of the regal powers intrusted to him as regent. The Irish privy council was prepared to follow the example. But the opposition in parliament, anxious to extend their own influence by gaining over the heir-apparent, who had till then always made professions of great liberality of political opinion, resolved to grant him the regency of Ireland, with no restrictions beyond those imposed by the constitution on the sovereign himself. An address to this effect, voted by both houses of parliament, in opposition to the lord-lieutenant, was forwarded to London. The sudden and unexpected recovery of the king prevented its effect. But the British minister, having now so fully before him a warning of the consequences that might result from similar collisions of the two legislatures upon future questions, seemed fully determined to seize on every opportunity of preventing it, by taking measures for effecting a union of the parliaments of both countries, similar to that which took place in Scotland at the commencement of the century. The prevalence of opposition to the wishes of the English cabinet was as transient as it had been sudden. The members who voted against the ministry on the regency question were again found in their places on all ministerial questions, with the exception of those whose rebellion had been too gross and daring to admit of pardon; and the parliamentary management of the country began to subside again into its former state of torpidity.

But the calm was not to be of long duration. A new element of convulsion was at work. The French revolution broke out in the same year in which the king's insanity had caused such excitation. For some time it produced but little effect on the popular movements in Ireland. The Protestants, indeed, began to call more loudly for reform, and the Catholics to press more openly for admittance into the pale of the constitution. Both were disregarded. The government felt itself strong in its majorities, and in the plenitude of its means for securing them. The question of reform was disregarded; that of Catholic relief was not only scouted with marked contumely, but, during the ensuing recess in 1792, every exertion was History. made on the part of government to draw forth from the grand juries of the several counties the strongest resolutions against any further concessions. Yet the very next year a bill was introduced into parliament by the government, for extending the elective franchise to the Catholics, which was passed by a majority nearly equal to that which had refused to take their claims into consideration in the last session. Bills for amending the representation, and for disqualifying placemen from sitting in the House of Commons, were also introduced. The promises of reform thus held out induced the minority to acquiesce in several coercive measures, particularly one against the holding of conventions by delegation. Enactments of the latter character having been secured, that of reform was allowed to languish, and, next year, was rejected by an overwhelming ministerial majority. The French war in which England was now involved had been the cause of this sudden burst of concession; but when the means of carrying it on, and of checking by severity any efforts to excite discontent at home, had been assured, the mask was thrown off, and the management of affairs carried on with increased profligacy of expenditure, and disregard of public opinion. The advocates of reform, despairing of any change of measures from parliament, endeavoured to carry the question of reform by a pressure from without, through the agency of voluntary associations. They formed a Whig Club, which afterwards was superseded by that of the United Irishmen. One of the leading features of both societies, especially of the latter, was the advocacy of the Catholic question, as it now appeared evident that the question of reform was hopeless, without the previous admission of the Catholic body to their rights of freemen. The government, after some further perseverance in measures of harshness and restraint, heightened by the increased violence of the leaders of the people, the principal of whom, Wolf Tone, Hamilton Rowan, and James Napper Tandy, were forced to expatriate themselves, changed at once to a system of conciliation. In assurance of the sincerity of the change of sentiment, Earl Fitzwilliam, a nobleman possessed of large estates in Ireland, and a steady advocate of liberal measures, was sent over as lord-lieutenant. He commenced his government by arrangements for bringing in a bill for the total repeal of the penal statutes, and by the removal from office of the inferior agents of government, who, by their long continuance in place, and the manner in which their mutual interests were connected, virtually possessed the supreme power. The latter of these efforts caused the lord-lieutenant's removal. The family of the Beresfords, which had for many years possessed the chief places of profit and influence, remonstrated effectually against their own dismission and the breaking up of the old system, and Earl Fitzwilliam was suddenly recalled. Earl Camden, who succeeded him as lord-lieutenant, recurred to the former system of patronage and coercion. The United Irishmen now looked not to a reform, but to a separation from Great Britain, and the establishment of an independent republic in alliance with that of France, as the only means of securing the independence of their country. A well-arranged system of secret confederacy was spread over the greater part of the kingdom, headed by an executive in the capital, the members of which, though wholly unknown, except to the few individuals in immediate communication with themselves, issued orders for enlisting, combining, and arming their adherents, which were zealously and implicitly obeyed. The northern and midland counties had for some time been disturbed by the fierce and deadly contentions of the peasantry of the two opposite religious creeds; the Catholics took the name of Defenders, the Protestants that of Orangemen. As the struggle grew more despe-

History. rate, the attraction of party extended to the higher classes, and the former of these predial disturbers merged into the great mass of United Irishmen, whilst the latter, consolidated by the infusion of a superior spirit of wealth and intelligence, formed a compact, well-organized, and resolute body, under the original name of Orangemen, determined to maintain to the utmost their own monopoly of power, and the entire exclusion of the Roman Catholics, who formed the great mass of the population, from any participation of it. The increasing hostility of both parties showed itself by acts of augmented atrocity on both sides. The Defenders' means of aggression were nocturnal plunder, house-burnings, and murders. The other party, backed by the sanction of the government, had recourse to the force of statutes of increased rigour, and, where these failed, to the agency of military violence beyond the law. In the year 1796 the organization of the united system on the one side, and on the other the increased severities of the Orangemen, supported by the government, and directed exclusively against the Catholic peasantry, compelled the leaders of the people to press upon the French government the necessity of an immediate invasion. In consequence of their repeated and urgent applications, aided by the exertions of Wolf Tone, who, since his departure from Ireland, had devoted himself to this object, a large armament was equipped in the western ports of France, for the avowed purpose of invading Ireland. The command of it was intrusted to Hoche, then considered as the first officer of the time. Taking advantage of a storm which drove the blockading squadron of England off the coast, a large fleet sailed from Brest under his command in the middle of December; but the same violence of weather which afforded it the opportunity of eluding the vigilance of the British navy dispersed it when at sea, insomuch that but a part of the armament arrived on the coast of Ireland. Having lain for some time in Bantry Bay undiscovered by the enemy, waiting the arrival of the general, who had embarked in a frigate, and finding the further continuance on the station every day more precarious, it departed, contrary to the pressing remonstrances of Wolf Tone, and returned to Brest, whither the remainder of the fleet soon afterwards arrived, with the loss of a few ships. A second expedition from the Dutch coast was equally unsuccessful. The possibility of an invasion being thus demonstrated, and the probability of its ultimate success, if effected on a great scale, being apprehended in the present excited state of the public mind, the government had recourse to still stronger measures to put down the spirit of insurrection. The habeas corpus act was suspended, domiciliary visits throughout the country parts were frequent, meetings of the people were dispersed by violence, torture was inflicted to force confession from suspected persons, and bodies of soldiery were allowed to live at free quarters in suspected districts. The relaxation of discipline and consequent outrages arising from these practices caused General Abercromby, who came over to take the command of the army at this juncture, to declare, in general orders to the troops, that "the army was in a state of licentiousness which rendered it formidable to every one but the enemy." The announcement was as unpalatable as it was harsh. The general was recalled. General Lake was sent in his place. By his commands the soldiery exercised an almost uncontrolled authority, in which they were sanctioned by instructions from the government empowering the army to use force at the discretion of the officers against the people. At the same time the strength of the United Irish Association was considerably impaired by the arrest or flight of the executive, caused by the treachery of some of their own body. This circumstance, however, produced no despondency. On the contrary, it led to increased exertion. A new executive was formed, and a resolution adopted to press forward the insurrection without waiting for French assistance. A second act of treachery baffled this effort. Twelve History. of the leading members of the United Irishmen were seized, with their papers, whilst in committee. A third act of treachery led to the disclosure of the details of the plans. Captain Armstrong, of the king's county militia, entered the association for the purpose of betraying its leaders. By his information two barristers of the name of Sheares, brothers, were arrested; and shortly afterwards, Lord Edward Fitzgerald, a brother of the Duke of Leinster, to whom the chief command of the insurrection had been intrusted, was seized in his place of concealment in Dublin, and carried to prison, where he soon after died either of his wounds or from his treatment whilst there. Notwithstanding these checks, the insurrection exploded at the time arranged by its leaders. On the evening of the 23d of May, the United Irishmen assembled in large bodies in the neighbourhood of Dublin and the adjoining counties. The warnings previously given to government were sufficient to provide against the intended attack upon the capital. The parties collected in its neighbourhood were easily dispersed, with the loss only of a few lives. Unfortunately the same vigilance did not extend to the more distant parts. The signal for commencing operations on the side of the insurgents was to be the non-arrival of the mail coaches at their respective places of destination. The northern and western mail coaches were stopped. The town of Naas was attacked, but, owing to an anonymous warning, the garrison was prepared, and the assault was repelled. Unsuccessful attacks were also made on Carlow, Hacketstown, and Monasterevan. A large body which had assembled on the hill of Tarah was routed with much slaughter. The operations of the army were seconded by the most violent acts on the part of the government. Several of the leaders who had been previously seized were tried and executed. Numbers arrested on suspicion were brought to places prepared for the purpose, and there tied up and flogged, to extort confession. The principal places in Dublin for these inquisitorial executions were the Royal Exchange, the Old Custom-House, the Prevot Barrack, and a riding house belonging to a cavalry corps commanded by one of the Beresford family. The atrocities practised in the capital under the sanction of the government were improved upon in the country parts, where the military, to whom full license was permitted, by putting the country under martial law, not only adopted the same method of extorting confession, but used others of more refined agony to elicit discoveries or to gratify revenge. In some cases they hanged up their victim, and let him down again just before life was extinct; thus repeating at pleasure the sufferings of strangulation. On the heads of others they applied caps lined with heated pitch, which, when fastened on, and allowed to cool, were suddenly torn off, carrying with them the hair and skin. In the spirit of fiendish mockery, they cut ridges in the hair of others, in the form of a cross, and filling up the furrow with gunpowder, set fire to it. On the first breaking out of the rebellion, a number of suspected persons, some of them respectable farmers, who had been confined in a racket-court at Hacketstown, were deliberately shot, without even the form of trial, on the removal of the troops from that place, lest they should join the rebel camps. A similar massacre was perpetrated at Dunlavin. The insurgents of Kildare, finding themselves defeated in almost every assault upon the king's troops, came forward to surrender on promise of pardon. Many laid down their arms, and were permitted to disperse in safety. But a large body of them, assembled for the same purpose, was unexpectedly attacked by a detachment of the military, who had not been made acquainted with the arrangement, and cut to pieces.

The system of torture was carried by the soldiery into the county of Wexford, which had hitherto remained quiet.

History. Here the insurgents were more successful. After cutting to pieces a detachment of cavalry from Dublin, and another of infantry and artillery from Duncannon Fort, and taking Enniscorthy by storm, they seized on the town of Wexford, which had been evacuated on the first alarm by the military. Having established themselves here, and at Vinegar Hill, an eminence near Enniscorthy, they remained comparatively quiet, being chiefly occupied in putting to death prisoners charged with having been active in the cruelties practised upon the insurgents. Their first serious defeat was at New Ross, from which they were repulsed after a sanguinary contest of ten hours. In revenge for this defeat, a party of the fugitives set fire to a barn at Scullabogue, in which upwards of an hundred of their prisoners were confined, all of whom were either burned, or piked in attempting to escape from the flames. The same impulse of sanguinary despair caused the insurgents in Wexford to put their prisoners to death, by piking them on the bridge, and flinging their bodies into the sea; a process of cruelty continued for several days, notwithstanding the active interference and remonstrances of several of their own clergy. At length, however, their main position at Vinegar Hill was invested by a large military force, and stormed after a short resistance. Wexford soon afterwards fell into the hands of the royal troops, having surrendered without resistance, on conditions which were immediately violated. The leaders of the insurrection who had not fallen in the field were executed by court-martial, and the insurrection in this and the neighbouring county of Wicklow totally suppressed.

The news of the first successes of the insurgents in Wexford caused a rising in the counties of Antrim and Down, which had remained passive on the first breaking out of the insurrection in Kildare. But it was speedily put down after a battle in the town of Antrim, and another at Ballynahinch, in both of which the insurgents, who displayed much courage, but no military skill, were totally defeated. The marauding parties, who still harassed the country after the dispersion of the main bodies, were ultimately broken up by the prudent and merciful conduct of Lord Cornwallis. This nobleman, who succeeded Earl Camden as lord-lieutenant, not only put an instant stop to the system of torture and extermination which had been adopted and perseveringly acted on by his predecessor, but issued an amnesty to all who submitted and returned to their dwellings. This merciful policy had its full effect; and the country, after being convulsed for two months by the deadly struggles of the contending parties, entertained the hope of being restored to tranquillity, when the prospect was suddenly overcast. Towards the close of summer, a small French squadron landed a force of about twelve hundred men at Killala, in the west of Ireland. Humbert, the general, being joined by a number of the inhabitants, pressed on to Castlebar, where a force of from five to six thousand men under General Lake was posted to oppose him. This force was taken by surprise, and routed almost without firing a shot. The French then proceeded to Coolooney, where they received a temporary check from a party of the Irish militia, which made a gallant stand against superior numbers; and thence proceeded, followed by General Lake, into the county of Longford. Having arrived at the village of Ballynamuck, the French commander, finding himself surrounded by an overwhelming majority of force, collected from all parts by Lord Cornwallis, surrendered at discretion, leaving his Irish auxiliaries to the mercy of the enemy. No quarter was given to these. A second attempt at invasion, equally feeble and futile, was made the following month. A small squadron appeared off the northern coast, filled with troops intended for disembarkation; but it was routed by a superior English fleet, with the loss of one line-of-battle ship and six frigates, in which were some of the expatriated Irish who were embarked in this desperate expedition. Amongst these was Wolfe Tone, who, on being brought prisoner to Dublin, anticipated the sentence of a court-martial by an act of suicide. History.

The British government of that day have been accused of fomenting the rebellion of 1798 for the purpose of bringing about a legislative union between Ireland and Great Britain. There is no foundation for the charge, but doubtless the government took advantage of the explosion of the insurrection of 1798 to hasten on the progress of a necessary measure, the adoption of which was only a question of time. The union of both countries had been proposed and debated without result in 1782, the year of so-called constitutional independence and final adjustment; three years after which, Mr Foster, the chancellor of the Irish exchequer, said in the Irish parliament, "Things cannot remain as they are; commercial jealousy is roused, and it will increase with two independent legislatures. Without a united interest in commerce, in a commercial empire, political union will receive many shocks, and separation of interest must threaten separation of connection, which every honest Irishman must shudder to look on as a possible event." Mr Fox stated in the British House of Commons that from the period of 1782 there had been growing sources of dissatisfaction and discontent in Ireland, and that its condition in 1797 was one at which no man could look without the greatest alarm.

The rebellion of 1798 alarmed all reasonable persons, and the dispute which had occurred in 1789 between the two parliaments of Great Britain and Ireland respecting the powers to be granted to the Prince of Wales as regent, clearly demonstrated that there was no security in the existing arrangement. The project of 1782 was revived, and a legislative union of Great Britain and Ireland recommended in the lord-lieutenant's speech at the opening of the parliament in January 1799. After a discussion in the Lower House on the address, which occupied twenty-two hours, a resolution approving of the principle was carried by a majority of one. After a subsequent debate, the opinion of the House having been declared against it by a majority of five, the paragraph in favour of the Union was expunged from the address to the throne. For a time the question remained in an unsettled state. Mr Pitt, in his speech of the 31st January 1799, said, "I wish that the question of the Union should be stated distinctly, temperately, and fully; that it should be left to the unprejudiced, the dispassionate, the sober judgment of the Irish parliament. I wish that those whose interests are involved in the measure should have time for its consideration. I wish that time should be given to the landed, to the monied interest, that they should look at it in all its bearings—that they should coolly examine and sift the popular arguments by which it has been opposed; and that then they should give their final judgment." The great body of the people were induced to give the measure a tacit though reluctant assent, from a promise held out to them of Catholic emancipation, and other advantages which they had little hope of obtaining from the Irish parliament. The government being resolved on the measure, found it necessary to prevent or disperse various public meetings of its violent opponents, and to make use of all the influence at their command to overcome the reluctance of the majority of the Irish House of Commons. Confiding in the success of his arrangements, Lord Castlereagh, the Irish minister, revived the question early in 1800; and on the final division, which took place on the 6th February in that year, 158 members voted for the Union, and 115 against it. The principle being admitted, and the details having been settled by the British parliament during the past session, no further difficulty was experienced. At the close of the year the two separate par-

History. liaments of Great Britain and Ireland were dissolved, and a proclamation issued for the assembling of an imperial parliament in January 1801. The articles of the Act of Union, eight in number, are,—1. The permanent union of the two kingdoms into one, under the name of the United Kingdom of Great Britain and Ireland. 2. The succession to the throne to continue as at present, limited. 3. The kingdom to be represented by one parliament, to be called the Parliament of the United Kingdom of Great Britain and Ireland. 4. 28 peers temporal elected for life, and 4 spiritual peers succeeding each other by a rotation of sessions, were admitted into the House of Lords; 100 representatives, 2 for each county, 2 for Dublin city, 2 for Cork city, and 1 each for 31 towns and the university, were to be elected into the Lower House. 5. The churches of England and Ireland were to be united into one, to be called the United Church of England and Ireland, the doctrine, worship, and discipline of which was to be the same as that established for the Church of England. 6. The subjects of Great Britain and Ireland were to be placed on the same footing as to manufactures, trade, and commerce. 7. The contribution of each portion of the empire towards the general expenditure was to be in the proportion of 15 to 2 between Great Britain and Ireland for 20 years; after which, to be regulated at the discretion of parliament. 8. The existing laws and courts of justice in each island were to continue as heretofore, except that appeals from the Irish chancery were to be brought before the House of Lords in England. The style of the king was in consequence changed to that of King of the United Kingdom of Great Britain and Ireland, and the blazoning of the royal standard was altered accordingly.

In 1793, eight years previous to the Union, Mr Grattan stated that, of 300 members of the Irish House of Commons, 200 were the nominees of private individuals, from 40 to 50 were returned by constituencies of not more than ten persons each; several boroughs had not more than one resident elector, and that out of 300 members thus returned, 104 were placemen and pensioners. At the Union compensation was awarded to the proprietors of 83 boroughs, an act having been previously passed by which the Irish parliament voted L.1,400,000 for the "losses sustained from the Union by the cities, towns, and boroughs, in Ireland, and to make compensation to persons for loss or reduction of emolument of office by the Union." Thus ended the Irish parliament, which, "the moment it arrogated to itself the powers of an independent legislature, imbibed the elements of dissolution, or separation from England; for there being no connecting link between the legislators of the two islands, but the precarious prerogative of the crown, there was unavoidably a constant endeavour of the executive to maintain an authority over the legislature, *prevention* in Ireland being of necessity more desirable than opposition by the *veto*. The government had long been dependent on an oligarchy, who maintained an ascendancy at their own price in Irish affairs. 'The Union,' as a national historian justly observes, 'broke the strength of the aristocracy; it effected that which it proposed, by untying the hands of government; it loosened its dependence upon a party, and restored to the state the privilege of good government.' Ireland, in fact, for centuries possessed but two classes of society, the rich and the poor; there was no solid bond between the crown and the people, and the feudalism which the religion of Luther in England, and of Calvin in Scotland, had tended so much to annihilate, flourished in most parts of Erin (as it still does in some places) in all its desolating vigour."[1]

The Act of Union did not at once produce the results promised by its advocates. It neither tranquilized the country, nor aided the consolidation of its resources. The Protestants, who constituted the aristocracy, found their influence diminished by it. The Catholics soon discovered the hopelessness of the expectation of being thereby admitted to the rights of freemen. When the question of their emancipation was about to be made an object of discussion, it was now for the first time publicly announced that the king had insuperable objections to the measure. The consequence was a change of ministry, which was followed up by legislative measures of great severity towards Ireland, founded on the suspected existence of a spirit of disaffection there. Martial law was re-enacted, and the acts for the suspension of the *habeas corpus*, and for preventing seditious meetings, were revived. These measures of prospective severity did not prevent the mischiefs apprehended. In 1803, less than three years after the passing of the Act of Union, an insurrection, devised by Robert Emmett, the younger brother of a barrister of the same name who had expatriated himself in consequence of the leading part he had taken in the proceedings of the united Irishmen, broke out in the city of Dublin. Its explosion was so sudden and unexpected, that no suspicions, at least none strong enough to lead to the adoption of measures of precaution, were entertained by the government. Soon after sunset on the 23d of July, Emmett, who had returned to Ireland, in ignorance of the altered state of public feeling, issued, at the head of a number of his followers, armed chiefly with pikes, from a depôt established by him in an obscure street in the west of Dublin, and after cutting down some of the military who were proceeding individually to their several quarters, moved towards the Castle, the main object of attack, when his followers were delayed by the approach of Lord Kilwarden's carriage. This excellent and popular nobleman, who had been chief-justice of the King's Bench during the late troublous times, was coming into Dublin as a place of security, in consequence of a rumour of a rising having reached him in his villa, a few miles from town. On being recognized, he was immediately assailed, and mortally wounded. The arrival of two small picquets immediately dispersed the collected multitude, with the loss of a few lives. Emmett, on finding the failure of his scheme, escaped to the neighbouring mountains, where he was soon afterwards taken, brought to trial, and executed. A similar attempt at insurrection was arranged in the north of Ireland by an associate of Emmett, named Russell, but discovered before the time fixed for its explosion. Measures of prevention were adopted, and its leader, being soon afterwards taken in his place of concealment in Dublin, was also executed. The only permanent consequence of these foolish plans of rebellion was the revival of statutes of extreme severity, which, by placing the people beyond the protection of the usual course of law, served to foster in the mind the seeds of discontent and disaffection, which it was the professed object of such legislation to extinguish.

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The agitation of the feelings of mutual irritation between the two great parties in Ireland, arising from the late insurrection, had not sufficiently subsided to admit of the most distant hope that the Catholic claims would receive the slightest attention in parliament till 1805. Even then, so powerful was the party adverse to the entertainment of the question, that motions for a committee on the petitions of the Catholics presented in that year were rejected in both Houses by overwhelming majorities. Even a bill, which asked no more than to put Roman Catholic officers in the army on the same footing in the English as they were in the Irish service, brought in by the then ministry, led to a dissolution, both of the administration and of the parliament, in consequence of the king's aversion to it. For several years afterwards, the question was periodically mooted in

[1] Martin's *Ireland and the Union*.

History. one or both houses of parliament, and uniformly rejected, though on each subsequent occasion by a diminished majority.

The Catholic committee, which had sat under various names and forms from time to time since its original institution in 1756, having, in 1811, proposed to assemble by delegation in Dublin, steps were taken by the government to put it down, as contrary to the provisions of the convention act, which prohibited such assemblages; but, in consequence of the acquittal of one of the members by a Dublin jury, no further proceedings were taken, and the increased activity of the association recalled the Orange lodges into existence, and led to frequent collisions among the people. In 1817 public opinion had advanced in favour of the Catholic claims so far as to admit of the question of securities being a topic of discussion. The chief point now was the exertion of a royal veto in the nomination of the Roman Catholic hierarchy, but the claim was fortunately afterwards abandoned.

In 1821 George IV. visited Ireland during the viceroyalty of Earl Talbot. The king landed at Howth on the 12th of August, and after a stay of nearly three weeks, during which all was loyalty and gaiety, his majesty embarked at Dunleary, afterwards called Kingstown, on the 3d of September, and Daniel O'Connell, at the head of a Catholic deputation, presented the king with a crown of laurel.

In 1823 the Catholic question began to assume a new and more imposing form. Its change of character was owing to Daniel O'Connell, then a practising barrister, who, after having signalized himself on his first entrance into political life by an eloquent protest against the extinction of the parliament of Ireland, had been subsequently an active and most influential actor in all the proceedings of the Catholic body. Deploring, along with his friend and coadjutor in political action, Mr Shiel, the state of torpid depression into which the question had declined, he suggested the revival of a central body to advocate and manage their cause, planned its details, and commenced its organization. The first meeting of this body, so soon, under the name of the Catholic Association, to be the acknowledged organ of the public sentiment of the greater part of the population of Ireland, commenced in a meeting of three individuals. Its distinguishing characteristics were the exclusion of any thing savouring of delegation, a strict adherence to the letter of any law that had been or might be enacted in order to stifle the expression of the sentiments of the Catholics, and, above all, the admission of the great body of the people into it. This last element of its constitution was finally secured and firmly grafted into it, after a continued and precarious struggle for existence, by a pecuniary contribution, which O'Connell denominated "the Catholic rent." Every Catholic was called upon to subscribe at least one penny per month to defray the expenses of the association, and thereby became a member of it. These expenses were far from inconsiderable. They were applied partly to protect poor Catholics from the petty persecutions of intolerant magistrates and landlords, partly to meet the general expenditure of the association, whose communications with all parts of the country could not otherwise be effectively carried on, and partly for the gratuitous circulation, throughout every part, of a newspaper, containing a detail of all the proceedings and debates of the association.

The dissolution of Mr Canning's ministry by the unexpected death of its leader, and the formation of the Wellington administration, gave a character of increased energy to the struggle for Catholic emancipation. The Duke was universally believed to be decidedly and irreclaimably adverse to concession on this subject; and one of the first measures taken by the Catholics on his accession to power, was the adoption of pledges, to be given by every candidate at an election, to oppose the new government. They were intended for the next general election, but Mr Vesey Fitzgerald having accepted a seat in the cabinet, a vacancy occurred in the representation of the county Clare, and O'Connell was elected, declaring that he would take his seat and vote. The agitation had now arrived at that point when it could no longer be resisted with safety, and the Catholic claims, which ought to have been admitted immediately after the Union, were granted in 1829. History.

The chief opponents of the Union were the Orange party in Ireland, who had been, and hoped to remain, in the ascendant; the Roman Catholics generally acquiesced in the arrangement, feeling that it would break up or at least diminish the power of the Protestant aristocracy. The first public attempt to put in question the repeal of the legislative Union between Great Britain and Ireland was made by the High Tory corporation of Dublin in 1810; the subject was afterwards debated in the House of Commons in 1822; and two years later Lord Cloncurry recommended the Catholics to join the Protestants on the Repeal question. The great leader of the Roman Catholic or national party having been re-elected for the county of Clare after the passing of the Relief Act, took his seat in the House of Commons, and surprised his opponents, who had supposed him to possess only the talents of a vulgar demagogue, by exhibiting his capacity to cope with the best parliamentary orators. To keep alive the spirit and activity of his followers, and coerce the government into granting measures of amelioration, O'Connell proclaimed, in the first year of his admission to a seat in parliament, that a repeal of the legislative Union was the only means of obtaining justice for Ireland, and systematically maintained the position which from first to last he had no serious thought of realizing. The Repeal Association followed the Catholic Association, and, in conjunction with the anti-tithe agitation, this new element of discord raised a storm so potent that it was with difficulty O'Connell could keep it within bounds, and the government was compelled to obtain additional powers by means of the Coercion Bill which passed the House of Commons, and was enforced by the Marquis of Anglesey, then lord-lieutenant of Ireland.

With a population approaching 8,000,000 in number, of which little more than 10 per cent. were members of the Established Church, every parish in Ireland was provided with a clergyman of that persuasion, supported by tithes received from the farmers who were almost universally Roman Catholics, the amount payable being ascertained by tithe proctors, who walked over the fields and valued the crops for that purpose. In 1823 compositions for tithe were authorized by statutable enactment, but few had taken advantage of the provisions of the act, and during the Reform Bill agitation the Roman Catholics pressed forward the anti-tithe movement. In 1830, Earl Grey, who had succeeded the Duke of Wellington, having promised a bill in parliament for the settlement of the tithe question, the resistance to further payment of tithe became general until 1832, when Lord Stanley introduced the Tithe Composition Bill. The Church Temporalities Act, which originally contained the famous *Appropriation Clause*, reduced the number of bishoprics, and transferred the revenues of the suppressed sees to the Board of Ecclesiastical Commissioners; and in 1838 compositions for tithe were abolished, fixed payments, or rent charges (consisting of three-fourths of the amount of the former composition), to be paid by the landlords, being substituted.

When parliamentary reform took place in 1832, Ireland acquired the privilege of sending five additional members to the Imperial Parliament, the qualification for voters in the counties of cities and towns was raised, and the franchise in other respects assimilated to that of the counties in which the rights of the 40s. freeholders had been taken away by the Catholic Emancipation Act. In the next year a commis-

History. sion was appointed to inquire into the state of the municipal corporations of Ireland. The abolition of the penal laws, and the establishment of the right of Catholics to sit in Parliament had not procured their admission into offices under the municipal corporations, all of which were exclusively under the control of Protestants; but the many abuses and restrictions which were found to exist in those bodies were remedied, or removed, by the Municipal Reform Act of 1840.

In 1836 the police system, originated in 1814 by Sir Robert Peel, when chief secretary for Ireland, was perfected by the consolidation of the law and complete establishment of the efficient constabulary force, which, disseminated in small bodies throughout the country, is the theme of general admiration for its efficiency and intelligence.

Second in importance only to the establishment of police for the security of order and property, is the foundation of a system of national education which was laid in 1833, and supported by grants of public money, for the education of the poor without distinction of religious creed. The system has so grown in extent and utility, that it must greatly contribute during the next half century to the rapid spread of civilization throughout the country.

Notwithstanding the numerous institutions for the relief of the poor, and the extent of private benevolence, the amount of pauperism existing in Ireland had become such that it was necessary, for the sake of policy as well as of humanity, to provide, by legislative enactment, for the support of the aged, impotent, and infirm poor. A commission appointed in 1836 to inquire into their condition, recommended that relief should be given only to the impotent; and in 1838 an act was passed authorising relief under strict limitations, but was gradually extended in the course of time, until in 1847 the right of the destitute poor to relief was established in consequence of the famine which had resulted from the continued failure of the potato crop.

After the return of Lord Melbourne as premier in 1835, the Government maintained for some time a good understanding with O'Connell, who established the Precursor Society to obtain "equality with England under the Union;" but the continued opposition of the House of Lords to the Municipal Reform Bill for Ireland, and the recall of the Marquis of Normanby from the lord-lieutenancy in 1839, induced O'Connell to infuse new vigour into the Repeal movement, and establish the "Loyal National Repeal Association." The ministry of Sir Robert Peel succeeded that of Lord Melbourne in 1841, and the Repeal Association was reorganized. The year 1843, denominated the Repeal year, was remarkable for what were known as monster meetings, commencing at Trim in the month of March, and ending at Mullaghmast on the 1st of October. Another meeting was to have been held on Sunday, the 8th of October, at Clontarf, but the Government took measures by proclamation and otherwise to prevent the assemblage of the people. O'Connell, upon understanding the determination of the Government, successfully used his authority to keep his followers away, and no monster meetings were afterwards attempted.

In January 1844 the state prosecutions against the agitator and his colleagues commenced, and resulted in the condemnation of the accused, who were sentenced to a short term of imprisonment. They were confined in Richmond bridewell, but on appeal to the House of Lords, the judgment of the Irish Court of Queen's Bench was reversed and their prison doors opened. History.

The Repeal question was one in which O'Connell had little hope, and his followers had much faith. The events of the last few years, when O'Connell had been carried beyond his judgment, had rendered him somewhat timid and doubtful of the result. He never again prosecuted the cause with the same vigour as heretofore. The people became indifferent to him, his health failed, and famine desolated the land. Early in 1847 O'Connell left Ireland for the last time, and, after a gradual decay, died at Genoa of disease of the brain.

Previous to the decease of O'Connell the influence of the young Ireland party had increased among the masses of the people, and in 1846 they formed a separate body, under the title of the "Irish Confederation." On the breaking out of the French revolution, early in 1848, the confederation transgressed all the bounds of moderation, sent a deputation to the Provisional Government of France, requesting aid on behalf of the "oppressed nationality of Ireland," and organised plans of insurrection. The Government allowed the rebellion, if such it could be called, to attain its full proportions, when, after much excitement, it was terminated by the arrest of Mr Smith O'Brien, who had incautiously appeared at the head of a small body of insurgents at Ballingarry, in the county of Tipperary. Mr Smith O'Brien and others were tried for high treason, and found guilty, but the sentence of death was commuted to transportation for life. In 1856, such of the convicts as had not broken their parole received their freedom from the Government.

Notwithstanding the various important ameliorations which had taken place in legislation on Irish affairs, it may be doubted whether any efforts of the Government, or of the people themselves, would have been sufficient to produce that improvement in the condition of the country which is now in progress, unless accompanied by provision for the removal of the surplus population which undoubtedly existed.

The will of Providence solved the difficulty. In 1846 the food upon which alone the great body of the people had been reduced to depend for subsistence failed, not for the first time, but more extensively than on any former occasion. The struggle now was not for emancipation, the abolition of tithes, or the repeal of the Union, but for life; and the utmost efforts of the Government, represented by the Board of Works, the Poor Law-Commission, and the two Relief Commissions, were exerted. The result of this "the greatest attempt ever made to grapple with famine over a whole country," was the preservation of the great body of the labouring population. Many, however, perished from want, and more from its effects; while the emigration which had previously commenced more than doubled in extent, and has assisted continuously since that period to reduce the population of Ireland from 8,175,124, which it numbered in 1841, to its present population of not more than 6,000,000. This reduction of the numbers or the people to a proportion more in accordance with the means of subsistence, and the demand for labour, in addition to the removal of all just causes of discontent, and the assimilation of rights and privileges to those enjoyed by other portions of the empire, will go far to render the political history of Ireland for the future identical with that of the remainder of the United Kingdom.

STATISTICS OF IRELAND.

Statistics. Ireland is an island, rhomboidal in shape, placed at the eastern extremity of the Atlantic Ocean, which washes its northern, western, and southern shores, while its eastern coast is separated from the adjacent island of Great Britain by the Northern Channel, which at one point is only 13½ miles wide, the Irish Sea about 130 miles in width, and St George's Channel, which is 69 miles wide between Dublin and Holyhead, and somewhat less at its southern extremity. Its geographical position is between N. Lat. 51. 26. and 55. 21., and W. Long. 5. 20. and 10. 26, comprising therefore 3. 55. of Lat., and 5. 6. of Long.—the degrees of latitude being the same as those under which are situated the dissimilar climates of Berlin, Hamburg, Rotterdam, Leipzig, Warsaw, part of Hudson's Bay, the Straits of Belleisle, and Petropaulowski, in Kamtschatka, which latter is nearly under the same parallel of latitude as Wicklow. The largest diagonal line that can be drawn within the island, viz., from Tor Head, in Antrim, to Mizen Head, in Cork, measures 302 miles; and the shorter, from Carnsore in Wexford, to Erris Head in Mayo, is 210 miles in length. The breadth of the country from Dundalk to Ballyshannon is 85 miles; from Dublin to the head of Galway Bay 110 miles; and the indentations of the coast by harbours, arms of the sea, and mouths of rivers are so numerous, that scarcely an acre of land in the country is more than 50 miles from the sea, or good navigation. The territorial divisions, and the acreable extent of Ireland, which, next to Great Britain, is the largest island in Europe, appear in the following table :— Statistics.

Territorial Divisions.				Acreable Extent, *According to the Ordnance Survey and Census Report,*						Annual amount of Griffith's Valuation.
Provinces.	Counties, and Counties of Cities and Towns.[1]	No. of Baronies.	No. of Parishes.	Of Arable Land.	Of Uncultivated Land.	Of Plantations.	Of Towns and Villages.	Of Water.	Total Area.	
										L.
Leinster.	1. Carlow	7	47	184,059	31,249	4,927	602	505	221,342	163,514
	2. Dublin	10	99	196,063	19,312	5,519	5,519	...	225,413	533,616
	City	...	...	...	...	...	...	...	...	594,886
	3. Kildare	14	116	356,787	51,854	8,288	490	1,017	418,436	313,494
	4. Kilkenny	11	140	470,102	21,126	13,899	1,549	3,056	509,732	343,445
	City	...	...	...	...	...	...	...	...	19,631
	5. King's	12	51	337,256	145,836	8,258	902	1,733	493,985	233,741
	6. Longford	6	26	191,823	58,937	4,610	364	13,675	269,409	150,785
	7. Louth	6	64	178,972	15,603	5,318	1,200	813	201,434	210,119
	Drogheda Town	...	...	...	...	...	...	...	...	20,238
	8. Meath	18	146	547,391	16,033	12,767	464	3,244	579,899	540,998
	9. Queen's	11	53	342,422	69,289	11,630	1,117	396	424,854	244,517
	10. Westmeath	12	63	365,218	56,392	8,803	628	22,427	453,468	306,803
	11. Wexford	9	144	510,702	45,501	14,325	2,392	3,668	576,588	377,835
	12. Wicklow	8	59	280,393	200,754	17,600	341	1,090	500,178	251,791
	Total	124	1,008	3,961,188	731,886	115,944	15,569	51,624	4,876,211	4,305,413
Munster.	1. Clare	11	80	455,009	296,033	8,304	728	67,920	827,994	313,801
	2. Cork	23	251	1,308,882	465,889	52,180	6,515	12,867	1,846,333	1,024,434
	City	...	...	...	...	...	...	...	...	124,834
	3. Kerry	8	87	414,614	726,775	11,169	807	32,761	1,186,126	275,971
	4. Limerick	13	131	526,876	121,101	11,575	2,759	18,531	680,842	455,536
	City	...	...	...	...	...	...	...	...	63,770
	5. Tipperary	12	193	843,387	178,183	23,779	2,359	13,523	1,061,731	671,252
	6. Waterford	8	82	325,345	105,496	23,408	1,525	5,779	461,553	277,949
	City	...	...	...	...	...	...	...	...	39,630
	Total	75	824	3,874,613	1,893,477	130,415	14,693	151,381	6,064,579	3,247,177
Ulster.	1. Antrim	15	75	515,771	180,423	10,358	2,037	53,288	761,877	474,36
	Car.-Fergus Town	...	...	...	...	...	...	...	...	13,521
	2. Armagh	8	28	265,243	35,117	8,996	778	17,042	328,076	241,908
	3. Cavan	8	36	375,473	71,918	7,325	502	22,142	477,360	250,726
	4. Donegal	6	51	393,191	769,587	7,079	479	23,107	1,193,443	225,049
	5. Down	10	70	514,180	78,317	14,355	2,211	3,432	612,495	455,697
	6. Fermanah	8	23	289,228	114,847	6,155	210	46,755	457,195	170,668
	7. Londonderry	6	43	318,282	180,709	7,718	1,559	10,327	518,595	220,430
	8. Monaghan	5	23	225,885	21,585	5,816	304	6,167	319,757	203,348
	9. Tyrone	4	42	450,286	311,867	11,981	710	31,796	806,640	277,556
	Total	70	391	3,407,539	1,764,370	79,783	8,790	214,956	5,475,488	2,533,265
Connaught.	1. Galway	18	120	742,805	708,000	23,718	1,801	90,030	1,566,354	426,626
	Town	...	...	...	...	...	...	...	...	26,658
	2. Leitrim	5	17	249,350	115,869	3,396	...	23,748	392,363	120,920
	3. Mayo	9	73	497,587	800,111	8,350	848	56,976	1,363,882	299,852
	4. Roscommon	9	58	440,522	130,299	6,732	768	29,370	607,691	289,011
	5. Sligo	6	41	290,696	151,723	6,134	460	12,740	461,753	190,653
	Total	47	309	2,220,960	1,906,002	48 340	3,877	212,864	4,392,043	1,353,720
	Total Ireland.	316	2,532	13,464,300	6,29 ,735	374,482	42,929	630,825	20,808,271	11,439,575

[1] The area of cities and towns is included in that of the counties to which they belong.

Statistics.

Giraldus Cambrensis, who was twice in Ireland, and collected materials for a topography of the island, reports favourably of the climate:—"Nec terrarum temperatissima, nec Cancri calor exæstuans compellit ad umbras, nec ad focos Capricorni rigor invitat, aeris amænitate temperieque tempora fere cuncta tepescunt;" and so it remains a country of mild winters and cool summers, temperate to a degree equal to that of any other country on the face of the globe. "The general temperature, in the vicinity of the capital, is somewhat lower than the 50th degree of Fahrenheit's thermometer, and a mean of the hottest or coldest months of the year rarely varies more than 10° from the standard heat; winter, therefore, is usually accompanied by a temperature of 40°; spring and autumn of 50°; and summer of 60°; and the general heat of any single month of these seasons seldom varies very much from the corresponding temperature of the particular season to which it belongs. Of these limits, the lowest is not sufficiently cold to check the natural herbage of the island, nor the highest sufficiently powerful to parch the surface of a moist soil, or to scorch its luxuriant grasses. Hence, the fields maintain a perpetual verdure, unimpaired by either solstice; the farmer is enabled to lay his lands under grass at almost every season, even at the commencement of winter, and the grazier never loses the benefit of his rich pastures at any period of the year, unless during the passage of a temporary drift of snow; so that horses, cattle, and sheep, attain, with little care, to a degree of perfection which they seldom acquire in other countries, without great care and expense."[1] "The worst circumstance of the climate of Ireland," says Arthur Young, "is the constant moisture without rain. Wet a piece of leather, and lay it in a room where there is neither sun nor fire, and it will not in summer even be dry in a month. I have known gentlemen in Ireland deny their climate being moister than England; but if they have eyes, let them open them, and see the verdure that clothes their rocks, and compare it with ours in England, where rocky soils are of russet brown, however sweet the food for sheep. Does not their island lie more exposed to the great Atlantic? and does not the west wind blow three-fourths of the year?" This humidity of the climate is owing more to the frequency of showers and cloudy weather, than to the quantity of rain which has been observed in the undermentioned localities to be as follows:—

Locality.	Observer.	Quantity.	Aver. of years.
Dublin.	Apjohn.	30·87	6
Belfast.	Portlock.	34·96	6
Castlecomer.	Aher.	37·80	18
Cork.	Smith.	40·20	6
Cork.	Royal Inst.	36·03	6
Derry.	Sampson.	31·12	7

Sir Robert Kane estimates the average annual fall of rain at 36 inches; but in so variable a climate thorough accuracy can only be obtained by observations made in numerous localities, and extending over considerable periods of time. So much, however, is certain—that the climate of Ireland is variable in detail—very mild and equable in temperature—that prolonged frosts and violent thunderstorms are of rare occurrence—and that the prevailing winds are those from the Atlantic Ocean, the S.W., W., and N.W., with a predominance during the early part of the year of the S.E. winds. So far as the human constitution is concerned, the climate of Ireland must be accounted extremely wholesome. "The greater prevalence of fevers and dysentery in Ireland, although partly attributable to the humidity of the atmosphere, in connection with marsh exhalations, is mainly owing to other causes; more especially to very poor and often unwholesome diet, to famine, to imperfect clothing, to sleeping on the earthen floors of the cabins, to neglect of personal and domestic cleanliness, and to various circumstances which associate themselves with the oppression, ignorance, and bigotry to which the lowest classes are subjected, and with the imperfect civilization to which they have as yet, in many places, attained. The very remarkable difference in moral constitutions, in temperament, and even in physical conformation, among the natives of the kingdoms, and especially between those of Ireland and Great Britain, cannot be explained by any appreciable differences of the climate or soil; they must, therefore, be referred, and are clearly indeed attributable, to other sources."[2]

Statistics.

The general surface of the country is a plain, not altogether level, but interspersed with low hills, rising towards the sea-coast into mountain ranges, which present a difference of geological structure of the most decided character, consisting mainly of the older or primitive rocks, while the great central plain is formed of calcareous strata. Were this great limestone plain sunk a second time beneath the waters, it would form a vast lake interspersed with islands, surrounded by the maritime counties, and communicating with the sea in the counties of Dublin, Galway, and the north of Clare. Next to the carboniferous limestone, which prevails so extensively, the principal rocks are granite, mica-slate, clay-slate, old red sandstone, yellow sandstone, and quartz. Granite is found chiefly in Wicklow, Galway, Down, and Donegal, and occasionally, but only in small quantities, in some other counties; in the granite districts are found the chief mines of lead, and some other minerals. Mica-slate forms the chief portion of Derry and Tyrone; it also appears extensively in Donegal, Galway, and Mayo. Clay-slate composes the greater part of the counties of Wexford, Louth, Down, Waterford, Cork, and Kerry, and smaller sections of other counties; this formation contains an important portion of the mineral wealth of Ireland. A considerable portion of the county of Cork is constituted of the old red sandstone formation.

Several coal-fields exist in Ireland resting on a limestone basis. In Ulster, the district of Coal Island, in the county of Tyrone, produces coal of good quality, extensively used in the neighbourhood; the small coal-field at Ballycastle, in Antrim, is of no economical importance. The province of Connaught affords beds of coal in Leitrim, Roscommon, and Sligo, but rarely exceeding three or four inches in thickness. The Munster coal-fields are in the counties of Cork, Kerry, and Limerick. The chief coal district, however, is that of Leinster, in Carlow, Kilkenny, and the Queen's County. This coal, as well as that of the Munster district, is anthracitous; that of Connaught is bituminous. The native coal is only used in the districts where it is raised, and neither the quantity nor the quality has been found such as to interfere with the importation of coal from Great Britain, which probably exceeds one million of tons annually.

More notable in Ireland are the unstratified igneous rocks, of which many varieties are found. Trap rocks exist in various parts of the country, but more especially in Antrim, where they are found in great variety. The basaltic columns of Fairhead and the Giant's Causeway form one of the most interesting geological districts in the British Empire. The trap-rocks often repose on the indurated chalk of Antrim, especially in Rathlin Island and at Cushendole. At the latter place, beds of trap and the chalk alternate. Of quartz rock, the chief development in Ireland is in Mayo and Donegal; it appears also in the peninsula of Howth and Dublin, the summits of the Sugar-Loaf Mountains, and Bray Head, in Wicklow, and in the district of Forth, in Wexford. No tertiary formation has been discovered in Ireland, except the clays containing lignite or wood-coal on the southern shore of Lough Neagh.

The elevation of the surface of Ireland is stated in the following table from the Land Tenure Commissioners' Map:—

		Square miles.
Between sea level and 250 feet in height		13,242¾
...	250 and 500	11,797¼
...	500 and 1000	5,797¼
...	1000 and 2000	1,589⅝
Above	2000 feet in height	82¼
		32,509⅝

The highest peaks in the chief mountain-groups are:—

Carntual, M'Gillicuddy's Reeks, Co. Kerry	3,414
Lugnaquilla, Wicklow	3,039
Slieve Donard, Mourne Mountains, Co. Down	2,796
Mulrea, Co. Mayo	2,688
Comeragh, Co. Waterford	2,597
Errigal, Co. Donegal	2,462
Trostan, Co. Antrim	1,810

The principal mountains in the S. are the Galtees, Bockra, &c., which range from 1500 to 3000 feet in height; and in the

[1] Hamilton on the *Climate of Ireland* (*Transactions of the Royal Irish Academy*, vol. vi.)
[2] M'Culloch's *Account of the British Empire*.

Statistics.

N. the Cuilcagh and Sperrin mountains, rising from 2188 to 2238 feet.

If the possession of numerous fine bays and harbours made a country great as a commercial and maritime power, Ireland would be second to none in Europe. Pre-eminent even in Ireland is the magnificent harbour of Cork, securely landlocked, protected by strong batteries, and used as the only naval station on the Irish coast. Baltimore harbour, Skull, Cape Clear, Crookhaven, Dunmanus and Bantry Bay, are all of sufficient depth and capacity for large vessels. On the western coast are Berehaven, Kenmare River, Valentia, Ventry, Smerwick, Brandon Bay, the estuary of the Shannon, Galway Bay, Roundstone Bay, Ardbear or Clifden, Ballynakill and Killery harbours, Clew, Blackrod, and Killala bays, with many others of less importance. On the northern coast are Milroy harbour, and the fine gulfs of Lough Swilly and Lough Foyle. The eastern coast has been less favoured by nature, and furnishes only one bay, with sufficient depth of water for the largest vessels, that of Strangford. The Bay of Dublin, which is much exposed, contains the fine artificial harbour of Kingstown. Belfast, Newry, Drogheda, Wicklow, Arklow, and Wexford, have all been converted into ports, but are naturally deficient in the requisites for good harbours. Between Wexford and Cork is the fine estuary of Waterford, formed by the confluence of the rivers Suir, Nore, and Barrow. Altogether, Ireland possesses 14 harbours for the largest ships, 17 for frigates, from 30 to 40 for merchant vessels, with many good summer roadsteads, and an infinity of small harbours for fishing boats.

The islands off the coasts of Ireland are numerous, but generally of small size; the largest are Rathlin and Tory in the N.; Achill, Clare, the South Arran Islands, and Valentia, in the W.; and Whiddy and Cape Clear in the S.

The lakes in Ireland are numerous. Lough Neagh, in Ulster, is the largest inland lake in the United Kingdom, and is only exceeded in Europe by Lake Ladoga in Russia, Lake Vener in Sweden, and the Lake of Geneva. According to the Ordnance Survey it covers 98,255 statute acres. The River Bann passing through it affords the means of lowering its surface, which is 48 feet above the sea at low water; but as its deepest part is beneath the level of low water, total drainage would be impracticable. Tradition states that it was once dry land, and that the tops of buildings may at times be seen in it,—a legend which has been made use of by Moore in one of his melodies. Lough Neagh contains but one islet, Ram Island, remarkable only for a round tower, and as contributing to break the sameness of the surface of the lake, which, being surrounded by shores almost as level as itself, and generally bare of wood, has little or none of the picturesque beauty which renders Lough Erne and Killarney so delightful. Its vicinity to the five counties of Ulster, Antrim, Down, Armagh, Tyrone, and Londonderry, each of which its waters touch, presents great advantages for internal trade by inland navigation; steam-vessels have been placed upon the lake, and, in conjunction with Coal Island, Newry, Ulster, and Lagan canals, Lough Neagh, with its 100 miles of coast, promises to increase in importance as a centre of internal traffic. Lough Erne, the next in size, lies wholly within the county of Fermanagh. Its total length is upwards of 40 miles, but its greatest breadth is not more than 8. Strictly speaking, it consists of two lakes, about 5 miles apart; the more inland measuring about 14 miles in length, and that nearer the sea 25. They are connected with each other by a fine river flowing from the upper or southern, into the lower or northern lake. On an island formed by the division of this river into two branches, the chief part of the town of Enniskillen is built. The upper lake covers 9278 statute acres, and contains above 90 islands; the lower and larger lake contains nearly 28,000 statute acres and numerous islets. Its coasts are studded with numerous seats and villas of much beauty. Lough Corrib and Lough Mask, in the west of Connaught, are separated from each other by an isthmus not more than 3 miles broad. The former of these lakes covers an area of 43,484 acres, and the latter 22,219. It discharges its waters into Galway Bay by a short but broad and rapid river, which skirts the town of Galway. Its level is but 14 feet above that of the sea, and works have long been in progress to connect the navigation of the bay with that of the two great lakes above it. Means of connecting them by water communication has not yet been effected. Farther north, and about 3 miles from Ballina, is the narrow lake of Lough Conn, 12 miles long. The lakes of Killarney, in Kerry, have long been celebrated for their picturesque scenery. They are small as compared with the larger lakes of Ireland; the lower lake covers 5001 acres, the middle lake 680 acres, and the upper lake only 430 acres. Lough Derg, in the south of Donegal, is small, but of great celebrity from an islet in it called St Patrick's Purgatory, which has been resorted to from time immemorial as a place of penance by pilgrims of the Roman Catholic persuasion. This lake is not to be confounded with the great Lough Dearg lying on the course of the Shannon, which contains 29,570 acres. Lough Gill, in Sligo, Lough Shellin to the north of Meath, and Lough Oughter, in Cavan, are also worthy of notice for their scenic beauties. There are many other lakes of small size in most parts of Ireland, but chiefly in the counties of Cavan, Westmeath, and Longford.

Statistics.

Ireland contains not only the largest lake, but also the largest river in the United Kingdom—the Shannon, which, rising in the mountains on the confines of Fermanagh and Leitrim, flows through Lough Allen, and thence in a south-western direction, separating Connaught from Leinster, till, arriving at Limerick, it turns westward, and discharges itself into the Atlantic, through a fine estuary, which, at its entrance between the capes of Loophead and Kerryhead, is 8 miles wide. It is navigable for large vessels to Limerick, and for vessels of small tonnage to within 5 miles of its source in Lough Allen. Its centre length measures 240 miles, and in consequence of the small amount of its fall, which does not exceed 150 feet, its current is very slow and often imperceptible. During its passage from Lough Allen to Limerick it expands into the large lakes of Lough Reagh, 15 miles, and Lough Dearg, 21 miles, in length, and studded with numerous islets. The Blackwater rises near Charleville, and, flowing south-eastwards, discharges itself into the Atlantic at Youghal, after forming the boundary between the counties of Cork and Waterford. Between the latter county and that of Wexford is the estuary of the Suir, the Nore, and the Barrow, all of which have their sources not far from each other in the central range of the Slievebloom Mountains; and, after diverging so that their streams enrich a great portion of the provinces of Leinster and Munster, unite again near the city of Waterford. The Slaney rises in the mountains of Wicklow, and empties itself into St George's Channel at Wexford. The Boyne, famous for its historical recollections as well as for its natural advantages, has its sources in the central elevated plain of Leinster, and, flowing north-eastwards, falls into the Irish Sea at Drogheda. The Bann rises in the Mourne Mountains, flows northwards through Lough Neagh, and, after separating the counties of Londonderry and Antrim, flows into the Atlantic at Coleraine. The Foyle is formed by the union of the streams of the Poe, the Mourne, the Finn, and the Derg, which, flowing from different parts of the interior of Ulster, discharge their combined waters into Lough Foyle near Londonderry. The Erne, which flows from Lough Erne, has a short but rapid course to the Atlantic westwards, and discharges its great body of waters into Donegal Bay, over a ledge of rocks rising 10 feet above the level of the ordinary tides. The other rivers, though numerous, amounting nearly to one hundred, are small, and mostly confined to the counties that give them birth. The Liffey, which rises in the mountain-land of Wicklow, and, after a circuitous course through Kildare, discharges itself into the Irish Sea, is remarkable for nothing except that the metropolitan city of Dublin is seated on its banks.

The extent of country forming the basin from whence each of the principal rivers derives its supply is as follows:—

	Sq. miles.		Sq. miles.
Shannon	4 544	Lee	735
Barrow, Nore, and Suir	3·400	Liffey	568
Galway, including Loughs Corrib and Mask	1·374	Blackwater, N.	526
Erne	1·585	Maine and Inney	511
Foyle	1·476	Feale and Galle	479
Bann and Maine	1·266	Roughty	475
Blackwater, S.	1·219	Ovoca	281
Boyne and Blackwater	1·086	Bandon	228
Moy	1·033	Lagan	227
Slaney	·815	Avonmore	200

Ireland was once so thickly covered with timber as to receive

Statistics.

the name of the Island of Woods. During the early periods of its connection with England, its extensive and impenetrable forests formed a main obstacle to the progress of the English troops. Westminster Hall is said to be roofed with oak cut in the woods of Shillelagh. Numerous trunks of large trees are constantly found in the bogs. Even in mountain tracts, devoted for a long succession of years to the pasturage of sheep, timber trees shoot up spontaneously wherever the land is secured from the intrusions of cattle. Many places, where the vestige of a plantation is not to be seen, retain names of which the word "wood" forms a component part; and in localities where the most attentive culture will not suffice to keep any tree or shrub alive on account of the western blasts, large trees are found imbedded in the bogs. The different kinds of timber found in the bogs of Ireland are confined to oak, fir, yew, holly, sallow, and birch. Two centuries ago, when Ireland was covered with forests, there were numerous small iron works, in which wood charcoal was employed, and vast quantities of wood used until the country was gradually stripped of its supply, and the working of iron was consequently abandoned. The extension of agricultural improvement, and more especially the timber act, which gives the tenant, at the expiration of his lease, a pecuniary interest in the trees he has planted, are gradually removing this defect, the consequence of ages of disturbance and desolation; but trees in large quantities are generally found in Ireland only in the vicinity of the residences of the gentry, except in some favoured spots, which are well wooded.

Ireland is reputed to contain much lead, copper, and iron, but notwithstanding many attempts to work the metallic mines discovered in the country, few have been found sufficiently productive to repay the necessary outlay of capital. Towards the close of the last century gold was discovered accidentally in the streams flowing from the mountain of Croghan Kinsela, on the confines of Wicklow and Wexford. The metal was found in lumps and small pieces down to the minutest grain. Many of the peasants having ruined themselves by leaving their proper occupations to join the search, Government, to put an end to the fruitless quest, took up the enterprise, and only relinquished it after satisfying the seekers of its worthlessness. "The gold is associated with magnetic ironstone, sometimes in masses of half a hundredweight; also iron pyrites, brown and red hematite, wolfram, manganese, and fragments of tinstone in crystals, together with quartz. From the nature of these attendant minerals, of which most are known to occur in the quartz veins of the adjacant mountain, it was hoped that by tracing up the rivulets to their sources, and laying bare in various directions the underlying rock, the metalliferous veins might be discovered, from the disintegration of which the sand and soil of the bed of the streams had been produced. All such trials proved useless, and the question as to the source from whence the gold in those streams in Wicklow has been derived, remains still unanswered."[1]

Statistics.

Copper ores are distributed throughout the clay-slate districts in a great number of localities more or less abundantly. The principal mines are those of Ballymurtagh, Conoree, Cronebane and Tigroney, and Ballygahan, in Wicklow county; the Knockmahon, Kilduane, Bonmahon, and Balinasisla, in the Waterford district; Allihies or Berehaven, Audley, and Cosheen and Skull, in the south-western district; and the mines of Hollyford and Lackamore, in the western district.

The total quantity and value of copper ore from Ireland, sold in Swansea, where it is smelted, were in—

Years.	Tons.	Value.	Years.	Tons.	Value.
1836	21,819	L.163,865	1847	14,857	L.96,330
1840	19,580	127,911	1848	12,808	82,039
1843	17,509	117,625	1849	10,425	68,794
1844	18,597	77,622	1850	10,021	69,594
1845	18,430	97,122	1851	10,577	77,713
1846	17,471	106,078	1852	12,171	104,822

The produce and value of the copper mines in Ireland for 1853–4 is shown in the following table:—

Mines.	1853. Ore.	1853. Copper.	1853. Amount.	1853. Produce.	1854. Ore.	1854. Copper.	1854. Amount.	1854. Produce.
	Tons.	Tons. cwts. qrs. lbs.	L. s. d.		Tons.	Tons. cwts. qrs. lbs.	L. s. d.	
CORK:—					...	...	...	...
Baltimore	153	7 16 1 0	716 9 0	5⅛	5,030	488 12 3 7	53,348 1 0	9 3/16
Berehaven	5,868	582 7 1 19	58,528 7 0	9 1/16	45	8 4 3 26	905 11 0	18¼
Cosheen	...	...	...	...	43	2 0 0 0	194 0 0	...
Crookhaven	...	...	...	...	67	5 13 0 22	617 19 0	8 1/16
Glandore	...	...	...	...	62	4 14 3 16	344 6 0	7⅞
South Cork	...	...	...	...				
GALWAY:—					...	...	...	...
Galway	54	5 2 2 5	471 15 0	9½				
TIPPERARY:—					555	97 17 0 23	10,979 4 6	17 5/16
Holyford	550	100 16 1 9	10,104 4 0	18 1/16	159	13 7 2 20	1,423 18 6	8 3/16
Lackamore	...	...	...	...				
WATERFORD:—					4,421	434 18 0 22	53,022 13 0	10 7/16
Knockmahon	3,373	352 1 0 21	38,559 13 6	10 3/16				
WICKLOW:—					53	1 19 2 7	167 14 0	4 7/16
Ballygahan	...	...	...	...	1,237	55 12 3 6	5,763 9 0	4½
Ballymurtagh	1,326	57 13 2 21	5,724 1 6	4⅜	...	...	...	...
Conoree	40	11 0 0 4	1,088 2 0	27⅜	58	7 13 2 17	826 11 0	13¼
Cronebane	121	11 18 2 12	1,196 11 0	9⅞	9	3 18 3 20	460 2 6	37½
Tigroney	...	...	...	...				
Total	11,485	1128 16 0 7	116,389 3 0	...	11,739	1,124 13 3 18	128,053 9 6	12¼

Lead is more extensively diffused through Ireland than copper. The granitic district of Wicklow contains numerous veins; the principal are those of Glendalough, Glenmalur, Glendasane or Luganure, and Ballycorus. The clay-slate districts also yield numerous indications of this metal, but few of the mines have proved profitable. Those still worked are at Clonligg, Newtownards, and Rathmullen, in Down county; Bond and Newry, in Armagh county; Castleblayney, in Monaghan county; Kenmare, in Kerry county; Kilbricken and Ballyhickey, in Clare county; Shallee, in Limerick county; and Bantry, in Cork county. A vein at Clontarf, near Dublin, was worked until the mine was filled with water by the ingress of the sea. At Ballycorus, where the lead ores from the mines of the Mining Company of Ireland are smelted, the quantities of ore worked up in 1851 from Luganure mines was 674 tons, which produced 460 tons of lead, equal to nearly 69 per cent. The proportions of silver to a ton of lead are generally found to be,—from the mine of Luganure, 8 oz.; Caime, 12 oz.; Ballyhickey, 15 oz.; Shallee, 25 oz.; Kilbricken, 120 oz.; Tollyratty, near Strangford, 10 oz. The average of silver extracted from the lead ore raised by the Mining Company of Ireland in 1851, was 7 oz. to the ton of lead; the total quantity 3860 oz.; producing L.1029, 6s. 8d. The working of the principal lead mines in Ireland for 1853–4 is shown in the following table:—

[1] Sir R. Kane's *Industrial Resources of Ireland.*

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County.	Mines.	1853. Ore. Tons.	Cwts.	Lead. Tons.	Cwts.	Silver. Ozs.	1854. Ore. Tons.	Cwts.	Lead. Tons.	Cwts.	Silver. Ozs.
Clare	Annaglough	100	0	77	10	...	67	10	51	0	...
,,	Kilbricken	31	10	22	10	2,416	98	0	70	0	6,650
,,	Miltown	10	0	8	0	296	...		...		...
Down	Newtownards	1,606	0	1,270	0	...	1,379	0	1,084	0	...
,,	Strangford	40	0	31	0	...	...		...		...
Louth	Dundalk	26	0	16	0	...	39	0	29	0	...
,,	Lanbrynmair	...		...		...	15	15	12	0	91
Limerick	Shallee	282	0	180	0	7,020	142	0	95	0	3,420
Tipperary	Gurtnadyne	220	0	154	0	3,280	213	10	145	0	2,900
Wicklow	Ballygoneen	...		...		...	20	0	14	10	65
,,	Luganure	909	0	636	7	4,287	1,095	0	710	0	4,970
,,	Wicklow	85	0	57	0	365	...		...		...
	Total	3,309	10	2,452	7	17,664	3,069	15	2,210	15	18,096

Statistics.

Native silver was found in a bed of iron ochre in Cronebane, but the deposit has been long since exhausted. Sulphuret of silver was found in the lead ore at Ballycorus some years since, and the Mining Company of Ireland have resumed operations to prove this valuable discovery. Tinstone has been found in the auriferous soil of Wicklow, but no veins or workable deposits have been discovered. Other minerals, useful in manufactures and the arts, and found in quantities in various parts of the country, are manganese, antimony, zinc, nickel, iron pyrites, alum, clays of various kinds, building stone, marble, flags, and roofing slates. Mineral springs, chiefly chalybeate, are numerous in many parts of the country. Those of chief note for their medicinal qualities are at Mallow, in Cork, resembling the hot wells of Bristol; Ballynahinch, in Down; Swanlinbar, in Cavan; Castleconnel, near Limerick; and Lucan, near Dublin.

Bogs

The bogs are chiefly found in the elevated central district. Two lines drawn across the island, the one from Howth to Sligo, the other from Wicklow to Galway, will comprehend by much the greater portion of bog throughout the island. This division is traversed by the Shannon from north to south and then divided into two parts, that to the westward of the river containing more than double the extent of the bogs which are to be found in the division to the eastward. "Most of the bogs which lie to the eastward of the Shannon, and which occupy a considerable portion of the King's county and the county of Kildare, are generally known by the name of the Bog of Allen; it must not, however, be supposed that this name is applied to any one great morass; on the contrary, the bogs to which it is applied are perfectly distinct from each other, often separated by high ridges of dry country, and inclining towards different rivers as their natural directions for drainage, and so intersected by dry and cultivated land, that it may be affirmed generally there is no spot of these bogs to the eastward of the Shannon so much as two Irish miles distant from the upland and cultivated districts. The total quantity, independently of small mountainous and detached patches, has been thus estimated:—

Flat red bog, capable of being reclaimed.....1,576,000 acres.
Mountain bog, mostly convertible into pasturage.....1,255,000

Total.....2,831,000

The bogs are distinguished, according to their substance, into red or fibrous, and black or compact. The former, which consists chiefly of the *Sphagnum palustre*, or bog-moss, is the most general. Its colour is of a reddish brown, approaching when dry to that of an olive. Its surface is generally covered with heath, which gives it a still darker hue. The black bog varies in colour from dark brown to perfect black; in which latter case it is extremely hard and close grained, separating, when broken, into angular fragments. On cutting downwards, the substance grows denser and darker, exhibiting a black mass very compact, strongly resembling pitch or coal, and when ignited emitting a smell so offensive as to prevent its general use as an article of fuel. The peat is found to rest on a blue clay, and ultimately on limestone gravel. The depth of the bogs in some places is nearly forty feet; twenty-five may be considered as a general average. In all cases they are found above the level of the sea. The greatest height of any is 488 feet, the least 25; and in all cases they might easily be connected with some river by which their superfluous waters can be carried off, where draining is requisite for reclaiming them.

Population.

Previously to the calculations made by Sir William Petty scarcely any data existed even for a probable or conjectural estimate of the number of the inhabitants of Ireland; ideas upon the subject were necessarily confused, and the statements found in books and writings differed greatly from each other. The marks of the plough observable on the tops of hills which have for many years been devoted to pasture only, have been adduced as a proof that the superabundant population of former ages compelled the farmers to have recourse to the poorer ground there to raise a sufficiency of grain; but the fact has been imputed, with equal show of probability, to the disturbed state of the country, when a ferocious enemy, having desolated and possessed the more fertile lands in the plains, compelled the natives to have recourse to the poorer soils on the hills. It has also been attributed by some to the superior mildness of the climate in ancient times. The opinion of Agricola, quoted by Tacitus, that a single legion would be sufficient to conquer the island, does not indicate a very numerous population at that period; and, subsequently, the smallness of the force with which Henry II. held possession of the country favours the same conclusion. After the close of the desolating wars of Elizabeth, in which the Irish in arms were generally exterminated as rebels, Fynes Moryson, Lord Mountjoy's secretary, asserts that not more than five or six hundred thousand escaped the edge of the sword or the horrors of famine. Sir William Petty's first estimate, as stated in the ensuing table, rests upon conjecture; his second is founded on the number of "smokes" or hearths in the country. Those given by the tax-collectors are founded on data of the same description, corrected in the work of Mr Bushe by collateral calculations. The returns of the established clergy were made at a time in which much of the country was without a resident clergy of this persuasion, and therefore must be of doubtful value. De Burgho's estimate formed from information collected through the Catholic clergy, then in a state of the lowest political degradation, must be equally dubious. Newenham formed his from a great variety of ingenious calculations on the quantity of food, exports, and imports, &c. The first of the parliamentary inquiries was a total failure, several counties having declined to make any return, and those of several others being very inaccurate. The second, which ascertained not only the number of the people, but the name, age, occupation, and degree of mutual relationship, of every individual, may be considered as approximating very closely to accuracy. In the third, which might be presumed to be an improvement on the preceding, the returns of the enumerators employed were not subjected to any effectual check, and therefore little reliance can be placed on some of its statements. The return of 1834 rests on the same defective basis as that of 1831; but as it was afterwards checked and corrected by the commissioners of public instruction, through the medium of the resident clergy, its statements are entitled to more credit; but the returns of this census having been made according to the ecclesiastical arrangement of dioceses, does not admit of comparison with the other returns, which

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are divided into counties. The parliamentary census of 1841 was fortunately of great authority, and admirably executed. Taken in connexion with the remarkable movement of the population of Ireland between 1841 and 1851, the accuracy of the parliamentary returns of the numbers of the people at those two periods became of great interest and importance.

The following is the result of the different estimates and census enquiries into the number of the population of Ireland at various periods:—

Year.		Pop.
1652	Sir William Petty	850,000
1672	Ditto	1,320,000
1695	Captain South	1,034,102
1712	Thomas Dobbs	2,099,094
1718	Ditto	2,169 048
1723	Ditto	2,317,374
1726	Ditto	2,309,106
1731	Established Clergy	2,010,221
1754	Tax Collectors	2,372,634
1760	De Burgho, Hibern. Dominican	2,317,384
1767	Tax Collectors	2,544,276
1777	Ditto	2,690,556
1785	Ditto	2,845,932
1788	Gervais P. Bushe	4,040,000
1791	Tax Collectors	4,206,612
1792	Dr Beaufort	4,088,226
1805	Thomas Newenham	5,395,456
1811	Parliamentary return	5,937,856
1821	Ditto	6,801,827
1831	Ditto	7,767.401
1834	Commissioners of Public Instruction	7,943,940
1841	Parliamentary return	8,175,124
1851	Ditto	6,552,386

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Few countries in the world have increased in population so rapidly as Ireland during the first forty years of the present, and the conclusion of the last century. Arthur Young, in his *Tour through Ireland*, in 1766, observed that it everywhere evinces the marks of a rapid increase of population. It is generally supposed that the number of the people increases in the ratio of food and comforts, and that an increase of population is a convincing proof of the advancing prosperity of a nation. The effect of the failure of the potato crop in depopulating the country would show that the population of Ireland had outstripped the progress of wealth, and the increase of industry, and had reduced their wants to the lowest point without procuring an addition to the comforts of life corresponding to the increase of the population.

The following table exhibits the population of each portion of the country, according to the censuses of 1821, 1831, 1841, and 1851, together with the house accommodation at the latter period:—

Provinces, Counties, and Cities.	1821.	1831.	1841.	1851. Males.	1851. Females.	1851. Total.	Families.	Houses in 1851. Inhabited.	Uninhabited. Built.	Uninhabited. Building.	Houses in 1851. Total.	Provinces, Counties, and Cities.
Leinster.												**Leinster.**
Carlow	78.952	81.988	86,228	33,013	35,046	68,059	12,542	11,177	699	13	11,889	Carlow.
Dublin	150,011	176,012	140,047	68,071	78,660	146,731	29,285	23,618	2,238	154	26,010	Dublin.
Dublin City	185,891	204,155	232,726	119,183	139,178	258,361	57,622	22,276	1,920	121	24,317	Dublin City.
Kildare	99,065	108,424	114,488	48,504	47.184	95,688	17,488	15,834	918	41	16,823	Kildare.
Kilkenny	158,716	169,945	183,349	67,573	71,200	138,773	24,999	23,373	1,493	26	24,892	Kilkenny.
Kilkenny City	23,230	23,741	19,071	8,917	11,056	19,973	3,777	2,587	401	3	2,091	Kilkenny City.
King's	131,088	144.225	146,857	55,285	56,795	112,080	21,125	18,798	1,234	15	20,047	King's.
Longford	107,570	112,558	115,491	41,042	41,308	82,350	15,311	13,858	827	26	14,711	Longford.
Louth	101,011	107,481	111,979	44,308	46,504	90,812	17,821	16,503	1,403	26	17,932	Louth.
Drogheda Town	18,118	17,365	16,261	7,945	8,900	16,845	3,634	2,957	355	17	3,329	Drogheda Town.
Meath	159,183	176,826	183,823	70,815	69,935	140 750	25,678	24,044	1.239	37	25,320	Meath.
Queen's	134,275	145,851	153,930	55,543	56,080	111,623	20,937	19,185	1,222	25	20,432	Queen's.
Westmeath	128,819	136,872	141,300	56,089	55,320	111,409	21,221	18,740	847	14	19,601	Westmeath.
Wexford	170,806	182,713	202,033	86,942	93,217	180,159	33,315	29,508	1,777	50	31,335	Wexford.
Wicklow	110,767	121,557	126,143	50,232	48,746	98,978	17,236	15,544	963	24	16,531	Wicklow.
Total	1,757,492	1,909,713	1,973,731	813,462	859,129	1,672,591	321,991	258,002	17,566	592	276,160	Total.
Munster.												**Munster.**
Clare	208,089	258.322	286.394	103,931	108,497	212,428	36,686	31,428	1,685	45	33,158	Clare.
Cork	629,786	703,716	773,398	278.858	284,468	563,326	96,370	84,188	6,732	118	91,038	Cork.
Cork City	100,658	107,016	80,720	39,052	46,693	85,745	18,230	9,419	1,043	48	10,510	Cork City.
Kerry	216,185	263,126	293,880	116,492	121,747	238,239	37.776	33,704	1,883	77	35,664	Kerry.
Limerick	218,432	248.801	281,638	103,304	105,384	208,688	35,068	30,819	1,697	46	32,562	Limerick.
Limerick City	59,045	66,554	48,391	24.083	29,365	53,448	9,966	5,565	905	16	6,486	Limerick City.
Tipperary	346.896	402,563	435,553	159.961	171,526	331,487	57,210	48,566	3,261	81	51,908	Tipperary.
Waterford	127,842	148,233	172,971	67,719	71,035	138,754	23,391	20,189	1,442	35	21,666	Waterford.
Waterford City	28,679	28,821	23,216	11,257	14,040	25,297	5,553	3,238	712	7	3,957	Waterford City.
Total	1,935,612	2,227,152	2,396,161	904,657	952,755	1,857,412	320,250	267,116	19,360	473	286,949	Total.
Ulster.												**Ulster.**
Antrim	217.683	268,685	276,188	121,011	130,370	251,381	47,274	44,077	2,406	50	46,533	Antrim.
Belfast Town	45,177	48,224	75,308	46.847	53,453	100,300	20,553	13,806	1,131	72	15,009	Belfast Town.
Carrickfergus Dis.	8,023	8,706	9,379	3.769	4,751	8,520	1,688	1,488	180	8	1,676	Carrickfergus Dis.
Armagh	197,427	220,134	232,393	95,718	100,367	196,085	37,409	35,073	2,142	36	37,251	Armagh.
Cavan	195,076	227,933	243,158	86.610	87,461	174,071	32,088	30,050	1,450	27	31,527	Cavan.
Donegal	248,270	289,149	296,448	124 691	130,469	255,160	46,679	44,618	2,251	77	46,946	Donegal.
Down	325.410	352.012	361,446	152,769	168,048	320,817	62,471	58,429	3,982	79	62,490	Down.
Fermanagh	130,997	149,763	156,481	56 807	59.200	116,007	22,127	20,214	1,071	45	21,330	Fermanagh.
Londonderry	193,869	222,012	222,174	93,032	98,836	191,868	35,869	33,339	1,947	70	35,356	Londonderry.
Monaghan	174,697	195.536	200,442	68,824	72,989	141,813	27,557	25,742	1,553	21	27,316	Monaghan.
Tyrone	261,865	304,468	312,956	126,205	129,529	255,734	47,016	45,037	2,534	49	47,620	Tyrone.
Total	1,998,494	2,286,622	2,386,373	976,283	1,035,473	2,011,756	380,731	351,873	20,647	534	373,054	Total.
Connaught.												**Connaught.**
Galway	309,599	381,564	422,923	146.915	151,221	298,136	54,466	49.208	2,142	87	51,437	Galway.
Galway Town	27,775	33,120	17,275	10.491	13.204	23,695	4,132	2 540	237	5	2,782	Galway Town.
Leitrim	124,785	141,524	155,297	56.087	55,754	111,841	20.172	18,922	816	24	19,762	Leitrim.
Mayo	293,112	366,328	388,887	133,376	141,236	274,612	49,860	46,940	2,062	71	49,073	Mayo.
Roscommon	208,729	249,613	253,591	86,357	87,060	173,417	31,989	29,530	1,311	56	30,897	Roscommon.
Sligo	146,229	171,765	180,886	62,879	65,631	128,510	23,411	22,163	1,037	42	23,242	Sligo.
Total	1,110,229	1,343,914	1,418,859	496,105	514,106	1,010,211	184,030	169,303	7,605	285	177,193	Total.
General Total	6,801,827	7,767,401	8,175,124	3,190,507	3,361,463	6,551,970	1,207,002	1,046,294	65,178	1,884	1,113,356	General Total.

Statistics.

The chief impediment to improvement in the condition of the people of Ireland during the present century has been the redundancy of the population. In a country almost wholly dependent on the cultivation of the soil, there were in 1841 as many as 335 persons to each square mile of arable land. Perhaps, with the exception of China there was no other country in the world so densely peopled, and certainly none where the population was so disproportioned to the means of employment. This great density of population was necessarily accompanied by an extreme competition for land and employment, with the absence of all inducements to the acquirement of skill, and in consequence of the low rate of remuneration for labour and high rents, the impossibility of any accummulation of capital in the hands of the cultivators of the soil. The following table shows the density of the population in 1841, and its remarkable decrease in 1851 :—

Statistics.

Counties.	Rural Population.		No. of Persons to the square mile								
			Of Arable Land.			Of the entire Rural District.			Of the entire Area (including the Town Population.		
	1841.	1851.	1841.	1851.	Decrease between 1841-51.	1841.	1851.	Decrease between 1841-51.	1841.	1851.	Decrease between 1841-51.
Leinster.											
Carlow	72,172	53,391	251	172	79	209	155	54	249	197	52
Dublin	113,778	89,857	371	295	76	330	266	64	1·045	1·145	...
Kildare	104,090	87,319	187	155	32	159	134	25	175	146	29
Kilkenny	173,157	134,044	236	185	51	218	169	49	254	199	55
King's	130,239	99,334	247	188	59	169	129	40	190	145	45
Longford	108,117	77,072	361	253	108	257	183	74	274	196	78
Louth	96,479	78,067	345	295	50	308	249	59	394	328	66
Meath	171,726	133,094	201	157	44	190	147	43	208	160	48
Queen's	138,873	99,850	259	181	78	210	151	59	232	168	64
Westmeath	131,316	100,613	230	177	53	185	142	43	199	157	42
Wexford	173,267	148,587	217	181	36	193	166	27	224	200	24
Wicklow	117,892	90,406	269	173	96	151	116	35	161	127	34
Total	1,531,106	1,191,634	247	189	58	202	157	45	259	220	39
Munster.											
Clare	267,907	195,620	377	229	148	207	151	56	221	164	57
Cork	683,919	478,898	334	221	113	238	167	71	296	225	71
Kerry	269,406	208,153	416	216	200	145	112	33	159	129	30
Limerick	274,520	201,931	333	226	107	259	191	68	310	246	64
Tipperary	364,261	261,741	276	194	82	220	158	62	263	200	63
Waterford	149,207	119,756	293	234	59	207	167	40	272	227	45
Total	2,009,220	1,466,099	332	218	114	212	155	57	253	196	57
Ulster.											
Antrim	261,846	233,500	325	257	68	221	191	30	303	296	7
Armagh	211,893	176,051	511	417	94	414	344	70	453	383	70
Cavan	234,914	166,651	400	269	131	315	224	91	326	233	93
Donegal	290,002	250,269	472	231	241	156	134	22	159	137	22
Down	323,807	280,699	403	343	60	339	294	45	378	344	34
Fermanagh	150,795	110,098	334	209	125	211	154	57	219	162	57
Londonderry	197,622	162,368	397	293	104	245	201	44	274	237	37
Monaghan	191,301	128,966	428	288	140	383	259	124	401	284	117
Tyrone	298,498	241,105	424	287	137	237	191	46	248	203	45
Total	2,160,698	1,749,707	406	280	126	253	205	48	279	235	44
Connaught.											
Galway	403,746	277,094	348	204	144	165	113	52	180	131	49
Leitrim	155,297	111,897	398	266	132	253	182	71	253	183	70
Mayo	369,138	257,933	475	255	220	173	121	52	183	129	54
Roscommon	243,539	162,460	354	277	77	257	171	86	267	183	84
Sligo	166,915	116,885	367	251	116	231	162	69	251	178	73
Total	1,338,635	926,269	386	241	145	195	135	60	207	147	60
General Total	7,039,659	5,333,709	335	236	99	217	164	53	251	202	49

Number of Persons by Occupations in 1841 *and* 1851, *classified according as Producers, Manufacturers, and Traders.*

Occupations.	1841.	1851.
Ministering to food—		
Producers	1,854,141	1,461,776
Manufacturers	13,995	18,035
Traders	35,935	52,103
Total	1,904,071	1,531,914

Occupations.	1841.	1851.
Ministering to clothing—		
Cloth manufacturers	669,224	278,223
Leather-workers	57,833	49,900
Clothes-makers	167,998	267,225
Traders	6,269	11,184
Total	901,324	606,532

Occupations.	1841.	1851.
Ministering to lodging, &c. :—		
Workers in stone	30,204	27,177
... wood	64,086	48,195
... metal	44,197	45,083
Miscellaneous	23,786	20,749
Traders	2,093	5,265
Total	164,366	146,469
Ministering to health	6,871	7,148
... charity	253	1,898
... justice	19,541	26,862
... education	16,814	17,407
... religion	7,192	8,398
Total	50,671	61,713
Unclassified :—		
Ministering to arts	3,495	2,674
... trade	59,549	54,470
... travelling	18,975	43,743
Miscellaneous	409,409	394,208
Total	491,428	494,995
General Total	3,511,860	2,841,623

The absence of a general system of registration of births, deaths, and marriages in Ireland renders it impossible to obtain perfectly accurate information on those important subjects. To remedy the defect as far as possible, the Census Commissioners collected from the information of the people themselves a statement of the number of deaths which occurred in Ireland from the 6th June 1841 to 30th March 1851, by diseases, seasons, and localities; also the total number of deaths. The following table shows the proportions in the several provinces:—

Provinces.	Diseases.				Seasons.				Localities.			Total Number of Deaths from 6th June 1841 to 30th March 1851.
	Epidemic Diseases.	Sporadic Diseases.	Violent or Sudden Deaths.	Causes not specified.	Spring.	Summer.	Autumn.	Winter.	Civic Districts.	Rural Districts.	Public Institutions[1].	
Leinster	122,072	203,069	8,692	21,477	109,298	95,556	56,868	93,588	84,770	180,350	90,190	353,310
Munster	216,499	174,501	17,052	62,790	154,076	135,014	58,837	113,527	77,080	231,555	162,207	470,842
Ulster	105,903	163,571	9,592	31,574	103,037	77,422	45,527	84,654	40,917	206,750	62,973	310,640
Connaught	109,327	80,571	14,421	19,940	76,771	65,756	30,773	49,016	14,768	154,164	55,327	224,259
Total of Ireland	553,801	621,712	49,757	135,781	443,182	373,748	192,005	340,785	217,535	772,819	370,697	1,361,051

The statement in the foregoing table being only the number of deaths recorded by persons living in Ireland at the time of the census of 1851, fall short of the actual number which must have occurred during the ten years. The Census Commissioners estimate that, had emigration and immigration been equal, and the average number of births and deaths in England taken as the basis of the calculation, the probable number of inhabitants which would have been in Ireland on the 31st of March 1851, was 9,018,798. From the effects of famine, emigration, &c., the actual number was reduced to 6,552,386 persons, and is still in course of reduction. Assuming the same rate of increase as in the above estimate, the commissioners give the following as the probable results:—

Estimated Decrease, by Emigration, of the Irish Population from 30th March 1851 to 31st December 1855.

Years.	Population.	Estimated Number of Births.	Estimated Number of Deaths.	Increase of Pop. by excess of Births over Deaths.	Emigration from Irish Ports.[4]	Decr. of Pop., being the difference between the excess of Births and the Emigration.
1851[2].	6,552,385[3]	158,525	109,206	49,320	179,507	130,188
1852...	6,422,197	207,168	142,715	64,539	190,322	125,869
1853...	6,296,328	203,107	139,918	63,277	173,148	109,959
1854...	6,186,369	199,560	137,475	62,174	140,555	78,470
1855...	6,107,899	197,029	135,731	61,388	91,914	30,616

The number of natives of other parts of the United Kingdom and of foreigners resident in Ireland has increased. Of those born in England and Wales, there were resident in Ireland in 1841, 21,552 persons, whilst in 1851 the number was 34,454. Of natives of Scotland living in Ireland there were in 1841, 8585 persons, and 12,309 in 1851. The number of persons born in foreign countries resident in Ireland in 1841 was 4471; in 1851 it was 9583.

Together with the decrease of the poorer classes of the population a proportionate removal of their habitations has taken place. The classification of houses adopted by the Census Commissioners in 1841 and in 1851, was as follows:—"In the lowest, or fourth class, were comprised all mud cabins having only one room; in the third, a better description of cottage, still built of mud, but varying from two to four rooms and windows; in the second, a good farm-house, or in towns, a house in a small street, having from five to nine rooms and windows; and in the first, all houses of a better description than the preceding classes."

The number of houses in 1841 and 1851, according to this classification, was as follows:—

Inhabited.	In 1841.	In 1851.	Difference between 1841 and 1851. Increase.	Decrease.
1st class	40,080	50,164	10,084	...
2d class	264,184	318,758	54,574	...
3d class	533,297	541,712	8,415	...
4th class	491,278	135,589	...	355,689
Total inhabited	1,328,839	1,046,223	...	282,616
Uninhabited { Built,	52,208	65,263	13,055	...
Uninhabited { Building,	3,313	1,868	...	1,445
General Total,	1,384,360	1,113,354	Net decr. 271,006.	

It thus appears that between 1841 and 1851, 355,689 mud cabins have disappeared from Ireland, and that while there has been this decrease in the fourth class, there has been an increase in the number of the better classes of habitations—of 10,084 in the first class, 54,574 in the second class (comprising the country good farm-houses), and 8,415 in the third class (or houses containing from two to four rooms, but built of mud.)

Physical varieties.

Amongst the population of Ireland there is greater physical variety and more distinctive peculiarities than are found in other portions of the United Kingdom. The Milesian race, with black hair, brilliant dark eye, oval face, and finely moulded sinewy form, predominate in the West and South. In the East and North the Saxon race prevails with lofty brow, broad ruddy face, blue eye, clear skin, red or flaxen hair, and powerful frame. Intermingled with these races are the several varieties of the Dane, the Norman, &c. The central and mountainous districts are chiefly occupied by people of Celtic or Gaelic race, with high cheek bones, round face, gray eye, rough brown hair, dingy complexion, and muscular body of short stature. The baronies of Forth and Bargie, in the county of Wexford, which were granted in 1169 by the Irish king Dermod MacMorrogh to the Constable Harvey de Montmorency, were by him and his followers cleared of the native population and colonized with settlers from Somersetshire and Pembrokeshire whose descendants still remain a peculiar race. Mason, in his *Statistical Account*, describes the people of these baronies as

[1] There were 11,331 deaths returned from workhouses in which the season could not be stated; the summary under this head is therefore unavoidably deficient that amount.

[2] The births, deaths, and emigration for 1851, are given for nine months only, viz.,—from 1st April to 31st December.

[3] According to the census.

[4] *i.e.*, Not including Irish emigrants who had been living in other parts of the United Kingdom.

Statistics. very different in language, customs, and dress, from those in any other part of Ireland, and asserts that when he visited the district (in 1819) they spoke the language in which Chaucer wrote. In the county of Limerick, near Adare, and other parts, a colony of German Protestants, known as "The Palatines," were introduced by Lord Southwell about a century and a half ago, and are still different in character and distinct in habits from the people of the country. Ferrar the historian of Limerick observes of the Palatines, that "they preserve their language, but it is declining; they sleep between two beds; they appoint a burgomaster, to whom they appeal in all disputes. They are industrious men, and have leases from the proprietors of the land at reasonable rents; they are, consequently, better fed and clothed than the generality of Irish peasants. Besides, their modes of husbandry and crops are better than those of their neighbours. They have by degrees left off their sour-crout, and feed on potatoes, milk, butter, oaten and wheaten bread, some meat, and fowls, of which they rear many. They keep their cows housed in winter, feeding them with hay and oaten straw: their houses are remarkably clean; to which they have stables, cowhouses, a lodge for their plough, and neat kitchen-gardens. The women are very industrious, and perform many things which the Irish woman could never be prevailed on to do; besides their domestic employments and the care of their children, they reap the corn, plough the ground, and assist the men in everything. In short, the Palatines have benefited the country by increasing tillage, and are a laborious, independent people, who are mostly employed on their own small farms." Statistics.

Language. Of the entire population, amounting in 1851 to 6,552,386, there were returned to the Census Commissioners 1,524,286 persons who could speak the Irish language. Of these, 740,045 were males, and 784,241 females. By far the greater portion of these persons, however, were also able to speak the English language, as will appear from the annexed table:—

Provinces.	Number of Persons who could Speak Irish only.			Number of Persons who could Speak English and Irish.			Population in 1851.
	Males.	Females.	Total.	Males.	Females.	Total.	
Leinster	51	149	200	29,915	29,061	58,976	1,672,738
Munster	62,056	84,280	146,336	334,424	335,025	669,449	1,857,736
Ulster	14,685	21,098	35,783	51,422	49,271	100,693	2,011,881
Connaught	59,271	78,012	137,283	188,221	187,345	375,566	1,010,031
Total of Ireland	136,063	183,539	319,602	603,982	600,702	1,204,684	6,552,386

Soil. Ireland is naturally, both from soil and climate, a pastoral country, and it was not until the commencement of the last century that efforts were made to introduce an attention to tillage on an extended scale. Primate Boulter, when one of the Lords Justices, pressed strongly on the British Government the necessity of enforcing a tillage system; and for this purpose proposed a law, in 1727, to compel landholders to till five acres out of every hundred in their possession, exclusive of meadows and bogs; and also to release tenants to the same extent from the penal covenants against tillage, inserted in their leases. Mr M'Culloch observes, in his *Statistical Account of the British Empire*, that the luxuriance of the pastures in Ireland and the heavy crops of oats raised, even with the most wretched cultivation, attest the extraordinary fertility of the soil. Strong retentive clay soils, sandy soils, chalky and gravelly soils, and several other descriptions of soil common in England, are seldom or never met with in Ireland, which affords no great diversity as compared with Great Britain. Mr Wakefield describes the soils of Ireland as follows:—"A great portion of the soil of Ireland throws out a luxuriant herbage, springing from a calcareous subsoil without any considerable depth. This is one species of the rich soil of Ireland, and is found throughout Roscommon, in some parts of Galway, Clare, and other districts. Some places exhibit the richest loam I ever saw turned up with a plough; this is the case throughout Meath in particular. Where such soil occurs, its fertility is so conspicuous, that it appears as if nature had determined to counteract the bad effects produced by the clumsy system of its cultivators. On the banks of the Fergus and Shannon, the land is of a different kind, but equally productive, though the surface presents the appearance of marsh. These districts are called *caucasses:* the substratum is a blue silt deposited by the sea, which seems to partake of the qualities of the upper stratum, for this land can be injured by no depth of ploughing.

"In the rich counties of Limerick and Tipperary there is another kind of rich land, consisting of a dark, friable, sandy loam, which, if preserved in a clean state, would throw out corn for several years in succession. It is equally well adapted for grazing and tillage, and I will venture to say, seldom experiences a season too wet, or a summer too dry. The richness of the land in some of the vales may be accounted for by the deposition of soil carried thither from the upper grounds by the rains. The subsoil is calcareous, so that the very richest manure is then spread over the land below, without subjecting the farmer to any labour.

"In the north the quantity of rich soil is not very considerable, yet valleys of extraordinary fertility are found in every county; and I was not a little astonished, amidst the rocky and dreary mountains of Donegal, where there was hardly a vestige of cultivation, to find myself drop all at once into a district where the soil was exceedingly fertile. Independently of the *caucasses*, the richest soil in Ireland is to be found in the counties of Tipperary, Limerick, Longford, and Meath. Some parts of the county of Cork are uncommonly fertile, and upon the whole, Ireland may be considered as affording land of excellent quality." "You must examine into the soil," says Arthur Young, speaking of Limerick and Tipperary, "before you can believe that a country which has so beggarly an appearance can be so rich and fertile."

The prevalent soil is a fertile loam, resting on a rocky substratum, chiefly of limestone. The depth, though in general not great, is in some parts such as to admit of fresh vegetable mould being repeatedly thrown up by successive ploughings to a greater depth. This occurrence is most striking in Meath, and in the district of the counties of Tipperary and Limerick, long distinguished by the name of the Golden Vale, from its extraordinary fertility. In some parts, particularly in Galway, the rock shows itself above the surface in ridges like waves, the interstices being filled with rich mould, which produces a thick, close sward, extremely grateful to sheep. Large tracts of grazing land similar to the Downs in England are unusual; the only tract of any extent of such description is the Curragh of Kildare, which has been used, time immemorial, for a sheep walk. The mountains are capable of tillage to a considerable height; and their summits, with the exception of a few of the very highest, are fit for pasturage in summer.

Wakefield, in his observations on the state of tillage, classed the country into nine agricultural districts, according to the peculiarities of soil and culture. The first comprehended the flat parts of Antrim, the eastern side of Tyrone, and the counties of Down, Armagh, Monaghan, and Cavan. In these the farms were small, and spade cultivation common. Potatoes, oats, and flax were the principal crops. The second district comprehends the counties of Londonderry and Donegal, the mountainous part of Antrim, and the north and west of Tyrone. Agriculture was in a more backward state here than in the preceding district. Wheat was little cultivated. In the third, which is confined to the northern parts of Fermanagh, the system of tillage was better, and the farms larger. Wheat was largely planted, but oats formed the great staple crop. The whole of the north-west of Ireland, comprehending Sligo, Mayo, Galway, Clare, with Roscommon and Longford, forms the fourth district. Oats was the prevalent crop, but much barley was also raised in the districts near the sea. The plough

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was often drawn by four horses abreast. Illicit distillation was carried on here upon an extensive scale, and much of the land leased to tenants in common, according to what is called the con-acre system. In the fifth district, which comprehends Limerick, Kerry, the south-western and northern parts of Cork, and all Waterford, cultivation was not far advanced, the greater part being a grazing country. Where tillage prevailed the land was much subdivided, and the farms consequently very small. The sixth district included the southern part of Cork. Spade culture was here frequent, the farms small, and hogs constituted the main dependence of the poor. The best farming in Ireland was to be seen in the seventh district, which comprised Tipperary, the Queen's and King's counties. Tillage was carried on in a systematic manner, and wheat formed an important part of the crop. The character of the eighth district, which comprehends Kilkenny, Kildare, Carlow, Westmeath, Meath, and Louth, much resembled that of the preceding, except that the system of tillage was not managed with so much neatness and precision. The farms were large, and the English mode of treatment adopted; but the details executed in a more slovenly manner. Wexford, and the arable part of Wicklow, formed the ninth district.

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The quantity of arable land in 1841, according to the return of the Census Commissioners, was 13,464,300 acres, and in 1851, 14,802,581 acres; and the proportion per cent. of cultivated and uncultivated surface, &c., at those two periods was as follows:—

Provinces.	Total Area in Statute Acres.	Division of Surface.									
		Arable Land.		Uncultivated.		Plantations.		Towns.		Water.	
		Proportion per cent.		Proportion per cent.		Proportion per cent.		Proportion per cent.		Proportion per cent.	
		1841.	1851.	1841.	1851.	1841.	1851.	1841.	1851.	1841.	1851.
Leinster	4,876,211	81·23	82·80	15·01	13·67	2·38	2·09	0·32	0·38	1·06	1·06
Munster	6,064,579	63·89	71·08	31·22	24·48	2·15	1·71	0·24	0·23	2·50	2·50
Ulster	5,475,438	62·23	72·95	32·22	21·89	1·46	1·07	0·16	0·16	3·93	3·93
Connaught	4,392,043	50·57	56·01	43·39	38·12	1·10	0·93	0·09	0·09	4·85	4·85
General total	20,808,271	64·71	71·14	30·25	24·14	1·80	1·47	0·21	02·2	3·03	3·03

When compared with its extent and the amount of its agricultural population the number of proprietors of land in Ireland is small, a circumstance which has to some extent led to the neglect both of the land and its tenantry. The confiscations and colonizations which took place in the reigns of Elizabeth and James the First, gave possession of large tracts of country to individuals whose more extensive properties in England made them careless of their estates in Ireland. The wars of Cromwell introduced into the country for the most part a small proprietary, who, being generally resident, produced a more beneficial influence on the relations of society. Respecting the enactment of the penal laws which affected the position of the great body of the people—the Roman Catholics—as regarded landed property, the Land Occupation Commissioners observe that they "must have had a very general influence on society in such a country as Ireland."

"These laws, both in their enactment and in their subsequent relaxations, have affected materially the position of occupier and proprietor. They interfered with almost every mode of dealing with landed property by those who professed that religion, and by creating a feeling of insecurity, directly checked their industry.

"The Protestant landlords also suffered indirectly from the operation of the same laws; for, in letting their estates, they were, to a great degree, confined in the selection of their tenants, to those who alone could enjoy any permanent tenure under them, and were exclusively entitled to the elective franchise. Many landlords parted with the whole, or a great portion of their property, for long terms, and thus avoided all immediate contact with the inferior occupiers, so that all the duties of a landlord were left for performance to a middleman. The latter, on the other hand, in the favourable position in which the laws had indirectly placed him, as regarded the proprietor, dictated very frequently his own terms to the landlord; and restrictive covenants against subletting or subdividing were seldom inserted.

"About eighty years after their first introduction, a relaxation of these laws took place.

"Among many measures professedly for the improvement of Ireland, an act was passed in 1771 which allowed Roman Catholics to take a lease for sixty-one years of not less than ten acres, or more than fifty, of bog, with only half an acre of arable land for the site of a house, but not to be situated within a mile of a town; and if it was not reclaimed in twenty-one years, the lease to be void. In 1777 it was enacted that titles not hitherto litigated should not be disturbed, and Roman Catholics were allowed to take leases for any term under 1000 years. In 1782 they were allowed to acquire freehold property for lives or by inheritance; and in 1793 was passed a further enactment, which materially affected the position of landlord and tenant. The 40s. franchise was by that act extended to Roman Catholics; the landlords and the middlemen then found the importance of a numerous following of tenantry; and subdivision and subletting, being by this law indirectly encouraged, greatly increased. The war with France raised considerably the profits of the occupier, who was thus enabled to pay a large rent to the mesne lessee. These causes produced throughout the country a class of intermediate proprietors, known by the name of middlemen, whose decline after the cessation of the war, and the fall of prices in 1815, brought with it much of the evils we have witnessed of late years. Many who, during the long war, had amassed much wealth, had become proprietors in fee; others, who had not been so successful, struggled in after years to maintain a position in society which their failing resources could not support. Their sub-tenants were unable to pay 'war-rents.' The middleman himself, who was liable for the rent during the same period, became equally unable to meet his engagements. All became impoverished; the middleman parted with his interest or under-let the little land he had hitherto retained in his own hands; himself and his family were involved rapidly in ruin. The landlord, in many cases, was obliged to look to the occupiers for his rent, or, at the expiration of the lease, found the farms covered with a pauper, and, it may be, a superabundant population. Subsequently, the act of 1829 destroyed the political value of the 40s. freeholder, and to relieve his property from the burden which this chain of circumstances brought upon it, the landlord, in too many instances, adopted what has been called, the 'clearance system.'"

The conditions under which this system was put in practice will be clearly seen from the description given by the Irish Railway Commissioners in their report, dated July 1838:—

"The misery and destitution which prevail so extensively, together with all the demoralization incident to the peculiar condition of the Irish peasantry, may be traced to this source [the 'Forty Shilling Freeholders' Act']. The country, particularly in the west and south-western counties, is overspread with small but exceedingly crowded communities, sometimes located in villages, but more frequently in isolated tenements, exclusively composed of the poorest class of labourers, who, removed from the presence and social or moral influence of a better and more enlightened class, are left, generally, to the coercive power of the law alone to hold them within the bounds of peace and order. No system of constant or remunerative

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industry is established amongst them. The cultivation of their patches of land and the labour of providing fuel are their sole employment, which, occupying but a comparatively small portion of their time, leaves them exposed to all the temptations of an idle, reckless, and needy existence.

"In such a community there is no demand for hired labourers. Every occupier, with such assistance as his own family can furnish, manages to raise the scanty supply of food which he may need for their support, and as much grain, or other produce, as may be required to pay his rent; but beyond this, there is no solicitude about cultivating the land, nor the least taste for improving or making it more valuable. At the periods of active labour, when additional hands are absolutely necessary, every expedient is resorted to in order to avoid the employment of a single paid labourer. Children of tender years are then forced to do the work of men in the fields, to a degree far beyond their strength; and all the females who are capable of rendering assistance are tasked in many ways utterly unsuited to their sex, and incompatible with the slightest attention to their proper cares and duties. At all times, indeed, of the year, whether the case be urgent or not, the share of labour out of doors imposed upon women and young girls, who might in every respect be so much better occupied, is as injurious to the moral condition, as it must be to the personal and domestic comfort of the peasantry.

"There is a class of landholders superior to these, holding from eight to twelve or fifteen acres, who are equally slovenly and careless in the management of their land; but necessarily obliged, on account of its greater extent, to procure assistance out of their own families. Sometimes, but rarely, these persons hire daily labourers among the neighbouring poor; and in such cases they are usually guided in their choice, not by the character or capability of the man they employ, but by the lowest rate of wages at which they can possibly obtain his service. More commonly, however, they engage, as farm-servants, young men between sixteen and twenty-five years of age, who reside in the family of their employer, and hire themselves out at remarkably low wages, seldom exceeding L.1 per quarter, and, in numerous instances, scarcely more than half that sum.

"The litigation which occupies a great portion of the time of the several Courts of Petty Sessions, arises out of the disputes of this class of servants with their employers; the former being usually impatient to break off their engagements at the busy and more profitable season of the year, and the latter anxious, of course, to reap the full benefit of the contract. Another common subject of angry contention before the same tribunals, is furnished by ill-defined boundaries, neglected fences, and consequent trespass between the neighbouring tenants of the small divisions of land above described. More time and money are commonly wasted in such contests than would suffice to repair all the damage which forms the ground of quarrel; and animosities are engendered which often lead to feuds of a lasting duration, and the most deadly consequences."

Formerly the custom prevailed of granting leases either in perpetuity for 999 years, or for lives renewable for ever, with a covenant of perpetual renewal on payment of a fine, sometimes merely nominal, on the fall of each life. This tenure is supposed to have originated in the desire of the grantees of confiscated estates, who were generally absentees, to obtain a recognition of their title. Hence some of the owners of large estates receive a very small share of the actual profits. The leases commonly granted at present are for sixty-one, thirty-one, or twenty-one years, with very frequently a life or lives, but the larger portion of the land is held by tenants-at-will. Landlords neither erect nor repair the farmsteads, and seldom expend money on permanent improvements, the maintaining and improving of the farm being thrown wholly on the tenant. The system of middlemen, who rent land from the proprietor, and re-let it to under-tenants, formerly prevailed. It is now rare. In many instances there were several middlemen between the head landlord and the occupying tenant, which latter, according to the law of real property in Ireland, thus becomes answerable for the payment of his own rent to his immediate landlord, and for that of all the rents of every intermediate holder under the original proprietor. Grazing farms are large; the arable in general small, particularly in Ulster, in which province much of the land in several counties, particularly in those where the domestic manufacture of linen prevailed, is parcelled out into very minute subdivisions. The practice of taking into cultivation large tracts of mountain bog or other land hitherto unreclaimed, is now very prevalent. The cottier system, by which the occupying tenant receives a patch of land, in part or whole payment of wages, and that of rundale, in which a large tract is held by a number of individuals in common, are still kept up.

Statistics.

A striking peculiarity is the mode in which occupiers hold their land in some of the northern counties. The custom is called tenant-right, and is supposed to have originated in the circumstance of large tracts of land having become the property of public bodies or individuals who, being absentees, let their farms, reserving to themselves a rent, but making no expenditure, and exercising little interference with the land. The tenant, where this custom prevails, claims and generally exercises a right to dispose of his holding for a valuable consideration, although he may himself be a tenant-at-will, and may have expended nothing in permanent improvements.

In 1847 an inquiry was instituted by the Irish government as to the annual amount of the agricultural produce of Ireland, which has been since carried on from year to year, the information being collected by the constabulary in the first instance, according to townlands, afterwards consolidated into poor-law unions, and thus published in the returns presented annually to both Houses of Parliament. The returns are made into two divisions, crops and stock.

The size of farms, as well as their mode of culture, varies greatly in different parts. Generally speaking, in the manufacturing districts of the north, the small allotments of land, there dignified by the name of farms, are limited to a few acres, the cultivators of which no more deserve the name of farmers than would the occupiers of mere cabbage gardens. In the grazing counties the farms are of very great extent, often spreading over upwards of a thousand acres; whilst in the counties in which greater attention is paid to tillage, they are more moderate in dimensions. The mixture of grazing and tillage so frequent in England is much less usual here, except on the farms of gentlemen, where both the feeding of stock and the growth of grain are carried on, in numerous instances, to as high a state of excellence as in any part of Great Britain. Nor are there any large tracts of country exclusively devoted to the breeding of cattle, as in the Highlands of Scotland.

The following table shows the changes which have taken place in the several classes of holdings in 1841, and between 1849 and 1854:—

Size and Number of Holdings in 1841, *and in* 1849 *to* 1854 *inclusive.*

Years.	Not exceeding 1 Acre.		Above 1, and not exceeding 5 Acres.		Above 5 Acres, and not exceeding 15 Acres.		Above 15 Acres, and not exceeding 30 Acres.		Above 30 Acres.		Total Holdings.
	Number.	Rate per cent.	Number.	Rate per cent.	Number.	Rate per cent.	Number.	Rate per cent.	Number.	Rate per cent.	Number.
1841	...	...	310,375	44·9	252,778	36·6	79,338	11·5	48,623	7·0	691,114
1849	31,989	4·9	98,179	15·1	213,897	32·9	150,120	23·0	156,960	24·1	651,145
1850	35,326	5·6	91,618	14·6	203,331	32·4	145,380	23·1	152,567	24·3	628,222
1851	37,728	6·2	88,083	14·5	191,854	31·6	141,311	23·2	149,090	24·5	608,066
1852	35,058	5·9	81,561	13·9	182,308	30·9	139,136	23·6	151,408	25·7	589,471
1853	35,795	6·1	79,418	13·6	178,701	30·5	138,864	23·8	152,571	26·0	585,349
1854	38,165	6·5	80,976	13·7	179,140	30·3	137,640	23·3	154,166	26·2	590,087

Statistics.

The total number of holdings has continued to decrease since 1841. The number of holdings returned for 1854 is greater than in 1853, by 4738, as may be seen from the following table:— Statistics.

Classification of Holdings.	Leinster.		Munster.		Ulster.		Connaught.		Total.		Increase between 1853 and 1854.
	1853.	1854.	1853.	1854.	1853.	1854.	1853.	1854.	1853.	1854.	
Not exceeding 1 Acre	15,051	15,067	7,796	8,749	7,180	8,178	5,768	6,171	35,795	38,165	2,370
Above 1 to 5 Acres	23,397	23,832	12,754	12,737	27,092	27,900	16,175	16,507	79,418	80,976	1,558
... 5 to 15 ...	30,565	30,386	22,081	22,034	80,254	80,556	45,801	46,164	178,701	179,140	439
... 15 to 30 ...	24,748	24,645	26,716	26,238	57,853	57,155	29,547	29,602	138,864	137,640	...
... 30 to 50 ...	15,812	15,930	21,628	21,753	22,997	22,801	9,860	10,337	70,297	70,821	524
... 50 to 100 ...	13,299	13,431	20,844	20,942	11,689	11,912	5,932	6,227	51,764	52,512	748
... 100 to 200 ...	6,331	6,401	8,499	8,507	2,901	2,978	3,043	3,140	20,774	21,026	252
... 200 to 500 ...	2,553	2,531	2,840	2,904	977	942	1,747	1,790	8,117	8,167	50
... 500 Acres.....	387	388	414	413	291	287	527	552	1,619	1,640	21
Total.....	132,143	132,611	123,572	124,277	211,234	212,709	118,400	120,490	585,349	590,087	4,738

It will be seen that the increase extended to every class—farms "above 15, and not exceeding 30 acres" alone excepted; the proportion which the numbers in each class bear to the total number has scarcely varied during the last three years. In 1854, of the entire number of farms, 6·5 per cent. did not exceed 1 acre in extent; 13·7 per cent. were above 1, and not exceeding 5 acres; 30·3 per cent. were above 5, and not exceeding 15 acres; 23·3 per cent. were above 15, and not exceeding 30 acres; and 26·2 per cent. were above 30 acres—thus, about half the farms in Ireland are above 15 acres in extent.

The average extent in each class of holdings remains nearly the same in 1854 as in 1853, with the exception of farms containing "500 acres and upwards," which in 1853 comprised 2,176,824 acres, and in 1854, 2,122,967 acres, being a diminution in the latter year of 53,857 acres; this, together with an increase of 21 in their number, reduced their average size from 1344½ acres in 1853 to 1294½ acres in 1854. The average extent of land held by each class in 1854 is shown in the following table:—

Classification of Holdings.	No. of Holdings in each class.	Extent of Land held by each class of Landholders.	Average Extent of the Holdings in each class.	Division of Land.				
				Tillage.	Grass.	Fallow.	Woods and Plantations.	Bog and Waste.
		Acres.	A. R. P.	Acres.	Acres.	Acres.	Acres.	Acres.
Holdings not exceeding 1 acre..	38,165	24,667	0 2 23	21,451	1,670	139	215	1,202
Do. above 1 and not exceeding 5 acres.	80,976	281,464	3 1 36	179,168	81,990	1,732	2,168	16,406
Do. above 5 and not exceeding 15	179,140	1,836,486	10 1 0	877,468	812,622	6,716	9,029	130,651
Do. above 15 and not exceeding 30	137,640	3,056,193	22 0 32	1,240,749	1,471,148	12,269	14,501	317,517
Do. above 30 and not exceeding 50	70,821	2,864,703	40 1 32	1,007,377	1,433,758	14,718	20,246	388,604
Do. above 50 and not exceeding 100	52,512	3,886,499	74 0 2	1,117,229	2,006,140	21,240	42,336	699,554
Do. above 100 and not exceeding 200	21,026	3,217,590	153 0 5	681,020	1,693,060	16,604	65,674	761,232
Do. above 200 and not exceeding 500	8,167	2,900,557	355 0 25	364,590	1,373,466	10,278	89,261	1,062,962
Do. above 500 acres.....	1,640	2,122,967	1,294 1 39	81,558	626,795	1,738	65,093	1,347,783
Total.....	590,087	20,191,136	...	5,570,610	9,500,649	85,434	308,532	4,725,911

Table showing the Extent in Acres of each description of Crop grown upon each Class of Holdings exceeding one Acre in extent in 1854.

Description of Crops.	Above 1 to 5 Acres.	Above 5 to 15 Acres.	Above 15 to 30 Acres.	Above 30 to 50 Acres.	Above 50 to 100 Acres.	Above 100 to 200 Acres.	Above 200 to 500 Acres.	Above 500 Acres.
Wheat.....	10,039	44,095	76,033	80,651	106,855	63,079	25,794	4,160
Oats.....	63,548	374,161	517,524	385,239	381,325	203,756	96,487	19,517
Barley, bere, and rye.....	10,509	35,448	53,516	51,412	60,782	34,429	14,806	2,643
Beans and peas.....	707	2,827	4,814	4,654	5,276	2,554	1,389	286
Total cereal crops.....	84,803	456,531	651,887	521,956	554,238	303,818	138,476	26,606
Potatoes.....	61,557	224,349	256,264	172,162	158,119	72,325	27,479	4,602
Turnips.....	6,289	36,197	63,242	60,172	73,785	50,615	30,834	7,568
Other green crops	2,961	10,807	16,734	14,432	17,126	11,997	7,586	2,187
Total green crops.....	70,807	271,353	336,240	246,766	249,030	134,937	65,899	14,357
Flax.....	4,092	34,764	48,243	31,390	22,679	7,124	2,154	846
Rape.....	66	666	1,518	1,496	2,437	2,685	3,243	976
Meadow and clover.....	19,400	114,154	202,861	205,769	288,845	232,456	154,818	38,773
Total flax, rape, and meadow.....	23,558	149,584	252,622	238,655	313,961	242,265	160,215	40,595
General total.....	179,168	877,468	1,240,749	1,007,377	1,117,229	681,020	364,590	81,758

Statistics. *Table showing the Extent of Land under Crops for each County and Province in Ireland, in 1854 and 1855, and the number of Acres under each species of Crop.* Statistics.

Provinces and Counties.		Wheat.	Oats.	Barley, Bere, Rye, Beans, and Peas.	Potatoes.	Turnips.	Other Green Crops.	Flax.	Meadow and Clover.	Total Extent under Crops.
Leinster—		Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.
Carlow	1854	8,745	26,491	5,710	10,973	5,537	1,220	32	23,662	82,370
	1855	9,569	25,724	5,060	11,061	5,956	1,261	81	25,396	84,108
Dublin	1854	11,889	25,105	5,630	10,314	3,558	4,100	5	45,406	106,007
	1855	14,207	24,301	4,850	11,989	3,488	4,087	1	45,823	108,746
Kildare	1854	18,381	43,520	7,767	13,109	9,988	2,053	6	45,123	139.947
	1855	20,698	43,953	6,251	14,110	10,990	1,907	9	48,707	146,625
Kilkenny	1854	34,968	54,205	8,582	25,567	11,270	3,027	54	44,241	181,914
	1855	37,297	53,102	8,659	22,812	12,689	3,196	45	47,437	185,237
King's	1854	17,767	33,174	6,335	21,038	8,705	2,666	214	38,857	128,756
	1855	18,502	32,489	5,636	21,725	9,343	2,583	254	39,896	130,428
Longford	1854	1,977	39,521	394	16,547	2,129	1,162	592	19,124	81,446
	1855	2,357	30,843	328	16,260	2,732	932	262	20,157	81,871
Louth	1854	6,903	36,670	24,928	11,813	8,666	2,489	694	17,071	109,234
	1855	9,675	38,514	22,034	11,937	9,234	2,536	190	17,276	111,396
Meath	1854	15,762	85,667	6,110	16,867	9,492	4,173	481	61,935	200,487
	1855	18,733	86,625	5,014	19,200	9,934	4,018	267	64,642	208,433
Queen's	1854	20,936	32,055	9,937	21,559	12,929	1,845	11	48,900	148,172
	1855	21,454	32,606	9,683	20,885	14,226	1,962	7	51,926	152,749
Westmeath	1854	3,915	53,769	2,233	17,877	5,656	2,320	260	38,465	124,495
	1855	4,618	54,531	1,531	18,486	6,444	2,344	200	40,545	128,699
Wexford	1854	21,905	86,633	44,797	27,980	14,542	4,969	466	43,295	244,587
	1855	23,921	86,102	41,940	27,686	16,253	4,933	825	45,711	247,371
Wicklow	1854	6,177	36,746	4,918	11,176	4,273	1,339	5	53,550	118,184
	1855	6,667	36,287	4,599	11,854	4,501	1,084	1	55,028	120,021
Total of Leinster	1854	169,325	553,556	127,341	204,820	96,745	31,363	2,820	479,629	1,665,599
	1855	187,698	553,077	115,585	208,005	105,790	30,843	2,142	502,544	1,705,684
Increase or Decrease in Leinster		inc. 18,373	dec. 479	dec. 11,756	inc. 3,185	inc. 9,045	inc. 520	dec. 678	inc. 22,915	total inc. 40,085
Munster—										
Clare	1854	8,540	37,817	14,155	34,097	7,647	2,321	909	49,156	154,642
	1855	9,318	39,298	13,394	35,807	8,453	2,386	890	52,179	161,725
Cork	1854	51,146	139,596	40,000	84,153	47,502	10,603	3,324	94,812	471,136
	1855	49,927	149,856	39,113	81,081	53,654	10,578	2,393	104,545	491,147
Kerry	1854	2,450	34,139	9,696	30,144	10,512	2,334	673	54,101	144,049
	1855	2,716	36,651	7,702	31,357	9,737	2,523	621	56,362	147,669
Limerick	1854	14,427	45,009	15,343	33,282	11,612	2,749	316	69,117	191,855
	1855	17,155	45,430	12,053	35,733	11,402	2,749	244	71,187	195,953
Tipperary	1854	50,735	77,026	12,017	54,048	26,587	4,124	199	76,740	301,476
	1855	54,325	78,180	11,635	52,148	29,738	4,220	103	83,851	314,200
Waterford	1854	24,272	30,892	9,488	20,725	11,052	3,294	31	16,112	115,866
	1855	24,325	30,831	9,460	18,818	11,964	3,139	43	17,647	116,227
Total of Munster	1854	151,570	364,479	100,699	256,449	114,912	25,425	5,452	360,038	1,379,024
	1855	157,766	380,246	93,357	254,944	124,948	25,595	4,294	385,771	1,426,921
Increase or Decrease in Munster		inc. 6,196	inc. 15,767	dec. 7,342	dec. 1,505	inc. 10,036	inc. 170	dec. 1,158	inc. 25,733	total inc. 47,897

Statistics. *Table showing the Extent of Land under Crops for each County and Province in Ireland, in* 1854 *and* 1855, *and the number of Acres under each species of Crop,*—Continued. Statistics.

Provinces and Counties.	Wheat.	Oats.	Barley, Bere, Rye, Beans, and Peas.	Potatoes.	Turnips.	Other Green Crops.	Flax.	Meadow and Clover.	Total Extent under Crops.
Ulster—	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.
Antrim { 1854	9,200	94,294	4,123	47,356	9,317	2,530	8,924	55,109	230,853
Antrim { 1855	11,090	98,729	4,572	46,957	12,376	2,598	6,719	53,640	236,681
Armagh { 1854	11,555	70,963	1,945	34,426	6,082	3,052	16,295	25,792	170,110
Armagh { 1855	12,225	78,717	2,447	31,690	8,046	3,179	9,284	25,555	171,143
Cavan { 1854	847	88,083	1,119	30,879	2,729	3,316	8,842	33,045	168,860
Cavan { 1855	865	91,371	800	31,256	3,167	2,939	6,029	34,952	171,379
Donegal { 1854	3,384	102,635	6,326	44,568	15,342	2,471	26,061	31,566	232,353
Donegal { 1855	2,963	108,784	7,298	41,559	16,654	2,626	15,799	33,000	228,683
Down { 1854	27,960	134,291	16,845	47,116	20,440	4,843	19,895	37,208	308,598
Down { 1855	30,359	142,631	15,836	47,222	22,119	4,734	11,166	36,357	310,424
Fermanagh { 1854	1,397	40,316	1,661	19,734	3,454	1,930	3,480	34,112	106,084
Fermanagh { 1855	1,413	40,770	1,111	18,212	4,252	1,680	2,006	34,775	104,219
Londonderry { 1854	3,532	85,395	2,131	33,283	9,515	1,655	17,230	20,543	173,284
Londonderry { 1855	3,052	91,783	2,113	32,234	11,474	1,411	11,818	20,443	174,328
Monaghan { 1854	2,957	78,262	3,924	26,522	5,508	2,337	16,222	15,053	150,785
Monaghan { 1855	3,466	83,569	3,712	25,394	7,053	2,128	11,859	15,377	152,558
Tyrone { 1854	4,760	147,133	1,729	47,012	12,947	3,237	22,453	31,298	270,569
Tyrone { 1855	4,694	153,817	1,536	43,643	15,231	2,979	13,224	30,865	265,989
Total of Ulster { 1854	65,592	841,372	39,803	330,896	85,334	25,371	139,402	283,726	1,811,496
Total of Ulster { 1855	70,127	890,171	39,425	318,167	100,372	24,274	87,904	284,964	1,815,404
Increase or Decrease in Ulster	inc. 4,535	inc. 48,799	dec. 378	dec. 12,729	inc. 15,038	dec. 1,097	dec. 51,498	inc. 1,238	tot. inc. 3,908
Connaught—									
Galway { 1854	16,602	80,917	10,644	51,499	14,830	9,324	785	43,020	227,621
Galway { 1855	18,818	81,347	10,397	52,894	15,607	8,203	544	45,886	233,696
Leitrim { 1854	293	26,959	323	23,666	988	1,626	1,022	27,748	82,625
Leitrim { 1855	270	28,829	555	23,530	1,078	1,191	718	28,472	84,643
Mayo { 1854	3,753	80,706	5,989	58,858	8,365	2,489	999	17,920	179,079
Mayo { 1855	4,594	83,633	5,426	59,039	9,547	2,183	741	18,234	183,397
Roscommon { 1854	2,795	55,585	404	35,830	3,613	1,638	430	28,930	129,225
Roscommon { 1855	4,148	59,185	486	36,785	4,729	1,725	384	30,224	137,666
Sligo { 1854	1,354	41,724	1,951	27,642	4,383	1,541	493	16,853	95,941
Sligo { 1855	2,088	41,467	2,334	28,165	4,426	1,080	379	15,642	95,581
Total of Connaught { 1854	24,797	285,891	19,311	197,495	32,179	16,618	3,729	134,471	714,491
Total of Connaught { 1855	29,918	294,461	19,198	200,413	35,387	14,382	2,766	138,458	734,983
Increase or Decrease in Connaught	inc. 5,121	inc. 8,570	dec. 113	inc. 2,918	inc. 3,208	dec. 2,236	dec. 963	inc. 3,987	tot. inc. 20,492
Total of Ireland { 1854	411,284	2,045,298	287,154	989,660	329,170	98,777	151,403	1,257,864	5,570,610
Total of Ireland { 1855	445,509	2,117,955	267,565	981,529	366,497	95,094	97,106	1,311,737	5,682,992
Increase or Decrease in Ireland	inc. 34,225	inc. 72,657	dec. 19,589	dec. 8,131	inc. 37,327	dec. 3,683	dec. 54,297	inc. 53,873	tot. inc. 112,382

Statistics

General Abstract, showing in "Quarters" the Cereal Produce of Ireland in 1855; also, the Produce of Potatoes in Tons.

Statistics.

Provinces and Counties.	Estimated Quantity of Cereal Produce in Quarters.					Estimated Produce of Potatoes.	
	Wheat.	Oats.	Barley.	Bere.	Rye.		
	1855.	1855.	1855.	1855.	1855.	1854.	1855.
	Quarters.	Quarters.	Quarters.	Quarters.	Quarters.	Tons.	Tons.
Leinster—							
Carlow	31,185	122,885	20,033	1,911	223	57,765	71,748
Dublin	57,975	143,580	23,307	688	102	75,252	86,931
Kildare	72,636	221.560	24,890	6,009	1,445	83,348	93,518
Kilkenny	109,545	242,042	34,488	3,659	135	114,507	117,845
King's	61,860	157,465	21,875	5,097	2,263	138,604	139,445
Longford	6,085	170,338	258	334	762	94,336	96,520
Louth	41,380	212,167	101,986	758	1,988	60,883	87,821
Meath	71,715	413,099	16,403	2,523	3,489	98,294	100,235
Queen's	65,028	156,477	39,538	6,995	164	108,410	117,905
Westmeath	15,513	279,041	1,588	3,865	2,459	103,957	113,876
Wexford	78,840	408,587	178,542	1,125	326	117,877	102,197
Wicklow	23,221	163,912	14,742	6,196	407	58,166	53,596
Total of Leinster	634,983	2,691,153	477,650	39,160	13,763	1,111,399	1,181,637
Munster—							
Clare	36,306	200,008	63,894	382	3,861	201,592	201,096
Cork	140,634	674,605	174,796	699	1,026	368,533	360,846
Kerry	9,433	140,739	34,930	102	3,196	190,678	181,882
Limerick	66,288	240,742	60,780	105	170	180,812	231,327
Tipperary	182,743	412,162	53,426	3,053	843	273,393	322,460
Waterford	70,384	123,492	37,957	291	1,675	97,187	61,842
Total of Munster	505,788	1,791,748	425,783	4,632	10,771	1,312,195	1,359,453
Ulster—							
Antrim	38,691	517,374	6,954	190	459	291,541	377,107
Armagh	38,467	351,633	7,523	993	517	141,443	202,549
Cavan	3,084	379,437	449	671	2,473	152,598	207,149
Donegal	13,958	549,901	27,064	377	3,201	184,992	283,313
Down	134,462	740,066	64,965	1,312	2,303	252,876	369,560
Fermanagh	5,485	202,996	799	1,197	2,651	94,786	137,939
Londonderry	9,852	475,970	1,774	2,200	1,187	146,385	216,610
Monaghan	13,284	391,636	10,112	4,132	1,418	82,437	170,450
Tyrone	17,222	766,673	2,291	586	1,450	211,314	298,060
Total of Ulster	274,505	4,375,686	121,931	11,658	15,659	1,558,372	2,262,737
Connaught—							
Galway	66,681	419,644	37,735	1,348	7,954	282,949	392,072
Leitrim	1,102	142,713	140	218	2,331	124,588	172,989
Mayo	20,604	362,214	19,502	154	5,762	317,371	430,396
Roscommon	11,498	253,761	831	193	1,093	203,304	274,034
Sligo	9,021	223,501	12,615	41	221	151,476	160,581
Total of Connaught	108,906	1,401,833	70,823	1,954	17,361	1,079,688	1,430,072
Total of Ireland	1,524,182	10,260,420	1,096,187	57,404	57,554	5,061,654	6,233,899

Table of the Acreage under Crops, the Estimated Average Produce per Statute Acre, and the Total Produce of Ireland in 1847, and from 1849 to 1855, inclusive.

Years.	Wheat.			Oats.			Barley.			Bere.			Rye.			Beans and Peas.		
	Extent of Crop.	Average Produce per Statute Acre.	Estimated Total Produce.	Extent of Crop.	Average Produce per Statute Acre.	Estimated Total Produce.	Extent of Crop.	Average Produce per Statute Acre.	Estimated Total Produce.	Extent of Crop.	Average Produce per Statute Acre.	Estimated Total Produce.	Extent of Crop.	Average Produce per Statute Acre.	Estimated Total Produce.	Extent of Crop.	Average Produce per Statute Acre.	Estimated Total Produce.
	Statute Acres.	Barrels, 20 Stones.	Quarters.	Statute Acres.	Barrels, 14 Stones.	Quarters.	Statute Acres.	Barrels, 16 Stones.	Quarters.	Statute Acres.	Barrels, 16 Stones.	Quarters.	Statute Acres.	Barrels, 20 Stones.	Quarters.	Statute Acres.	Bushels, 8 Gallons.	Quarters.
1847	743,871	6·6	2,926,733	2,200,870	8·4	11,521,606	283,587	8·7	1,379,029	49,068	8·6	274,016	12,415	8·2	63,094	[2]23,768	28·4	[2]84,456
1848[1]	Incomplete.																	
1849	687,646	5·3	2,167,743	2,061,185	7·6	9,836,893	290,690	8·4	1,352,354	60,819	8·2	320,587	20,168	8·2	101,714	53,916	26·6	179,521
1850	604,867	4·4	1,550,196	2,142,596	7·7	10,841,973	263,350	8·9	1,299,335	57,811	8 3	308,291	18,342	7·8	88.307	62,990	25·4	198,959
1851	504,248	5·0	1,493,525	2,189,775	7·9	10,771,236	282,617	8·8	1,375,518	53,347	8·3	286,149	19,697	8·0	97,187	49,717	25·8	160,451
1852	353,566	5·5	1,154,205	2,283,149	8·2	11 712,528	249.476	9·1	1,257,398	40,933	8·7	231,075	12,993	7·9	63,289	36,189	20·7	120.821
1853	326,896	5·8	1,133,585	2,157,849	7·9	10,690,881	272,644	9·3	1,398,705	28.380	8·4	153,765	12,376	8·2	62,284	35,242	26·4	116,165
1854	411,284	5·9	1,452,467	2,045,298	8·8	11,293,101	236,293	9·3	1,212,047	16,920	8·1	89,066	11,366	7·9	55,687	22,575	26·6	74,980
1855	445,620	5·7	1,524,182	2,116,898	7·8	10,260,420	226,454	8·7	1,096,187	11,347	7·8	57,404	11,633	8·0	57,554	18,494	30·1	69,569

[1] The returns for 1848 were incomplete, owing to the then disturbed state of some counties.

[2] Beans only.

Statistics.

Table of the Acreage under Crops, the Estimated Average Produce per Statute Acre, and the Total Produce of Ireland in 1847, *and from* 1849 *to* 1855, *inclusive*,—Continued.

Statistics.

Years.	Potatoes.			Turnips.			Mangel-Wurzel.			Cabbage.			Flax.			Hay.			Total Extent under Crops.
	Extent of Crop	Average Produce per Statute Acre.	Estimated Total Produce.	Extent of Crop.	Average Produce per Statute Acre.	Estimated Total Produce.	Extent of Crop.	Average Produce per Statute Acre.	Estimated Total Produce.	Extent of Crop.	Average Produce per Statute Acre.	Estimated Total Produce.	Extent of Crop.	Average Produce per Statute Acre.	Estimated Total Produce.	Extent of Crop.	Average Produce per Statute Acre.	Estimated Total Produce.	
	Statute Acres.	Barrels, 20 stones.	Barrels, 20 stones.	Statute Acres.	Tons.	Tons.	Statute Acres.	Tons.	Tons.	Statute Acres.	Tons.	Tons.	Statute Acres.	Stones 14 lbs.	Stones, 14 lbs.	Statute Acres.	Tons.	Tons.	Statute Acres.
1847	284,116	57·7	16,385,562	370,344	15·5	5,760,616	13,766	18 0	247,269	...	...	...	58,312	48·0	2,798,976	1,138,946	1·9	2,190,317	5,238,575
1848[1]	Incomplete.																		
1849	718,608	44·7	32,112,979	360,069	16·1	5,805,848	18,758	18·5	346,595	25,083	14·4	361,720	60,314	39·6	2,387,202	1,141,371	2·0	2,287,134	5,543,748
1850	875,357	36·6	31,567,917	347,331	15·7	5,439,005	20,390	17·9	364,036	22,790	13·9	317,302	91,040	39·4	3,588,470	1,200,124	2·0	2,453,259	5,758,292
1851	868,501	40·9	35,528,175	383,548	15·9	6,081,326	25,847	18·0	466,235	28,962	13·9	401,622	140,536	38·6	5,417,766	1,246,408	2·0	2,518,977	5,858,951
1852	876,532	38·7	34,044,831	356,790	15·9	5,675,897	30,830	18·1	557,139	28,452	14·2	404,680	137,008	41·4	5,673,994	1,270.713	2·1	2,690,598	5,739,214
1853	893,733	51·1	45,932,301	399.377	16·4	6,562,471	33,283	17·7	588,988	28,421	14·1	401,828	174,579	40·2	7,018,059	1,270.742	2·0	2,518,984	5,696,951
1854	989,660	40·9	40,493,286	329,170	15·8	5,207,636	21,351	17·2	366,427	26,758	13·3	356,649	151,403	37·6	5,696,979	1,257,864	1·9	2,494,951	5,570,610
1855	982,028	50·8	49,871,192	366,311	16·6	6,063,965	22,278	18·0	401,844	24,080	13·0	312,510	97,048	38·6	3,746,274	1,313,680	2·0	2 663,958	5,684,607

When Mr Wakefield wrote, flax was cultivated in every county of Ireland, except Wexford and Wicklow, but in consequence of the withdrawal of the bounties, its cultivation declined, but of late years flax has been more extensively grown.

The following Table gives the breadth of Flax cultivated in each Province since 1849:—

Provinces.	1849.	1850.	1851.	1852.	1853.	1854.	1855.
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.
Leinster	741	1,801	4,889	4,433	4,497	2.820	2,142
Munster	937	2,094	5,991	4,179	5,225	5,425	4,294
Ulster	57,651	85,065	125,407	125,175	160,308	139,003	87,904
Connaught	985	2,080	4,249	3,221	4,549	3,724	2,766
Total	60,314	91,040	140,536	137,008	174,579	150,972	97,106

The Census Commissioners of 1841 ascertained the quantity of land in every farm in Ireland, and the number of horses and mules, asses, cattle, sheep, pigs, and poultry, on each holding, in that year—the returns published in their report afford a valuable basis for comparison with the information annually published in the returns of agricultural produce. The commissioners assumed an average rate per head for each description, viz.,—horses and mules were valued at L.8 each; asses at L.1; horned cattle at L.6, 10s.; sheep at L.1, 2s.; pigs at L.1, 5s.; poultry at 6d. By this means they arrived at an approximation to the value of the live stock in Ireland in 1841. Horses and mules, cattle, sheep, and pigs, should now be estimated at higher prices, but for the sake of comparison with previous years, the prices of 1841 have been adopted. The following table affords a general view of the extent of the changes which have taken place since that year.

Number of Holdings exceeding 1 *Acre, and Live Stock thereon, in* 1841, *and in* 1849–1854.

Years.	No. of Holdings.	Horses and Mules.	Asses.	Cattle.	Sheep.	Pigs.	Goats.	Poultry.	Value of Stock.	Increase of Value between each period.
1841..	691,114	576,115	92,365	1,863,116	2,106,189	1,412,813	...	8,458,517	£19,399,843	...
1849..	619,027	548,288	117,939	2,771,139	1,777,111	795,463	182,988	6,328,001	25,692,616	£6,292,616
1850..	592,896	548,719	123,412	2,917,949	1,876,096	927,502	201,112	6,945,146	26,951,959	1,259,343
1851..	570,338	543,312	136,981	2,967,461	2,122,128	1,084,857	235,313	7,470,694	27,737,393	785,434
1852..	554,413	545,900	144,120	3,095,067	2,613,943	1,072,658	278,444	8,175,904	29,134,229	1,416.836
1853..	549,554	561,100	148,720	3,383,309	3,142.656	1,444,945	296,182	8,660,738	31,458,785	2,757,965
1854..	551,922	564,530	150,576	3,497,901	3,722.219	1,342,549	311,492	8,630,488	33,508,371	1,679,994

The grazing of various kinds of stock is seldom combined. A usual mode with respect to black cattle, particularly in Connaught, is to collect yearling calves, which are fed till they are four years old, when they are sold at the great annual fair at Ballinasloe, to the graziers of Limerick, Tipperary, Roscommon, and Meath, by whom, when fattened for the butcher, they are either shipped alive for Liverpool, or sent to the markets of Dublin and the larger northern towns, or to Limerick and Cork, where they are cured for exportation.

The dairy farms form a conspicuous feature in the rural economy of the country, occupying a still larger portion of the soil than that used by the grazier. Butter, much celebrated for its excellence, is exported in large quantities. That of Carlow bears the highest character in the foreign market. It may appear strange that a country whose character stands so high in the production of butter, should be so unsuccessful in that of cheese. Yet such is the fact. With the exception of some made in the county of Antrim, particularly at Carrickfergus, Irish cheese is of very inferior quality. The failure of the many attempts to produce a good article may in some cases be attributable to the want of that tact in the management of it during its fabrication, which is only to be acquired by long and persevering practice; but several attempts made by capitalists with the assistance of persons skilful in the manufacture, have failed.

[1] The returns for 1848 were incomplete, owing to the then disturbed state of some counties.

[2] No separate returns, this crop being included under the head of "other green crops."

Statistics.

The following Table exhibits the Quantities of Grain and Malt exported from Ireland to Great Britain, from 1840 *to* 1854, *inclusive.*

Statistics.

Years.	Wheat and Wheat Flour.	Barley, Barleymeal, Bere or Bigg.	Oats and Oatmeal.	Rye.	Pease and Peameal.	Beans and Beanmeal.	Malt.	Total.
	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs.	Qrs
1840	174,439	95,954	2,037,835	122	1,403	14,573	3,456	2,327,782
1841	218,708	75,568	2,539,380	172	855	15,907	4,935	2,855,525
1842	201,998	50,297	2,261,435	76	1,551	19,831	3,046	2,538,234
1843	413,466	110,449	2,648,033	372	1,192	24,329	8,643	3,206,484
1844	440,152	90,656	2,242,310	264	1,091	18,579	8,153	2,801,205
1845	779,113	93,095	2,353,985	165	1,644	12,745	11,154	3,251,901
1846	393,462	92,854	1,311,592	...	2,227	14,668	11,329	1,826,132
1847	184,022	47,578	703,463	1,498	4,659	22,361	5,956	969,537
1848	304,873	80,077	1,546,568	15	2,572	12,314	6,365	1,952,784
1849	234,680	46,591	1,123,469	414	3,369	22,450	5,181	1,436,706
1850	176,566	40,946	1,075,388	360	4,360	21,551	8,425	1,328,939
1851	95,116	44,839	1,141,976	...	3,781	25,002	6,431	1,324,688
1852	56,066	107,155	1,650,313	...	3,318	27,664	8,741	1,853,257
1853	74,197	124,922	1,542,579	600	2,089	22,095	11,998	1,778,480
1854	138,159	81,239	1,818,169	360	1,987	23,157	9,182	2,072,253

The clumsy and defective construction of agricultural implements, formerly so conspicuous, becomes every year less observable. In most parts much attention is paid to their construction; and where they differ from those most in vogue in Great Britain, the cause can be traced to the peculiarities of the soil. The Irish spade is narrower in the blade than the English, and longer in the handle. In many parts its use is supplied by a narrow spade, with a projection for the foot only on one side; it is called a loy. In cutting turf, a kind of double loy, called a slane, is used. Oxen are little employed in tillage. When used in the plough they are yoked sometimes by the horns, sometimes by the breast. The Scotch cart or dray, with two large wheels and a single horse, is to be found in every part, its structure having been found best adapted to a hilly country such as Ireland generally is. It has in a great measure superseded the old Irish car. The fences vary according to the character of the soil. In the rocky districts in the north and west they are mostly dry-stone walls, sometimes of great thickness at bottom, being used as well for a means of disposing of the numerous loose stones on the surface, as for inclosing the land. A mound, planted at top with furze or gorse, is a common fence in those parts where fuel is scarce. In the more improved parts white thorn hedges are most usual. Lime or limestone gravel is the most general manure. It is often used mixed with turf mould. On the sea-coasts coralline sand and sea-weed are employed; the former is often conveyed to great distances into the interior.

Ballinasloe great cattle fair held in October is the chief mart for the sale of sheep and horned cattle, and the prices obtained there have considerable influence over the general markets throughout the kingdom. The following table affords a comparative view of the number of cattle exported from Ireland to Great Britain from 1847 to 1854:—

Year.	Oxen, Bulls and Cows.	Calves.	Sheep and Lambs.	Swine.
1847	189,960	9,992	324,179	106,407
1848	196,042	7,086	255,682	110,787
1849	201,811	9,831	241,061	68,053
1850	184,616	4,462	176,945	109,170
1851	183,760	2,474	151,807	136,162
1852	197,644	3,826	158,020	151,895
1853	180,785	5,281	224,500	101,396
1854	204,004	7,514	356,780	170,188

Woollen manufactures.

The rich pasturages, adapted both for black cattle and sheep, furnished in abundance the material for two branches of manufacture, the woollen trade, and the tanning of leather. The former was carried on to a considerable extent at a very remote period. Traces of an export of woollens to Italy as early as the reign of Edward III. have been discovered. The manufacture was an object of legislative interference as early as the third year of Edward IV. (1462); and an act of Henry VIII. in 1542 expressly notices the exportation of woollen yarn from Ireland. The former of these acts was the first attempt to restrict the importation of foreign goods into England. By it woollens, laces, and ribbons were prohibited; but a provision was inserted, "that all wares and chaffers made in the land of Ireland may be brought and sold in this land of England, as they were wont to do before the making of this statute." Although subsequent prohibitory acts of Elizabeth, James, and Charles I. make no mention of Ireland, there is little reason to suppose that any change was made as to the freedom of trade with this country, until the 12th of Charles II., when an act was passed in the English parliament, imposing such rates of duty as effectually prevented importation. By an act of the same year, the exportation of wool from England was prohibited generally, as was that from Ireland, to foreign countries. An act of the 9th and 10th of William III. prohibited the exportation of fullers' earth to Ireland. But the great blow to this branch of national industry was caused by an address from both Houses of the English parliament to William in 1698, praying him "with a view to secure the woollen manufacture as much as possible entire to England, that he would use his utmost diligence to hinder the exportation of wool from Ireland, except to be imported hither; and for discouraging the woollen and encouraging the linen manufactures of Ireland." The immediate consequence of these addresses was the passing of an act prohibiting the exportation of wool or woollens, except to England, from which country the manufactured article was already excluded by the act of the 12th Charles II. still in force. Under this code England effectually restrained the Irish trade. The supply of the raw material was narrowed by the impossibility of importing British wool, and the manufactured goods were confined to the domestic consumption of the country. The laws which prohibited the exportation of Irish woollens to foreign countries, and to the British colonies, were repealed in 1779. By the Act of Union, the duties on woollens imported into either island were confined to those called "old and new draperies;" and the high duties of Charles II. were reduced to eightpence halfpenny per yard on the old, and twopence three farthings on the new draperies. By the same act, England relaxed her monopoly so far as to permit the export of wool and woollen yarn duty free to Ireland. Previous to the Union, when the import of English wool was prohibited, the manufacture of Ireland was confined to the coarsest description of goods, for which alone the Irish wool was suited. Previous to the introduction of carding machinery the manufacture of woollens was inconsiderable, but immediately after the Union, machinery worked by water-power became general and the trade increased, but the combinations of workmen and protecting duties rendered the Irish manufacturers unable to compete with those of Great Britain, and the trade continued limited to the demand for home consumption. Flannels are made in Wicklow, and blankets in Kilkenny. Frieze of the coarsest kind is in some parts manufactured by the peasantry for domestic consumption, and the supply of the adjoining district.

Linen.

The same legislative measure which was intended to discourage the woollen manufacturer stated, that "if the Irish turned their industry and skill to the settling and improving of

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the linen manufacture, they should receive all the countenance, favour, and protection for its encouragement, and promotion to all the advantage and profit they might be capable of deriving from it." This declaration should not lead to the inference that the manufacture had been previously unknown or disregarded in Ireland. On the contrary, the use of linen was so prevalent amongst the higher orders, that sumptuary laws were enacted to check its excessive use. The unfortunate Earl of Strafford seems also to have anticipated the views of the British manufacturers on the subject. Instead of extinguishing the woollen trade by exclusive duties, he laboured to foster that of linen. He imported flax seed in large quantities from Holland, and held out premiums to induce Flemings and Dutchmen acquainted with the manufacture to settle in Ireland. On these laudable objects he spent upwards of L.30,000 of his private fortune; and his example was followed by the Duke of Ormond. Still, however, the woollen manufacture prevailed, particularly in the S. and W., where the climate and the extensive pasturage for sheep insured a copious and cheap supply of the raw material. In the same spirit, an act was passed by the English parliament in 1696, to encourage foreign linen manufacturers to settle in Ireland; and with that view all articles made of flax or hemp in this country were admitted into England duty free,—a privilege which is estimated to have given that branch of trade an advantage of L.25 per cent. over other nations in the English market. The Irish parliament, responding to the sentiments and wishes of that of England, promised that "it would heartily endeavour to establish the linen and hempen manufacture, so as to render it useful to both kingdoms;" adding, that "it hoped to find such a temperament in respect to the woollen trade here, that the same may not be injurious to England." The "temperament" here announced was evinced most effectually by laying prohibitory duties on the export of its own woollens, thus accepting the compact on the part of Ireland, and giving the country an incontrovertible claim upon England for a perpetual encouragement of that branch which was to be nurtured in lieu of the natural staple of the country. In furtherance of the measures mutually agreed on between both kingdoms, a board of trustees for the encouragement of the linen manufacture was established in 1710, consisting of a number of individuals of influence in each province. Under its control a code of regulations was devised and maintained, which extended to the most minute particulars of the processes, and had the effect for many years of securing the fabric a decided preference both in the home and foreign market. A large sum was annually granted to this board, for premiums and the supply of wheels and other implements, which was continued till the year 1830, when the grants were discontinued, and the board ceased to act. The flax seed is chiefly imported. Little is grown in the country, as, notwithstanding all the exertions made by the grower, the plant raised from it is considered of inferior quality.

The first flax-spinning machinery erected in Ireland was at Cork in 1805. About 1825, English and Scotch yarns were first imported into Ireland, and undersold the hand-spun article. The use of machinery gradually increased, and the linen manufacture soon became extinguished in the S. and W., and concentrated in the N. In 1821 the yarns were all made by hand. With one or two trifling exceptions, not a spinning factory was to be seen. In 1849 there were upwards of 70. In 1819, with the existence of bounties on the export of linens, and heavy duties on the admission of foreign flax and linen fabrics, only 40 millions of yarns were exported from Ireland. In 1849 these exports had increased to 75 millions.

In the *Hand-Loom Commissioners' Report* in 1840, Mr Cæsar Otway, describing Banbridge, records the salvation of the linen trade by the introduction of machinery:—"The numerous falls, and the extensive water-power afforded by the river Ban and its tributaries, the undulatory formation of the surface of the country, so well adapted for bleach-greens, the central position of the district, as regarded the great linen-weaving counties, and its contiguity to Belfast, attracted, at an early period, attention as a favourable location for the investment of capital in the linen trade. Between Banbridge and Guildford some of the first manufacturers who invested large capital in the linen trade established themselves, and here the great experiment of placing the linen trade of Ireland on a new foundation was tried: the great subdivision of the capital invested in the linen trade, the want of a proper division of labour being applied to it, and a direct market for the disposal of the produce year after year, rendered it more apparent that it could not be longer continued on its former system. All the attempts on the part of the legislature to protect the trade, and of the Linen Board to encourage it, had only aggravated the evils they intended to remedy. On the repeal of the protecting duties, and the introduction of mill-spun yarn into England and Scotland, it became evident to the capitalists of the north of Ireland, either that the linen trade should be placed on a new foundation, and conducted on the improved principles that were being applied to its manufactures in the other portions of the United Kingdom, or that Ireland should lose its linen trade altogether. The question became not as to whether the employment of linen-weavers by extensive manufacturers, and confining them to the mere process of weaving, was or was not more advantageous than the old system, where the producer of the raw material, the weaver of the cloth, and the merchant who disposed of it, were the same individual; but whether it would be more profitable to alter the system or lose the trade. The result was, the linen manufacture was placed on a new foundation, and men of extensive capital and skill became engaged in it. The linen trade was not only thus preserved, but extended, and all the individuals engaged in its operations here have been bettered by the change."

Manufactures.

The following tables show the value of the brown or unbleached linen sold in the several linen markets in Ireland during a period of four years, as furnished by the returns of the seal-masters and inspectors of the Linen Board to parliament in 1825. The sums stated in the former of these tables are the first cost paid to the manufacturer by the country purchaser; the value of most of the linen sold is afterwards considerably increased by the process of bleaching and other treatment.

Total of Brown or Unbleached Linen sold in Ireland.

Years.	Leinster.	Ulster.	Munster.	Connaught.	Total.
	L.	*L.*	*L.*	*L.*	*L.*
1822	285,354	2,066,122	68,870	117,664	2,538,010
1823	336,698	2,127,529	82,202	130,914	2,677,343
1824	207,638	1,968,180	95,195	140,856	2,411,869
1825	192,888	2,109,309	110,420	168,090	2,580,707
Total	1,022,578	8,271,140	356,687	557,524	10,207,929

(Since 1825 no returns have been kept.)

The number of yards of linen exported from Ireland was—

	To Great Britain.	To Foreign parts.	Total.
1800	No separate returns.		35,676,908
1801	34,622,898	3,288,704	37,911,602
1809	33,018,884	4,147,515	37,166,399
1813	35,018,884	3,926,731	38,945,615
1817	50,290,321	5,940,254	56,230,575
1821	45,519,509	4,011,630	49,531,139
1825	52,560,926	2,553,589	55,114,515
1835	...	...	60,916,592

The apparent amount of exports of linen from Ireland is now small, arising from the fact, that nearly all is sent by cross-channel steamers to the English and Scotch ports, whence it is transhipped to foreign countries. The entire export from Ireland to Great Britain and all foreign countries reaches about 106,000,000 yards; value, L.4,400,000. The following table shows a comparison of the production and value of the yarns made, and amount of wages paid, in an interval of ten years:—

	Bundles of Yarn produced.	Value.	Wages Paid.
1840	5,000,000	L.1,500,000	L.208,000
1850	7,400,000	1,942,500	317,000

Cotton.

The cotton manufacture was introduced in 1777, and became an object of attention to the Irish parliament, which endeavoured to secure a monopoly of the home market by high import duties and bounties. The first cotton mills were erected at Prosperous, in the county of Kildare, and in Belfast, about the year 1784. From that period till the Union, it throve, in consequence of the measures adopted to prevent foreign competition. At the Union it was arranged that the then existing duties should continue for eight years, after which they were

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to be gradually lowered, by eight annual reductions, in such manner that, after the year 1816, they should stand at 10 per cent. *ad valorem*. The progress of the manufacture has been very slow as compared with that of Great Britain. The alteration of the scale of duties materially affected the home demand, and the immense capital and great superiority of the British artist have contributed much to secure to his manufacture a preference in the foreign market.

In 1822 the quantity of cotton wool imported was 3,755,024 lbs., and of cotton yarn, 1,197,294 lbs.; leaving a total quantity of 4,576,816 lbs. of cotton yarn consumed, after allowing 10 per cent. for waste, &c., on the cotton imported.

Silk.

The silk manufacture was introduced into Ireland in 1693, by French emigrants after the revocation of the Edict of Nantes. Its seat was the city of Dublin, where it was maintained by the aid of protecting duties. Some feeble attempts to fix it in the country parts failed completely. The last of these was so lately as 1825, when a company was formed for the purpose of fixing the trade on a secure basis in the south of Ireland, by rearing the silk-worm there, and thus having the benefit of the raw material for the labour of producing it; but after considerable expense had been incurred for the purchase of ground and the planting of mulberry trees, the scheme was relinquished as hopeless. One branch of the manufacture, a fabric of mixed worsted and silk, known by the name of tabbinet or Irish poplin, is in considerable demand, both at home and elsewhere, for the richness and beauty of the texture. It is almost the only branch now flourishing. The general trade has been nearly annihilated by the removal of the protecting duties in 1821, after which, in consequence of the combination of the workmen to keep up the rate of wages, the Irish manufacturer became unable to compete successfully with the English trade.

Lace.

The manufacture of lace is carried on to some extent in Limerick, and of late years a great source of employment for females has been introduced in the working of patterns on muslin with the needle.

Metals.

Manufactures in metal exist only to a small extent; and the making of glass, which was once carried on largely, has declined.

Provisions.

The provision trade, together with the exportation of the agricultural produce of the country, has always been, and will probably long remain, the principal commercial business carried on in Ireland. This export trade is mainly with Great Britain to Liverpool, Bristol, and Glasgow, from Belfast, Dundalk, Drogheda, Newry, Waterford, Limerick, and more particularly from Cork and Dublin. In 1825, 181,276 barrels of beef and pork, 362,278 cwts. of bacon and hams, 474,161 cwts. of butter, and 35,279 cwts. of lard, were exported. Since that period the provision trade has vastly increased, but in consequence of the cessation of the duties on the cross-channel trade, there are no means of accurately ascertaining the present extent of the trade.

Distillation.

The art of distillation, and the use of spirituous liquors, was introduced into Ireland at an early period. Camden, who derived his knowledge of the country from preceding writers, states that "the excessive moisture of the air and soil occasions many to be troubled with fluxes and catarrhs, particularly strangers, to stop which they have excellent usquebagh, much less heating and more drying than ours." It was not, however, subjected to fiscal regulations until the reign of Charles II., when, in 1661, an excise duty of 4d. per gallon was charged, and continued at that rate till 1715, when an additional duty of 3d. was imposed; and two years after a further duty of 1d. This duty in 1719 produced a revenue of L.5785. In 1785 the duty was fixed at 1s. 2d., and so continued for some years. Its produce at that rate in 1791 was L.204,648. After a variety of changes, by which it was progressively raised, it stood in 1814 at 5s. 6d.; and shortly afterwards an attempt was made to maintain a duty of 6s., but the experiment was found to be unsuccessful, and it was lowered to the former rate after two years' trial. Severe restrictions were imposed, and a complicated and harassing system of checks established, upon every part of the process, to prevent the possibility of yielding to the temptations to defraud the revenue occasioned by the large rate of duty. The consequence was, that the whole spirit trade was thrown into the hands of a few capitalists, who, by their mutual understanding, were enabled to check and control the officers of the revenue in their attempts to stop the issue from the distilleries of spirits which had not paid duty; whilst in the country parts, and particularly in the mountainous districts in the north and west, illicit distillation was carried to an enormous extent. In 1811, when the duty was 2s. 6d. per gallon, 6,500,000 gallons were paid for; in 1822, when it was raised to 5s. 6d., only 2,950,000 gallons were brought to charge, whilst at this latter period the commissioners of revenue estimated the total consumption at not less than 10,000,000 gallons, of which therefore upwards of 7,000,000 paid no duty. The profits on the manufacture were such as to induce the people engaged in illicit distillation to run all risks, and to set at defiance every effort of the constituted authorities to put down the practice, and consequently the duty was reduced in 1822 from 5s. 6d. to 2s. the wine gallon, or 2s. 4d. the imperial gallon. The results are best exhibited by the following table, showing the quantity of spirits that paid duty each year, the rate of duty, and the net amount of revenue collected:—

Manufactures.

Years.	Gallons Imperial Measure.	Rate per Gallon.	Net Amount of Revenue.
1821	3,311,462	5s. 6d. per Irish gallon	L.912,288
1822	2,910,483	Ditto	797,518
1823	3,590,376	Ditto	634,460
1824	6,690,315	2s. per English gallon	771,690
1825	9,262,744	Ditto	1,084,191
1826	6,834,867	2s. 10d. per imperial gallon	964,509
1827	8,260,664	Ditto	1,122,096
1828	9,937,903	Ditto	1,395,721
1829	9,212,223	Ditto	1,305,064
1830	9,004,539	2s. 10d., 3s., and 3s. 4d. per do	1,409,128
1831	8,710,672	3s. 4d	1,451,580
1832	8,657,756	Ditto	1,442,845
1833	8,168,596	Ditto	1,360,769
1834	9,763,808	3s. 4d. and 2s. 4d	1,464,581

The following table shows the number of gallons of Irish spirits brought to charge since 1840, and the amount of duty:—

Years.	Gallons.	Duty.
1840	10,815,709	L.1,261,832 14 4
1841	7,401,051	936,126 3 8
1842	6,485,443	864,725 14 8
1843	5,290,650	904,908 8 0
1844	5,546,483	852,418 11 4
1845	6,451,137	860,151 12 0
1846	7,605,196	1,014,026 2 8
1847	7,952,076	1,060,276 16 0
1848	5,737,687	804,984 8 0
1849	8,126,507	943,057 14 8
1850	6,973,333	929,777 14 8
1851	7,408,086	987,774 19 0
1852	7,550,518	1,006,735 14 8
1853	8,208,256	1,094,434 2 8
1854	8,136,362	1,273,151 18 8

The principle of extracting the largest possible amount of revenue from the duty on spirits having been adopted, the rate was raised in 1855 to 6s. 2d. per gallon, when the number of gallons brought to charge declined to 6,228,856, and the maximum rate of duty productive to the revenue appears to have been attained, if not exceeded.

There are breweries in most of the large towns in Ireland, the produce of which has superseded the use of beer imported from Great Britain, and also furnishes quantity sufficient for a large export trade, which has of late years much increased.

Cross-channel trade.

The external trade of Ireland branches out into two great divisions, the cross-channel trade with Great Britain, and the commerce with foreign nations. The relative importance of each port, as respects its commercial character, will appear from the first and second tables following, which contain a specification of the number and tonnage of vessels that entered and cleared out coastways, from and to the British colonies and foreign countries in 1853, in each of the ports of Ireland; while the progress of domestic navigation will appear from the third and fourth tables, containing a summary, in triennial periods, of the tonnage of ships belonging to and registered at the different ports in Ireland, and of the number and tonnage of those employed in the cross-channel trade.

Statistics. *Number and Tonnage of Sailing Vessels and Steam Vessels that Entered and Cleared Out Coastways at each of the Ports in Ireland in the Year* 1853. Statistics.

Ports.	Sailing Vessels.				Steam Vessels.			
	Inwards.		Outwards.		Inwards.		Outwards.	
	Vessels.	Tonnage.	Vessels.	Tonnage.	Vessels.	Tonnage.	Vessels.	Tonnage.
Belfast	5,163	470,065	1,180	198,561	1,477	419,511	1,399	412,604
Cork	2,080	170,291	1,513	94,769	265	104,376	257	101,329
Drogheda	559	42,462	265	19,757	208	80,240	256	94,142
Dublin	5,110	396,392	2,510	129,787	1,436	440,446	1,608	493,132
Londonderry	588	39,000	256	15,320	468	148,815	464	146,693
Newry	697	42,987	198	11,791	145	40,686	135	38,266
Waterford	905	72,391	736	50,955	169	49,357	177	50,400
Other Ports	2,999	183,877	1,912	127,255	690	201,396	396	122,844
Total	18,101	1,417,465	8,570	648,195	4,860	1,484,827	4,692	1,459,410

Number and Tonnage of Vessels that Entered and Cleared out from and to the Colonies and Foreign Ports at each of the Ports of Ireland (including their repeated voyages), distinguishing British and Irish from Foreign Vessels, in the year 1853.

Ports.	From and to British Colonies.								From and to Foreign Places.							
	Inwards.				Outwards.				Inwards.				Outwards.			
	British & Irish.		Foreign.		British & Irish.		Foreign.		British & Irish.		Foreign.		British & Irish.		Foreign.	
	Ves.	Ton.	Ves.	Ton.	Ves.	Ton.	Ves.	Ton.	Ves.	Ton.	Ves.	Ton.	Ves.	Ton.	Ves.	Ton.
Belfast	57	17,968	24	7,921	31	10,472	12	3,043	160	22,603	205	33,157	69	13,340	211	40,869
Cork	52	14,952	5	1,342	54	15,691	16	3,358	157	28,665	224	50,164	61	11,422	207	49,216
Dublin	61	20,545	22	7,244	26	9,184	13	3,905	157	21,786	175	31,538	51	13,836	181	34,838
Limerick	39	11,206	...	...	38	12,419	4	1,210	99	22,656	98	24,994	29	6,878	71	18,952
Waterford	22	6,029	...	...	28	8,274	13	3,346	51	10,819	96	20,136	24	5,149	83	18,652
Other ports	78	70,700	9	2,837	43	13,923	11	2,615	226	38,007	337	58,166	85	23,626	202	39,101
Total	309	90,356	60	19,344	220	69,953	69	17,477	850	144,536	1135	218,155	319	74,251	945	201,628

Account of the Tonnage belonging to, and Registered at the Irish Ports at different Triennial Periods, with the Increase between the first and last Periods.

Name of Port.	Years 1840, 1841, 1842.	Years 1843. 1844, 1845.	Years 1846, 1847, 1848.	Years 1849, 1850, 1851.	Increase between first period, 1797-98 99, and last period, 1849-50-51.
	Tons.	Tons.	Tons.	Tons.	Tons.
Ballina	...	...	...	162	...
Belfast	149,809	154,402	202,011	226,414	213,352
Coleraine	..	...	2,795	1,030	...
Cork	101,349	115,658	145,127	149,465	136,041
Drogheda	14,507	14,692	19,287	20,524	17,528
Dublin	94,742	105,101	126,288	123,182	89,697
Dundalk	...	...	7,971	8,918	...
Galway	...	...	11,443	12,170	...
Limerick	42,247	42,837	43,155	39,646	36,256
Londonderry	26,155	23,507	27,844	23,383	20,527
Newry	32,720	35,018	35,714	30,743	18,251
Ross	...	...	25,824	28,371	...
Skibbereen	...	...	...	8,649	...
Sligo	13,030	9,353	14,296	13,112	12,766
Strangford	...	...	...	5,626	...
Tralee	...	...	979	3,180	2,640
Waterford	60,346	66,547	81,926	69,237	60,308
Westport	...	...	735	624	...
Wexford	26,098	24,583	25,318	27,089	20,205
Other ports	8,291	40,283	11,230	...	...
Total	569,294	631,981	781,943	791,525	627,571

Number and Tonnage of Vessels employed in the Intercourse between Great Britain and Ireland, which entered Inwards and cleared Outwards with Cargoes, at the Ports of the United Kingdom during Four Years.

	1851.		1852.		1853.		1854.	
	Ves.	Ton.	Ves.	Ton.	Ves.	Ton.	Ves.	Ton.
Inwards	9,187	1,679,483	9,406	1,762,197	9,840	1,931,939	10,606	2,042,146
Outwards	19,051	2,378,097	18,676	2,409,905	19,244	2,591,555	20,685	2,819,395

These tables exhibit the great preponderance of the cross-channel trade, which has been greatly augmented since the introduction of steam navigation.

The earliest attempt at establishing a company for this purpose was made in Dublin about the year 1816. Two small vessels were fitted out; but the construction of their machinery was faulty, their dimensions were too small, and the effort proved abortive. The cross-channel trade, with the exception of that in coal, is almost wholly carried on by means of steam vessels, but since 1825, when the trade between Great Britain and Ireland was placed upon the footing of a coasting trade, no separate returns have been made out at the custom-house of the quantity or value of the exports and imports.

Fisheries. The coasts of Ireland abound with fish; and Sir William Temple observed, "that the fishery of Ireland, if improved, would prove a mine under water, as rich as any under ground." Arthur Young also remarks, "that there is scarcely a part of Ireland, but what is well situated for some fishery of consequence; and that her coasts of innumerable creeks and river mouths, are the resort of vast shoals of herrings, cod, ling, hake, and mackerel, &c., which might, with proper attention,

Statistics. be converted into funds of wealth." Yet the Irish fisheries have never prospered.

Bounties to encourage the fisheries first granted in 1764, and continued for several years, failed to place them on a productive footing. The experiment was repeated in 1819, when commissioners were appointed for applying in Ireland the system previously adopted for the Scotch fisheries, with powers to grant bounties to persons building fishing-boats of a certain tonnage, and for the curing of herring and some other kinds of fish. An annual sum of L.5000 was placed at their disposal, the application of which was afterwards limited to the building of piers and the repairing of boats; a large portion of the grant was also employed as a loan fund, to enable the poorer fishermen to procure the necessary gear on advantageous terms. The Irish Fishery Board was abolished in 1830, and the unapplied residue of the grants vested, in the first instance, in the Board of Inland Navigation, and subsequently in that of Public Works, to whom sums of L.4500, L.3500, L.2500, L.1500, and L.1000, were granted during the five ensuing years, to be applied to the completion of piers erected before 1830, and for defraying the expenses incurred in the collection of the outstanding loans of the former commission. In 1842, the Board of Public Works were appointed commissioners for the improvement and regulation of the fisheries, and the coast has been portioned out into 28 fishery districts. Statistics.

The following table shows the number of vessels and hands engaged in the sea fisheries under different circumstances, viz., —1. Under the system of bounties and loans; 2. After the withdrawal of bounties; 3. When carried on without any assistance either of bounty or loan; 4. Before the years of famine; 5. After the famine; and in the years 1851 and 1852:—

	1830.	1836	1844.	1845.	1848.	1851.	1852.
Vessels and Boats.....	13,119	10,761	17,955	19,883	15,932	14,756	13,277
Men and Boys.....	64,771	54,119	84,708	93,073	70,011	64,612	58,822

Later returns have been found to be somewhat inaccurate in detail, but it is certain that the progressive decline in the number of vessels and men employed still continues.

The most ancient annals of Ireland record a twofold division of the country by two of the descendants of Milesius, who made an imaginary line, drawn from Dublin to Galway, the boundary of their respective shares; of these the northern was called Leath Conn, the southern Leath Mogha. In the time of Ptolemy the island was partitioned out by a number of tribes, whose position has been determined by Whitaker as follows:— Territorial divisions.

Name according to Whitaker.	Name according to Ptolemy.	Modern County.	Boundary From	Boundary To
NORTH.				
Robogdii	Ροβογδιοι	Londonderry, Antrim	Hornhead	Fairhead.
EAST.				
Darini	Δαρινοι	Antrim, Down	Fairhead	Ardglas.
Voluntii	Οὐολουντιοι	Down, Armagh, Louth	Ardglas	Boyne River.
Eblani	Ἐβλανοι	Meath, Dublin	Boyne River	Læbius or Liffey River.
Caucii	Καυκοι	Dublin, Wicklow	Liffey River	Oboca or Ovoca.
Manapii	Μανσπιοι	Wicklow, Wexford	Oboca	Carnsore Point.
Coriundi	Κοριονδιοι	Wicklow, Kildare, Carlow	Between the Boyne and Barrow Rivers, the Eblani, and the Brigantes.	
SOUTH.				
Brigantes	Βριγαντες	Wexford, Waterford	Carnsore	Blackwater River.
Vodii	Οὐοδιοι	Cork	Blackwater	Bann River.
Uterni	Ὀυτερνοι	Cork, Kerry	Bann	Ibernus or Dingle Bay.
WEST.				
Luceni	.....	Kerry	Dingle Bay	.....
Veliborii	Ὀυελιβορνοι	Kerry, Limerick	.....	Senus or Shannon River.
Gangani	Γαγγανοι	Clare	.....	.....
Auteri	Ἀυτερνοι	Galway	Galway Bay	Libnius River.
Nagnatæ	Ναγναται	Mayo, Sligo, Roscommon, Leitrim, Fermanagh	Libnius	Rhebius or Ballyshannon River.
Herdini	Ἐδινοι	Donegal	Ballyshannon	Hornhead.
CENTRAL.				
Scoti	.....	Tyrone, Fermanagh, Leitrim, Monaghan, Cavan, Longford, Westmeath, King's, Queen's, Kilkenny, Tipperary	Bounded by the Shannon, Loughs Allen and Erne, west; Barrow, Boyne, and Lough Neagh, east; Suir and Blackwater south; and a chain of mountains north.	

A subsequent division was that into the five petty kingdoms of Leinster, Ulster, Munster, Connaught, and Meath, which latter consisted of the counties of Meath, Westmeath, Longford, and parts of Armagh and Louth. This division continued until after the English invasion; but, in the reign of King John, the portions of Ireland subject to his sway were formed into the twelve counties of Dublin, Meath, Kildare, Uriel (now Louth), Carlow, Kilkenny, Wexford, Waterford, Cork, Kerry, Limerick, and Tipperary. No further change took place until the reign of Philip and Mary, when the King's and Queen's Counties were formed. Elizabeth divided Connaught into the seven counties of Galway, Clare, Roscommon, Mayo, Sligo, Leitrim, and Longford; and Ulster, into the nine counties of which it consists at present. Wicklow was separated from Dublin and made a distinct county by James I. The practical division of the country was, however, for centuries into the English and Irish portions of the island, or Ireland within, and Ireland beyond the Pale. No alterations have taken place since the reign of James I., excepting the division of Cork and Tipperary into ridings.

The 32 counties of which Ireland consists, are divided into 316 baronies, comprising 2,532 parishes, and these again into townlands; or, as they are sometimes called, ploughlands, which is the name of the smallest of the territorial subdivisions.

Statistics. The number of these townlands is about 60,760, averaging 300 acres each. There are also eight counties of cities and towns, viz. Dublin, Cork, Limerick, Waterford, Kilkenny, Galway, Drogheda, and Carrickfergus. Independently of the above-named divisions, the whole country is divided into 163 Poor-Law Unions, which are subdivided into about 3440 electoral divisions. The names of all the smaller divisions of land and of most villages, towns, lakes, rivers, &c., are of Celtic origin; and the following explanation, taken from Dr Beaufort's *Memoir of a Map of Ireland*, of those words which most frequently occur in composition, will render the names of places more intelligible.

Agh, a field.
Anagh, or *Ana*, a river.
Ard, a high place or rising ground.
Ath, a ford.
Awin, a river.
Bally, or *Ballin*, a town, or inclosed place of habitation.
Ban, or *Bane*, white or fair.
Beg, little.
Ben, the summit of a mountain, generally an abrupt head.
Bun, a bottom, a foundation or root.
Car or *Cahir*, a city.
Carrick, *Carrig*, *Carrow*, a rock, or stony place.
Cork, *Corragh*, a marsh or swampy ground.
Clara, a plain.
Croagh, *Croghan*, a sharp-pointed hill resembling a rick.
Clogh, *Clough*, a great stone.
Curragh, a marsh or fenny plain.
Clon, a glade or level pasture ground.
Col, *Cul*, a corner.
Derry, a clear dry spot in the midst of a woody swamp.
Dow, a height or fastness, a fortress.
Donagh, a church.
Drom, a high, narrow ridge of hills.
Inch, *Inis*, an island.
Ken, a head.
Kill, a church or cemetery.
Knock, a single hill or a hillock.
Lick, a flat stone.
Lough, a lake or a pool.
Magh, a plain.
Main, a collection of hillocks.
More, large or great.
Rath, a mound or entrenchment, a barrow.
Ross, a point of land projecting into water.
Shan, old.
Sliebh, a range of mountain, a hill covered with heath.
Tack, a house.
Temple, a church.
Tom, *Toom*, a bush.
Tra, a strand.
Tober, *Tubber*, a well or spring.
Tullagh, a gentle hill, a common.
Tully, a place subject to floods.

Government. The executive government is vested in the lord-lieutenant, who must be a peer, assisted by a privy council, indefinite in number, appointed by the crown, and by a chief secretary, a member of the House of Commons. Since 1801 there have been 18 viceroys, and 27 chief secretaries of Ireland. In the absence of the lord-lieutenant, his place is supplied by lords-justices, who are usually the primate or the Archbishop of Dublin, the lord-chancellor, and the commander of the forces. Each county is in charge of a lieutenant, generally a peer, an indefinite number of deputy lieutenants and magistrates, who act gratuitously, and one or more resident paid magistrates, all appointed by the crown, during pleasure. The counties of cities and towns, and the boroughs, are governed by their own magistrates. The judicial establishment consists of the Lord Chancellor, the Master of the Rolls, four judges in each of the courts of Queen's Bench, Common Pleas, and Exchequer; an assistant barrister for each county, a bankrupt court with two judges, a commissioner of the Insolvents' Court, the judges of the Prerogative Court and of the Admiralty. Two of the judges hold assizes for criminal and civil pleas, in each county, in spring and summer every year. The country is divided into six circuits: *Home*—Meath, Westmeath, King's, Queen's, Carlow, Kildare; *North-East*—Louth with Drogheda, Down, Antrim with Carrickfergus, Armagh, Monaghan; *North-West*—Longford, Cavan, Fermanagh, Tyrone, Donegal, Londonderry county and city; *Leinster*—Wicklow, Wexford, Waterford county and city, Kilkenny county and city, Tipperary E. and W. Ridings; *Munster*—Clare, Limerick county and city, Kerry, Cork county and city; *Connaught*—Roscommon, Leitrim, Sligo, Mayo, Galway county and town. The details of the execution of the laws are committed to the constabulary in the counties, and the police in Dublin. Statistics.

The country is now represented in the imperial parliament by 4 spiritual peers in rotation, 28 temporal peers elected for life, and 105 commoners; of which latter class 64 represent the 32 counties, 2 the university, 12 the cities and towns of Dublin, Cork, Limerick, Waterford, Belfast, and Galway, and 27 the boroughs. The number of electors under the Reform Act was, in 1832, 98,857; on 1st January 1850, the constituency had diminished to 61,036—27,180 in the counties and 33,856 in the cities and boroughs. The Act 13th & 14th Vict., cap. 69, was passed in 1850 to amend the representation; and in addition to those persons previously qualified to register and vote in county elections, occupiers of any tenements rated in the last poor rate at a nett annual value of L.12 and upwards, are entitled to vote in elections for counties, subject to registration in accordance with the act and to certain limitations therein; also owners of certain estates of the rated nett annual value of L.5. In boroughs, occupiers rated in the last poor-rate at L.8 and upwards are entitled to vote, subject to registration and certain limitations in the act. The number of electors registered on the 1st January 1851 was 163,546, being 135,245 in the counties, and 28,301 in the cities and boroughs. Of the 300 members who composed the Irish House of Commons in 1793 no less than 200 were stated by Mr Grattan to be the nominees of private individuals; and from 40 to 50 members were returned, it is said, by constituencies of not more than 10 electors. Eighty-three of these nomination boroughs were afterwards abolished, the proprietor of each receiving L.15,000 compensation, for which purpose the sum of L.1,245,000 was voted by the Irish parliament. The Act of Union reduced the number of representatives in the House of Commons to 100, and the Reform Act of 1832 added five to that number.

By the Municipal Reform Act, 3d & 4th Vict., cap. 118, 11 of the principal towns, each containing upwards of 12,000 inhabitants, are divided into wards, and are governed by a council consisting of a chief magistrate called mayor, sovereign, provost, or portreve—that of Dublin styled lord mayor—and a certain number of aldermen and councillors for each ward; all of whom are elected by the inhabitants entitled to vote in right of their property. The total number of existing corporations is 95, possessing an income of about L.62,000 per annum. Independently of the towns with corporations, the Act of 9th Geo. IV., cap. 82, enabled every city and town to elect commissioners to superintend the lighting, paving, and cleansing of their respective districts, but the Towns Improvement Act of 1854 supersedes the Act of 9th Geo. IV. in each town after the election of commissioners under the new act.

Militia. The *Irish Militia* consists of 12 regiments of artillery, and 35 regiments of infantry, numbering, when embodied, 31,349 men.

Police. The first regular police force established throughout Ireland was originated by the Act 54th Geo. III., cap. 131, passed in 1814—"To provide for the better execution of the laws in Ireland by appointing superintending magistrates and additional constables in counties, in certain cases." Other acts followed, but all were consolidated or repealed by the 6th Will. IV., cap. 13, passed in 1836. Originally the expense was defrayed partly by grand jury presentments, and partly out of the Consolidated Fund; but the Act 9th & 10th Vict., cap. 97, passed in 1846, provides that the whole expense shall be borne by the Consolidated Fund, except a moiety of the cost of additional constabulary force applied for by the magistrates of any county or district, or of the reserve force when employed therein, or of an increased force stationed there by the lord-lieutenant. The Act 6th Will. IV., cap. 13, likewise authorized the lord-lieutenant to appoint resident stipendiary magistrates, to act in disturbed districts, or where for any other sufficient cause it should appear to be expedient. The constabulary force consists of an inspector-general, 2 deputy inspectors-general, 2 assistant inspectors-general, a receiver, surgeon, veterinary surgeon, 35 county inspectors, 248 sub-inspectors, 335 head-constables; 2049 constables, and 9491 sub-constables; total, 12,166, with 360 horses, whose maintenance in 1854 amounted to L.596,760, including the expense of 71 stipendiary magistrates. The proportion of the expense of the force charged on the Consolidated Fund in 1854 was L.572,511.

Statistics. *Statement exhibiting the effective strength of the Constabulary Force in each County and County of a City or Town in Ireland on 1st January* 1855; *with the Total Expenditure on account thereof, for the Year ending 31st December* 1854. Statistics.

Counties.	County and Sub Inspectors.	Head Constables.	Constables and Acting Constables.	Sub-Constables.	Total.	Total Expenditure of each County. L.	s.	d.
Antrim	7	7	46	181	241	11,846	14	9½
Armagh	6	7	37	149	199	11,536	7	3¾
Carlow	5	5	30	115	155	7,439	14	2¾
Cavan	9	10	61	326	406	17,406	18	10¼
Clare	10	11	72	310	403	19,359	13	3
Cork, East and West Ridings	21	25	156	575	777	37,668	2	7¼
Donegal	9	12	52	266	339	16,451	17	10
Down	7	8	48	199	262	12,105	8	6¼
Dublin	6	6	45	173	230	10,124	12	9¾
Fermanagh	6	6	35	141	188	8,676	12	7½
Galway, East and West Ridings	17	19	113	557	706	33,696	15	2¾
Kerry	7	7	44	173	231	12,030	14	6½
Kildare	6	7	49	186	248	11,258	16	5¾
Kilkenny	8	9	74	310	401	18,528	16	0
King's	7	8	65	274	354	16,328	19	2¼
Leitrim	7	18	46	264	325	14,338	2	11½
Limerick	7	16	99	502	627	27,527	18	6¼
Londonderry	5	5	22	72	104	5,208	19	6
Longford	6	7	37	146	196	9,817	5	6½
Louth	6	8	37	187	238	11,197	15	0
Mayo	10	10	57	207	284	16,152	1	0¼
Meath	9	10	68	307	394	17,145	19	3½
Monaghan	5	6	35	158	204	11,096	14	5½
Queen's	9	12	60	270	351	15,690	15	1¾
Roscommon	8	12	74	354	448	20,905	1	7
Sligo	7	8	36	148	199	10,298	12	8¼
Tipperary, North & South Ridings	21	23	193	879	1116	47,894	3	10¾
Tyrone	7	7	32	135	181	9,028	17	10
Waterford	7	8	43	186	244	11,623	9	3¾
Westmeath	8	8	56	220	292	13.240	11	0½
Wexford	8	8	50	167	233	11,967	8	8¾
Wicklow	7	6	38	168	219	10,477	15	3¼
Cities and Towns.								
Carrickfergus	...	...	1	6	7	276	1	2½
Cork	1	3	23	82	109	4,857	7	2¾
Drogheda	1	1	6	33	41	1,513	13	10
Galway	...	1	9	43	53	2,130	15	0½
Kilkenny	1	2	7	31	41	2,312	9	8¾
Limerick	1	2	13	56	72	3,757	18	3½
Waterford	1	2	11	55	69	3,386	4	8
Depôt, Recruits	...	...	5	515	520	14,416	13	7
Reserve Force at Phœnix Park	5	9	81	296	391	15,281	10	3
Officers at Head Quarters	...	...	...	...	9	40,755	5	5
Total	281	329	2066	9422	12107	596,759	15	3

The Revenue Police organized for the suppression of illicit distillation, consists of about 1200 officers and men, maintained at an expense in 1855 of L.62,720.

Revenues. Before the arrival of the English, the revenues of Ireland were paid in cattle; and even after that period the custom prevailed for several centuries in the parts less subject to foreign influence. Traces of it have been met with so late as the reign of Elizabeth. The new government, under the English, introduced the method of raising money by subsidies. John exacted a subsidy from the Irish clergy, and established the court of exchequer for the general management of the revenue. The same method was continued during the reigns of Henry III. and the first Edwards; but the income thus extracted from the people proved so inadequate to meet the expenditure that recourse was had to the legalized extortion of coygne and livery, which was the levying of man's meat and horse's meat for the soldiery in time of service. The amount of the regular revenue, in the reign of Edward III., is stated by Walsingham and Holingshed to have been L.30,000; but Sir John Davis, who collected his information from the pipe-rolls, and other authentic sources, reduces it to L.10,000. The most remarkable financial measure of Richard II. was a tax upon absentees. In 1433, the eleventh of Henry VI., the revenue was reduced to L.2339, 18s. 6d., whilst the expenses of the government were L.2348, 16s. 11½d., thus exceeding the income by L.18, 17s. 5½d. At the latter end of the same reign, the Duke of York, when sent over as lord-lieutenant with extraordinary powers, not only obtained the whole revenue, but stipulated for an additional supply from England of 4000 marks for the first year, and L.2000 for every year thereafter. Edward IV. raised money by the imposition of duties on all merchandize sold in Ireland except hides. In the fifteenth year of Henry VII. a duty of one shilling in the pound was laid on all merchandize imported and exported, except wine and oil; and a tax, by way of subsidy, of 13s. 4d. on every hide of land. During this reign the revenue seldom exceeded L.5000. Henry VIII. increased the revenue by the suppression of monasteries. The laws against absentees were also enforced. During the first fifteen years of Elizabeth, the revenue was L.120,000, or L.8000 per annum, whilst the expenses amounted to L.490,779, 7s. 6½d. In 1599, at the close of Tyrone's rebellion, L.600,000 were spent in six months; and Sir Robert Cecil affirmed that Ireland had cost the queen L.3,400,000 in ten years' time. In the pacific reign of James the customs increased from L.50 to L.3000, and at the close of his reign to L.9700. The wardships and other feudal rights produced about L.10,000, notwithstanding which the income was inadequate to the expenditure. To defray the expense of the army, an order of baronets was established, by which L.98,500 were raised, in addition to which L.247,433 were remitted from England to clear off the debts incurred by Elizabeth. The Irish parliament granted the same king a subsidy of 2s. 8d. in the pound on every personal estate of three pounds annual value, and fourpence in the pound on every real estate of one pound value; an act of liberality with which James was so much pleased, that he declared "he would hereafter hold his Irish subjects in equal favour with those of his other kingdoms." In the succeeding reign Strafford raised the customs to four times their previous amount. In the same reign the first mention is made of an excise tax. Thurloe, however, in his state papers, mentions that the revenue for two years ending in 1657 amounted to L.137,558, whilst the expenditure was L.142,509. When the Irish parliament met after the Restoration, it granted, first, an hereditary revenue to the king, his heirs and successors; second, an excise for maintaining the army; third, the subsidy of tonnage and poundage for the navy; and, fourth, a tax of two shillings each on hearths, in lieu of the feudal burdens, which were then abolished. After the Revolution, the information respecting this important element of national statistics becomes more precise and satisfactory. The revenue, from the landing of Schomberg in 1689 till the end of the reign of William, was as follows, the total of the previous military expenditure of the war with James having amounted to L.3,851,655:—

Year.	Revenue.	Year.	Revenue.
1689	L.8,834	1696	L.513,534
1690	93,910	1697	548,967
1691	274,949	1698	601,846
1692	393,926	1699	701,932
1693	444,183	1700	766,620
1694	430,534	1701	697,955
1695	438,304	1702	581,286

Statistics.

During the earlier part of Anne's reign the income exceeded half a million, but in her latter days it was less productive. In the reign of George I. the state of the revenue continued nearly as in the preceding reign. In that of George II. there was a surplus, which was applied, not always judiciously, to public works.

The national debt of Ireland, incurred by an excess of expenditure beyond the income of the country, increased with great rapidity towards the close of the last century and till the year 1817, when it ceased to form a separate item in the public accounts, in consequence of the consolidation of the British and Irish exchequers. Its progressive increase since the Revolution is exhibited in the following table:—

Public Debt of Ireland

1716	L.16,106	1770	L.628,883
1720	87,511	1780	1,067,565
1730	220,730	1790	1,586,067
1740	296,988	1800	22,245,190
1750	205,117	1810	75,240,790
1762	223,438	1817	134,602,769

Statistics.

The following table gives an account of the gross revenue levied in Ireland, in each year from 1840 to 1853; distinguishing the expenses of collection and the other payments out of the revenue in its way to the exchequer; also an account of the amount of repayments into the exchequer on account of advances for public works, employment of the poor, distress, &c., &c., in Ireland, for the like period.

Gross Revenue levied in Ireland, in each year from 1840 *to* 1853.

Years.	Revenue.			Charge.				Total discharge of the Income.	Payments into the Exchequer on account of Repayments of Advances for Public Works, &c.	Total Payments into the Exchequer on account of Revenue, Repayments, &c., being amount of cols. 6 & 9.
	Balances outstanding at the commencement of the year.	Gross Receipt of Revenue after deducting Drawbacks, Discounts, &c.	Total Income, including Balances.	Charges of Collection.	Payments out of the Revenue in its way to the Exchequer, other than charges of Collection.	Payments into the Exchequer on account of Revenue.	Balances outstanding at the termination of the year.			
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
	L.	*L.*	*L.*	*L.*	*L.*	*L.*	*L.*	*L.*	*L.*	*L.*
1840	220,509	4,107,866	4,328,375	542,716	35,808	3,559,462	190,389	4,328,375	353,638	3,913,100
1841	190,389	4,118,689	4,309,078	537,615	35,643	3,536,192	199,628	4,309,078	433,441	3,969,633
1842	199,628	4,156,892	4,356,520	536,707	37,256	3,562,492	220,065	4,356,520	371,877	3,934,369
1843	220,065	4,099,062	4,319,127	534,833	36,550	3,574,917	172,827	4,319,127	384,794	3,959,711
1844	172,827	4,406,509	4,579,336	528,700	35,438	3,845,260	169,938	4,579,336	420,470	4,265,730
1845	169,938	4,667,462	4,837,400	539,124	34,654	4,096,853	166,769	4,837,400	394,305	4,491,158
1846	166,769	4,919,622	5,086,391	533,351	34,017	4,339,821	179,203	5,086,391	370,283	4,710,104
1847	179,203	4,454,462	4,633,665	546,499	35,560	3,840,920	210,686	4,633,665	514,481	4,355,401
1848	210,686	4,521,958	4,732,644	566,701	35,764	3,970,448	159,731	4,732,644	357,117	4,327,565
1849	159,731	4,291,807	4,451,538	545,958	38,141	3,711,304	156,135	4,451,538	621,155	4,332,459
1850	156,135	4,257,686	4,413,820	618,744	36,813	3,613,911	144,351	4,413,820	505,021	4,118,932
1851	144,352	4,382,000	4,526,352	561,821	34,072	3,672,883	157,574	4,526,351	360,195	4,642,195
1852	157,574	4,424,785	4,582,359	561,207	33,019	3,820,186	167,946	4,582,359	466,329	4,286,515
1853	167,946	4,752,233	4,886,444	580,713	30,460	4,118,449	156,821	4,886,444	445,889	4,564,338

An Account of the Nett Produce of the Revenue of Ireland, paid into the Exchequer there, in each year, from 1840 *to* 1854, *distinguished under the different heads of Revenue.*

Years.	Customs.	Excise.	Stamps.	Property and Income Tax.	Post Office.	Miscellaneous.	Imprest and other Moneys.	Repayments of Advances for Public Works.	Total.
	1.	2.	3.	4.	5.	6.	7.	8.	9.
	L.	*L.*	*L.*	*L.*	*L.*	*L.*	*L.*	*L.*	*L.*
1840	2,030,159	1,177,407	432,722	...	6,664	6,929	5,581	353,638	4,013,100
1841	1,999,257	1,097,918	425,771	...	...	7,411	5,835	433,441	3,969,633
1842	1,949,834	1,110,342	491,851	...	3,000	5,248	2,216	371,878	3,934,369
1843	1,960,498	1,082,722	521,981	...	3,000	5,059	1,677	384,794	3,959,731
1844	2,126,149	1,147,940	545,898	...	16,000	6,590	2,683	420,470	4,265,730
1845	2,091,651	1,408,471	558,569	...	22,000	6,347	9,816	381,938	4,478,792
1846	2,258,043	1,467,060	573,767	...	29,000	6,063	5,888	352,642	4,692,463
1847	2,009,133	1,152,932	567,996	...	59,000	5,698	46,160	484,924	4,325,844
1848	2,069,773	1,321,915	532,924	...	39,000	4,835	2,000	304,927	4,275,375
1849	1,941,122	1,231,548	502,073	...	26,000	6,633	3,928	621,155	4,332,459
1850	1,827,289	1,312,123	462,691	...	...	5,744	6,063	505,021	4,118,932
1851	1,854,268	1,348,911	451,534	...	5,000	9,000	4,470	327,499	4,000,682
1852	1,856,160	1,478,092	474,374	...	...	7,732	3,829	466,329	4,286,515
1853	1,924,511	1,708,621	474,430	27,976	...	7,206	3,681	475,445	4,621,870
1854	1,852,108	2,208,580	453,812	549,011	10,000	5,202	4,812	351,281	5,434,807

Circulating medium.

The circulating medium in Ireland was, until lately, subject to a great variety of alterations. Without entering into the disputed question of the existence of a mint in Ireland established by the Ostmen or Danes, the first certain account of a mint there is that established in 1210, by King John, who caused pennies, halfpennies, and farthings to be coined and made current by proclamation. Further coinages were made by Henry III. and by Edward I., who added the title of Dominus Hibernie to that of Rex Anglie on his Irish coinage. It consisted of groats, halfpence, and farthings. The first important alteration as to value was in the latter part of the reign of Edward III. who caused the ounce of silver to be cut into twenty-six deniers or pennies, instead of twenty, as before, which caused the depreciation of eight and one-third per cent. in the Irish, as compared with the British currency, which existed until the final assimilation of the two currencies in 1825. Henry VI., or rather the Duke of York, his lieutenant in Ireland, had mints in Dublin and Trim, in which

Statistics. both silver and copper money were coined. In the beginning of the subsequent reign of Edward IV. the value of silver coins was raised to double their previous amount. The consequence was an enormous increase of price in all the necessaries of life; to remedy which, the Irish parliament enacted, that the master of the mint should strike, in the castles of Dublin and Trim, and in the town of Drogheda, five kinds of silver coins; the gross (or groat), the demi-gross, the denier (or penny), the demi-denier, and quadrant (or farthing); eleven groats to weigh an ounce troy, and each, unclipped, to pass for fourpence. A few years afterwards, the price of silver was again raised so excessively, that the difference between the Irish and English groat was fifty per cent. in a pound of bullion. In the reign of Henry VII. the difference between the two coinages was one-third. Soon after the accession of Henry VIII. the coin in Ireland was so clipped, defaced, and scarce, that the Earl of Surrey, then lord-lieutenant, sued for his recall, in consequence of the want of money to carry on the war against the Irish. Elizabeth ordered the ounce of silver to be cut into sixty pennies, so that the coin of that name was reduced in weight from the twentieth to the sixtieth part of an ounce. The total value of the money coined in Ireland by that princess is said to have been L.94,577, 19s. 6d. English, which, at the rate of sixteen-pence Irish for a shilling English, amounts to L.118,222, 9s. 4½d. Irish. The Irish shilling, or harp as it was called, from the impression on its reverse, was worth ninepence English. By a proclamation issued in the fifth year of James I. the same proportion of values was continued. In 1613 English money was current in Ireland at an increased value; the English five-shilling crown-piece passing for six shillings and eightpence, and the other coins in proportion. The exchange between Dublin and London was twenty-one shillings Irish for fifteen English, with sixpence or eightpence per pound extra, payable in London. By a proclamation in 1637, the name of Irish money was ordered to be abolished, and all payments were reduced to English sterling money. About 1672, small change was so scarce in Ireland, that towns and private dealers were obliged to issue copper tokens. James II., on his arrival in Dublin in 1688, issued a proclamation, by which the English guinea was to pass current at L.1, 4s., the crown-piece at 5s. 5d., and all lesser coins in the same proportion. In 1690, he depreciated still further the value of the coin, by the issue of pieces of base metal, which were to pass at a nominal value far above their intrinsic worth; so that the coins issued of the nominal value of L.965,375 according to some, but, according to others, of L.1,596,799, were really worth no more than L.6495, estimating the metal at fourpence per pound. On the accession of William, this coinage was cried down. In 1725, the new gold coin of Portugal was made current in Ireland, the largest coin, or Portugal piece, being rated at L.4. About the same time, in consequence of the scarcity of small change, Wood obtained his patent for the issue of a copper currency, which was prevented by the literary exertions of Dean Swift in his celebrated publications called the *Drapier's Letters*. In 1780, the acts of parliament prohibiting the carrying of gold or silver into Ireland were repealed. At that time the value of the precious metals in circulation as specie, or hoarded, was estimated at L.3,000,000 Irish. No further legislative change took place until the assimilation of the Irish and English currency in 1825, previously to which, however, the want of a metallic circulation was so severely felt, particularly during some periods of the French war, that private bankers and traders issued notes or tickets for small sums, from five shillings down to twopence-halfpenny; and also copper tokens. The evils of this combined pressure of the scarcity of legal and the abundance of counterfeit coin, was ultimately remedied by the issue of stamped dollars estimated at six shillings, and by silver tokens of tenpence and fivepence, by the Bank of Ireland, which circulated freely until they were replaced by the issue of a pure standard coinage of silver from the royal mint. Statistics.

The entire banking business of Ireland, until 1783, was in the hands of private individuals, who often issued notes to an amount not only far beyond their respective capitals, but exceeding in a great degree, what the wants of the country required, or its credit could support. To remedy the evil effects of a system so pernicious, a national bank was established in that year, with similar privileges to those of the Bank of England in respect to the restriction of more than six partners in a private bank. The injury that Ireland has sustained from the repeated failure of banks may be mainly attributed to this injudicious regulation. The loss that the country has suffered by the failure of banks may be described in a few words. In 1804, there were fifty registered banks. Since that year, many more were opened; but all have failed or wound up their accounts, with the exception of three in Dublin. In 1821, in consequence of the failure of eleven banks nearly at the same time in the south of Ireland, government made an arrangement with the Bank of Ireland, by which joint-stock companies were allowed to be established at the distance of 50 Irish miles from Dublin, in return for which concession that company, which was originally established with a capital of L.600,000, and increased at various times, was permitted to increase its capital L.500,000, making its entire capital amount to L.3,000,000, of which L.2,630,769 was lent to the government. In consequence of several restrictions remaining unrepealed, no joint-stock company was formed until 1825, when the Northern Banking Company of Belfast, formed on a private bank, began to act on the new system. In the same year the Provincial Bank of Ireland began business with a capital of L.2,000,000; the Hibernian Bank with a capital of L.1,000,000, and the Bank of Ireland established branch-banks in several of the larger towns. The Belfast Banking Company was formed in 1827, and the National Bank in 1835. In 1836 the Royal Bank of Ireland was formed, and in 1837 the Ulster Banking Company commenced business. The last joint-stock banking company formed in Ireland was the unfortunate Tipperary Bank, which did not issue notes.

On the expiry of the Bank of Ireland's charter in 1838, it was continued by act of parliament from year to year until 1845, since which time it has been regulated by the new Banking Act, 8th & 9th Vict., c. 37, according to the following principles:—The bank to continue the banker of Government, which is to pay for the ten subsequent years 3½ per cent. on the debt it owes to the bank. The proceedings of the establishment to be under the same rule which has been applied by parliament to other banking institutions, and to make weekly returns, similar to those of the Bank of England under the new act, containing a full development of its affairs, the amount of its bullion, and the variations in the quantity. The joint-stock banks now doing business are as follow:—

NAME. Thus marked * do not issue their own Notes.	When instituted.	No. of Branches.	Capital.	Capital paid up.	Paid up per share.	Reserved Fund.	Fixed Issue.
Bank of Ireland	1783	23	L.3,000,000	L.3,000,000	L.100	L.1,144,000	L.3,738,428
*Hibernian Joint-Stock Co., Dublin	1824	2	1,000,000	250,000	25	68,000	...
Provincial Bank of Ireland	1825	38	2,000,000	540,000	25	162,216	927,667
Northern Banking Co., Belfast	1825	11	500,000	150,000	30	59,778	243,440
Belfast Banking Company	1827	22	500,000	125,000	25	...	281,611
National Bank	1835	45	1,000,000	450,000	22½	40,826	761,757
Ulster Banking Company, Belfast	1836	18	1,000,000	187,000	2½	...	311,079
Clonmel National Bank	1836	2	80,000	16,235	2½	...	66,428
Carrick-on-Suir National Bank	1836	...	40,000	4,962	2½	...	24,084
*Royal Bank, Dublin	1836	...	1,044,250	209,175	10	60,000	...

Statistics.

The Annual Average of the Returns of the several Banks of Issue in Ireland under the Provisions of the Act 8th and 9th Vict., cap. 37, for the years 1846 to 1854.

Statistics.

Years.	Certified issue of all the Banks.	Notes of L.5 and upwards.	Notes under L.5.	Total issue of all the Banks.	Gold held.	Silver held.	Total specie held by all the Banks.
1846	L.6,354,494	L.3,121,259	L.4,144,461	L.7,265,721	L.2,106,004	L.334,258	2,440,266
1847	6,354,494	2,844,049	2,986,375	5,830,425	1,263,517	491,953	1,755,475
1848	6,354,494	2,439,121	2,389,868	4,823,992	1,083,919	502,975	1,586,898
1849	6,354,494	2,204,474	2,105,802	4,310,283	1,089,476	528,783	1,541,094
1850	6,354,494	2,197,117	2,315,401	4,512,443	1,017,036	375,322	1,315,439
1851	6,354,494	2,113,077	2,349,870	4,462,909	937,408	318,574	1,255,985
1852	6,354,494	2,215,503	2,602,935	4,818,238	994,548	249,028	1,243,576
1853	6,354,494	2,517,570	3,132,883	5,650,455	1,393,867	182,729	1,576,600
1854	6,354,494	2,872,007	3,423,597	6,295,607	1,745,329	213,711	1,959,043

Savings-banks were introduced into Ireland in 1810. The greatest amount deposited was in 1845, previous to the years of distress consequent on the famine; and the fluctuations which have since taken place appear in the annexed table:—

Years.	Depositors.	Amount.	Years.	Depositors.	Amount.
1845	96,422	L.2,921,581	1850	47,987	L.1,291,798
1846	93,853	2,855,827	1851	49,554	1,347,617
1847	80,351	2,410,720	1852	52,142	1,447,315
1848	48,512	1,334,296	1853	55,630	1,586,010
1849	45,548	1,200,273			

The amount of subscriptions raised in England for the relief of sufferers by the famine of 1822 having exceeded the expenditure, the surplus was intrusted to a committee in London, and was retained under the name of the Irish Reproductive Loan Fund, as a permanent fund for organizing loan societies, ultimately originated the present loan fund system, under which small sums are advanced to industrious individuals of the working classes, to be repaid by instalments, with interest, and which was placed under the control of a commission in 1836, by the Act 6th and 7th Will. IV., c. 55. The rate of discount on loans, made chargeable by it at 6d. in the pound, has been reduced to 4d. in the pound by the Act of 6th and 7th Vict., c. 91, which placed the general control over all charitable loan societies and charitable pawn or deposit offices under the superintendence of the "Loan Fund Board." The number of funds, with their capital and circulation since the commencement of the system, has been—

Years.	No. of Funds.	Capital.	Circulation.
1838	50	...	L.180,526
1839	224	...	816,473
1840	215	...	1,164,046
1841	268	L.370,507	1,438,598
1842	300	124,920	1,691,871
1843	298	403,343	1,650,963
1844	259	417,584	1,702,918
1845	255	444,427	1,857,457
1846	250	408,842	1,770,397
1847	228	270,613	863,647
1848	177	217,119	717,865
1849	160	189,187	649,934
1850	132	182,501	662,794
1851	123	186,240	712,073
1852	113	186,271	739,056
1853	112	212,338	842,803
1854	115	214,735	870,024

Pawn offices, on the plan and under the name of the French *Monts de Piété*, were opened in several towns of Ireland in 1841, with the object of advancing money on pledges at rates more moderate than those of the licensed pawnbrokers; but all have since been discontinued.

By means of navigable rivers and canals, Ireland possesses extensive inland navigation. For the details of the various canals, see NAVIGATION, *Inland*.

The railway from Dublin to Kingstown, which was opened at the latter end of 1834, was the first, and for several years the only railway in Ireland.

The progress and condition of the railway system may be seen in the following tables, compiled from the board of Trade Returns:—

Traffic and Receipts of the Railways in Ireland from 1836 to 1854, inclusive.

Years ending 30th June.	Miles open on the 1st January in each year.	No. of Passengers.	Receipts		
			From Passengers.	From Goods	Total.
			L.	L.	L.
1836 (15 mon.)	6	1,237,800	35,316	105	35,421
1837	6	1,184,428	31,901	44	31,945
1838	6	1,243,972	33,318	270	33,588
1839	6	1,341,208	34,409	307	34,716
1840	13½	1,358,761	36,176	414	36,590
1841	13½	1,629,024	41,002	466	41,468
1842	13½	2,046,903	54,219	2,520	56,739
1843	31¼	2,074,444	56,548	6,802	63,350
1844	31¼	2,588,096	62,608	8,886	71,494
1845	65	3,481,707	104,762	14,636	119,398
1846	65	3,610,506	105,469	18,274	123,743
1847	120¾	3,866,294	149,581	35,000	184,581
1848	209½	4,374,749	211,593	60,215	271,808
1849	428	6,059,947	290,604	127,462	418,066
1850	515	5,495,796	339,076	174,959	514,035
1851	580	5,633,603	365,603	198,459	564,062
1852	666	6,166,127	435,910	243,609	679,519
1853	771	7,074,475	537,259	294,310	831,569
1854	865	6,911,170	521,671	352,806	874,477

The internal traffic of the country is carried on chiefly by wheel-carriage roads. Their condition, both as to lines of direction and mode of construction, is excellent. Materials for the construction and repairs of roads are very generally distributed throughout the whole island, either in quarries, ridges, and masses of gravel, or in the beds or channels of rivers and streams. The limestone, which is the general substratum of the greater part of the country, is the best material for their formation; and the system known under the name of macadamizing was long and successfully practised in many of the leading lines of road in Ireland before it was thought of in Great Britain. Young remarks upon this peculiarity as early as the year 1779. "For a country," says he, "so very far behind us as Ireland to have got so suddenly the start of us in the article of roads, is a spectacle that cannot fail to strike the English traveller exceedingly. I will go here; I will go there; I could trace a route upon paper as wild as fancy could dictate, and everywhere I found beautiful roads, without break or hindrance, to enable me to realize my design. But from this commendation the turnpikes in general must be excluded; they are as bad as the cross roads are admirable."

Statistics.

The cause of this eulogy is to be traced to acts passed on the subject from the time of Charles I. to the beginning of the reign of George III. Before that time the roads were constructed and repaired, like those in England, by the rule of six days' labour, or statute-labour system. This was found inadequate to its purposes, and the roads were afterwards maintained and repaired by Grand Jury presentments, and the main roads by turnpikes. At present all the main lines of road are under the care of the Grand Juries of the respective counties. The Grand Jury cess is a tax levied under votes of the Grand Juries, called presentments, made at the assizes. The purposes for which presentments are made are,—1, Making new roads, bridges, quays, and gullets; 2, Repairing same; 3, Building and repairing courts of justice; 4, Building and repairing prisons; 5, Prison expenses; 6, Police expenses; 7, Salaries to county officers; 8, Public charities; 9, Repayment of government advances; 10, Miscellaneous. Some of those presentments are imposed and rated at the pleasure of the Grand Jury; the following are imperative by act of parliament:—County infirmary and fever hospitals; district fever hospitals and infirmaries (partly); building and repairing diocesan schools; expenses of inquests; constabulary force (partly); prosecution of offenders; maintaining deserted children; expenses of the general valuation; expenses of Commissioners of Public Works; compensation for malicious injuries; expenses under the Arms' Act; repayment of government advances; and some others of minor importance. Presentments for the general use of the county are levied on the county at large; those for particular districts on the baronies or parishes enjoying their benefit. The amount of Grand Jury cess from 1840 to 1854, was—

Years.	Amount.	Years.	Amount.
1840	L.1,269,880	1848	L.1,241,854
1841	1,240,602	1849	1,349,124
1842	1,191,684	1850	987,677
1843	1,151,110	1851	944,924
1844	1,129,432	1852	884,976
1845	1,149,923	1853	879,328
1846	1,180,287	1854	922,852
1847	1,175,474		

and the purposes to which it was applied in 1853 and 1854, as follows:—

	1853.	1854.
Roads, bridges, &c.	49,520	76,025
Repairs of roads, &c.	327,879	367,450
Erection and repairs of court or sessions' houses	4,051	3,110
Erection and repairs of prisons	6,183	5,828
Other prison and bridewell expenses	88,597	92,232
Police and witnesses	38,107	35,489
Salaries of county officers	100,785	102,063
Public charities	52,731	56,162
Repayments to Government	100,650	111,130
Miscellaneous	110,825	73,961
Total	879,328	922,852

The *Infirmaries* for counties and cities are supported by county assessments not exceeding L.700 at each assizes, or L.1400 annually for each county, aided by Treasury grants of L.100 Irish for the surgeon's salary, by subscriptions, donations, and bequests, and by petty sessions' fines. They are governed by corporations, consisting of the primate, lord-chancellor, bishop of the diocese, rector or vicar of the parish, life-governors who have paid L.21, and annual subscribers of 3 guineas. The Poor-Law Commissioners may inspect these institutions, as well as other hospitals supported in part by Grand Jury cess or parliamentary grants, and give directions in concert with the local governors, as to their management. In 1849, the number of intern patients in the infirmaries was 11,114; extern, 45,930; total, 57,044. The expenditure amounted to L.27,475, 18s. 5d., and the average cost per head for each patient was 16s. 4½d., exclusive of the expense of medicine and salaries. Subscriptions, L.1332, 11s. 10d.

Statistics.

Fever Hospitals are of three kinds,—1, County hospitals, maintained by presentments, not exceeding L.250 at each assizes, or L.500 annually; 2, District hospitals, for cities, towns, or other parts of a county, maintained by private subscriptions, and aided by presentments not exceeding double the amount of the voluntary fund; 3, Poor-law union fever hospitals, the expenses of which are charged upon the union rates. The provisions of the Medical Charities Act, 14th & 15th Vict., cap. 68, passed in 1851, by which boards of guardians were empowered to form the poor-law unions into dispensary districts, and to place the management of the dispensaries under the control of the Poor-Law Commissioners, took effect in 1851. Each dispensary district is placed under a committee of management, consisting of the guardians in the district and of rate-payers elected by the board of guardians of the union,—the number of each committee being fixed by the commissioners. The board of guardians provide the requisite accommodation for the dispensaries in the several districts, medicines, and appliances, and pay the salaries of the medical officers; the expenses being charged upon the poor-rates. The 163 unions have been divided into 723 dispensary districts, giving an average of rather more than 4 divisions to each district, the average population of the districts being about 9000. The Act put an end to all previous provisions for affording dispensary relief by means of presentment from county cess.

The Census Commissioners report the number of the sick in Ireland on the night of the 30th March 1851, to have been 104,495 persons, or 1·59 per cent. of the population. Of these, 5180 were deaf and dumb, 7587 blind, 5046 lunatic, 4904 idiotic, 4375 lame and decrepit.

The "Act for the more effectual relief of the destitute poor in Ireland" was passed in 1838, and the system came into operation in 1839. Four workhouses were completed in 1840, and in 1846 there were 129 unions. In 1850 the number of unions was 163, comprising about 3440 electoral divisions.

The following table affords a series of annual returns of the number of paupers relieved in the workhouses from the commencement of proceedings under the Irish Poor Relief Act until the year 1847:—

Year.	No. of Unions.	No. of Paupers relieved in workhouse.	Annual expenditure.
1840	4	10,910	37,057
1841	37	31,108	110,278
1842	92	87,604	281,233
1843	106	87,898	244,374
1844	113	105,358	271,334
1845	123	114,205	316,025
1846	129	243,933	435,001
1847	130	417,139	803,686

In consequence of the great strain to which the system was subjected by the great and sudden increase of pauperism caused by the failure of the potato crop, the Out-door Relief Act of 10th Vict., c. 31, was passed in 1847, and the numbers relieved since that period, together with the total expenditure, have been:—

Year.	Number of Unions.	Number of Paupers relieved in workhouse.	Number of Paupers relieved out of workhouse.	Total number relieved.	Annual Expenditure.			
					In-maintenance.	Out-relief.	Salaries and all other expenses.	Total.
1848	131	610,463	1,433,042	2,043,505	L.605,136	L.725,578	L.504,920	L.1,835,634
1849	131	932,284	1,210,482	2,142,766	797,294	679,604	700,753	2,177,651
1850	163	805,702	368,565	1,174,267	710,945	120,789	598,374	1,430,108
1851	163	707,443	47,914	755,347	692,914	11,399	437,334	1,141,647
1852	163	504,864	14,911	519,775	517,445	4,917	360,905	833,267
1853	163	396,436	13,232	409,668	446,030	4,920	334,768	785,718
1854	163	310,608	9,008	319,616	463,858	3,715	292,579	760,152
1855	163	269,794	35,432	205,226	432,842	4,702	247,715	685,259

Statistics.

Maximum and Minimum Number of Paupers in the Workhouses in each of the Years ending 29th Sept. 1851-55.

Years.	Maximum No.	Years.	Minimum No.
14th June 1851	266,934	27th Sept. 1851	140,031
21st Feb. 1852	196,966	18th Sept. 1852	111,117
30th April 1853	144,812	24th Sept. 1853	79,410
11th Feb. 1854	116,033	16th Sept. 1854	66,474
24th Feb. 1855	99,627	22d Sept. 1855	56,518

The system of out-door relief, which was adopted as a matter of necessity, is now almost entirely discontinued, the house accommodation being amply sufficient for all applicants. The poor-law system in Ireland has been conducted with a view to the support of those who are not in a condition to maintain themselves by their own personal labour, but at the same time to discountenance in the young and healthy all reliance on eleemosynary relief. Since the disastrous period of the famine "the labours of the Poor-Law Commission have been incessant to improve and perfect the system of relief, tempering the sound economical principles on which it is founded with every humane modification of which they are susceptible. The result has been that they have at length established a system as complete as any such progressive system can well be; and which is no less distinguished for its general philosophical principles than for its humane spirit. As now established it will not only render any future miseries like those of the famine years in Ireland impossible; but will, while ministering to the inevitable and habitual wants of the poor, open up a perennial source of progressive amelioration for that class of the community, until the time arrives when all such extraneous aid can be dispensed with."[1]

The poor-rate is levied under the assessment of poundage rate on the net annual value of the property rateable, which annual value is "the rent for which one year with another the property might be let from year to year, the probable annual average cost of repairs, insurance, and other necessary expenses for repairs, and all public charges, except tithes, being paid by the tenant." The property liable to poor-rates includes:—All land and buildings; mines seven years open; commons, and all profits out of land; navigations; rights of way, and other rights and easements upon land; tolls. The following kinds of property are exempt:—Turf-bogs, for which rent is not paid; places of worship; buildings used exclusively for charitable purposes; buildings used for public purposes; burial grounds. The persons liable are—the occupier of the rateable property at the time the rate is made, except the occupier of tenements under L.8 value in certain boroughs, and at and under L.4 value elsewhere, who is not liable, and in such cases the immediate lessor is to be rated instead. The owner of any rent (except owners of rent charges) is liable to allow the person paying him rent one-half the amount of the rate. The annual amount levied as poor-rates, since passing of the act, has been returned to parliament as follows:—

1840	L.21,985	1848	L.1,619,810
1841	73,962	1849	1,674,793
1842	208,557	1850	1,571,110
1843	271,776	1851	1,039,173
1844	278,474	1852	1,109,630
1845	295,781	1853	1,000,312
1846	376,507	1854	925,154
1847	645,657		

During the pressure caused by the famine, the expenditure for the relief of the poor in some cases equalled or even exceeded the rent, but in 1855 it had been so much reduced as not to exceed an average of 1s. 2¼d. in the pound on the total poor-law valuation, which, in that year, amounted to L.11,565,466.

The results of the parliamentary returns of the state of crime in Ireland during the ten years from 1845 to 1854 was:—

Years.	Summary Convictions before Magistrates.		Number of cases tried at Assizes and Quarter Sessions.					Proportion of Convictions to population.
	Petty offences.	Drunkenness.	Males.	Females.	Total.	Convicted.	Acquitted.	
1845	17,512	22,076	12,807	3,889	16,696	7,101	9,595	1 in 1,127
1846	16,695	23,282	14,204	4,288	18,492	8,639	9,853	1 in 946
1847	25,810	15,406	23,552	7,657	31,209	15,233	15,976	1 in 536
1848	49,717	12,302	28,765	9,757	38,522	18,206	20,316	1 in 449
1849	63,586	11,604	31,340	10,649	41,989	21,202	20,787	1 in 386
1850	64,802	13,938	22,682	8,644	31,326	17,108	14,218	1 in 477
1851	72,019	12,617	17,337	7,347	24,684	14,377	10,307	1 in 453
1852	59,215	19,504	12,444	5,234	17,678	10,454	7,224	1 in 626
1853	43,186	12,404	10,260	4,884	15,144	8,714	6,430	1 in 758
1854	37,958	12,215	7,937	3,851	11,788	7,051	4,737	1 in 920

The ecclesiastical arrangement of the country was formerly framed on the same fourfold provincial division as the civil, but under different names and with different boundaries. There were four archbishoprics, one for each province, but named from the place in which the archiepiscopal see was fixed. The number of bishoprics subject to each of these varied at different periods, and two or more sees were frequently united to afford a revenue supposed to be necessary to maintain the dignity of the bishop. Formerly the dioceses were more numerous than at present, as may be seen from the following list, extracted from an old Roman provincial:—

Armagh, containing Meath or Elnamirand, Down or Dundalethglass, Clogher of Lugundun, Connor, Ardachad (Ardagh), Rathbot (Raphoe), Rathlue (now part of Derry), Daln-liquir (unknown, but by some supposed to have merged into Meath), Dearri (Derry); *Dublin*, containing Glendelagh, Fern, Ossori or De-Canic, Lechlin, Kildare or Dare; *Cassel*, containing Isle of Gatha (now Innis-Scattery, and united to Limerick), Limric, Laon or De Kendalnan (now Killaloe), Cellumabrath (called also Fenebore, now Kilfenora), Melie or Emileth (Emly), Ross or Roscrea, Waterford or Baltifordian, Lismore, Clone or Cluanan (Cloyne), Cork, Rosalither (now part of Cork), Ardforth; *Tuam*, containing Duac or Kilmacduach, Mage (or Mayo, now part of Tuam), Enachdun (also part of Tuam), Cellaiar (unknown), Rescommon (translated to Elphin), Clonfert, Achad (Achonry), Lade or Killaleth (Killala), Conani (Clonmacnois, now part of Meath), Kilmunduach (Kilmacduagh), Elphin.

By the Church Temporalities Act 3d and 4th Will. IV., c. 37, the archbishoprics of Cashel and Tuam were reduced to bishoprics, the whole of Ireland divided into two provinces, and the bishoprics, as vacancies occurred, reduced to ten.

The bishoprics and their incomes are thus classed according to the provisions of the Church Temporalities Act:—

NORTHERN PROVINCE.

Armagh with Clogher	L.12,087
Meath and Clonmacnoise	4,068
Derry and Raphoe	8,000
Down, Connor, and Dromore	4,204
Kilmore, Ardagh, and Elphin	6,253
Tuam, Killala, and Achonry	4,600
Total	L.39,212

SOUTHERN PROVINCE.

Dublin, Glendelagh, and Kildare	L.7,786
Ossory, Leighlin, and Ferns	4,200
Cashel, Emly, Waterford, and Lismore	5,000
Cork, Cloyne, and Ross	2,498
Killaloe, Kilfenora, Clonfert, and Kilmacduagh	3,870
Limerick, Ardfert, and Aghadoe	4,973
Total	L.28,327

[1] Sir John Forbes's *Memorandums made in Ireland.*

Statistics. The following account of the gross and net revenues of the sees of the archbishops and bishops, with the charges and deductions to which such revenues are subject, is taken from a *Return* to the House of Lords (No. 13, 1854):— Statistics.

Provinces and Sees.	Gross Revenues. From Rents.	Gross Revenues. From Fines.	Gross Revenues. From other sources.	Gross Revenues. Total.	Charges and Deductions.	Net Income.
Northern Province.	*L. s. d.*	*L. s. d.*	*L. s. d.*	*L. s. d.*	*L. s. d.*	*L. s. d.*
Armagh, with Clogher	8,233 0 0	6,767 8 4	1298 13 7	16,299 1 11	1,664 12 9	14,634 9 2
Meath and Clonmacnoise	2,644 7 6	1,180 0 7	483 14 2	4,308 2 3	544 1 1¼	3,764 1 1¾
Derry and Raphoe	9,892 5 7	2,301 4 5	563 17 2	12,847 7 2	4,786 3 5½	8,061 3 8½
Down, Connor, and Dromore	3,017 5 9	1,799 19 2	170 19 1	4,988 4 0	1,329 6 6¾	3,658 17 5¼
Kilmore, Ardagh, and Elphin	3,702 16 7	2,174 1 4	1078 4 6	6,955 2 5	347 10 2	6,607 12 3
Tuam, Killala, and Achonry	2,742 17 8	1,959 18 6	377 19 1	5,080 15 3	1,182 7 7½	3,898 7 7½
Southern Province.						
Dublin, Glandelagh, & Kildare	6,887 13 10	1,273 7 6	88 7 1	8,249 8 5	612 10 2	7,636 18 3
Ossory, Ferns, and Leighlin	2,647 2 3	1,643 19 6½	314 17 5	4,605 19 2½	731 3 0¾	3,874 16 1¾
Cashel, Emly, and Waterford	3,283 4 5	1,925 17 7	125 1 8	5,334 3 8	642 12 1½	4,691 11 6½
Cork, Cloyne, and Ross	1,794 0 0½	739 3 7	155 10 0	2,688 13 7½	378 2 0¼	2,310 11 7¼
Killaloe, Kilfenora, Clonfert, and Kilmacduagh	2,253 18 7	1,248 1 4½	417 19 3½	3,919 19 3	609 3 8¾	3,310 15 6¼
Limerick, Ardfert, & Aghadoe	3,209 18 11½	1,245 4 2	80 0 0	4,535 3 1½	547 5 11¾	3,987 17 1¾
Total	50,308 11 2	24,348 6 1	5155 3 0½	79,812 0 3½	13,374 18 9	66,437 1 6½

The revenues of the suppressed sees were, in the years ending 1st August 1853 and 1854, as follows:—

	1853.	1854.
Ardagh	L.3,556 16 6½	L.2,471 2 9
Clogher	10,560 17 6	9,003 14 2
Clonfert and Kilmacduagh	2,600 14 3	3,017 0 11¼
Cork and Ross	4,682 6 2½	6,467 3 6
Dromore	4,677 3 7	4,378 3 4
Elphin	9,483 19 3	8,092 2 10
Kildare & Deanery of Christ Ch	5,500 18 10	5,756 17 0½
Killala and Achonry	6,204 11 11	4,211 8 8¼
Ossory	3,877 19 0	2,874 11 3
Raphoe	6,272 11 8½	4,448 6 9½
Waterford and Lismore	4,103 5 7	3,376 18 7
Total	L.61,521 4 4½	L.54,097 9 10½

These revenues of the suppressed bishoprics, together with those of suspended dignities and benefices, and disappropriated tithes, were vested by the Church Temporalities Act in the Board of Ecclesiastical Commissioners, to be applied by them to the erection and repairs of churches, to the providing for the church expenses which had been defrayed by vestry rates, and to other ecclesiastical purposes.

The aggregate income of the Ecclesiastical Commissioners, and their annual expenditure, from their establishment in 1833 to 1854, was,—

Years.	Receipts.	Disbursements.
1834	L.68,728 10 8	L.51,042 17 9
1835	168,027 8 10	120,252 17 6
1836	181,045 3 1	168,292 9 5
1837	103,221 0 7	163,859 12 5
1838	100,497 0 6	114,255 17 9
1839	138,160 9 2	119,827 6 1
1840	139,268 14 10	146,426 19 4
1841	115,723 9 9	108,334 19 8
1842	82,906 18 3	96,380 6 6
1843	110,916 2 4	90,680 11 1
1844	105,913 0 7	119,721 12 2
1845	116,104 11 2	125,248 3 10
1846	112,195 19 4¾	111,894 0 1½
1847	96,694 11 5	97,658 7 10
1848	92,971 9 0½	88,069 1 11½
1849	79,924 11 6	84,361 9 5
1850	80,877 14 5	74,438 4 5½
1851	99,015 6 3	100,719 8 11
1852	111,355 5 0	110,297 6 2
1853	136,884 9 3	144,497 3 10
1854	117,936 2 11	112,064 9 11
Total	L.2,358,367 18 11¼	L.2,348,323 6 1½

The incomes of the parochial clergy arises from tithe rentcharge together with glebe lands and houses. The collection of tithes having been a perpetual source of vexation to the majority of the people, the Tithe Composition Bill of 1823 was passed by the Wellesley administration. By the act of 1st and 2d Vict., c. 109, compositions for tithe were abolished, and fixed payments or rent charges substituted, consisting of three-fourths of their amount, and to be paid by the landlords or others having a perpetual interest in the land.

In cities and towns corporate, and in the suburbs and liberties adjoining, where there are small or no tithes, or other duties settled by law upon the incumbents of parishes having actual cure of souls, a power was vested in the lord-lieutenant to authorize valuations upon oath to be made from time to time of each and every house belonging to any or all of such parish or parishes, and upon the return of such valuation the lord-lieutenant and six of the privy council are empowered to allot and charge any sum or sums of money to be paid out of each house belonging to said parish unto the several and respective incumbents, either by apportioning the said payment according to the yearly value of each house or otherwise. This tax is denominated ministers' money, and was originally levied under the statute of 17th and 18th Car. II., c. 7, upon certain cities and towns, for the maintenance of the incumbents there having actual charge of souls, at the rate of one shilling in the pound on the yearly value of each house—but so that houses valued at upwards of L.60 per annum are to be taxed at the rate of those of L.60 and no more. The tax is levied only in Dublin, Cork, Limerick, Waterford, Drogheda, Kilkenny, Clonmel, and Kinsale; none of the cities or towns in Ulster being subject to it.

The act 17th and 18th Vict., c. 11, passed in 1854, repeals the 17th and 18th Car. II., c. 7, and enacts that the charge of ministers' money for the year ending 31st December 1853 be ascertained, and the sums certified shall, in future, be raised in each parish of the towns liable, by a rate on all houses now chargeable, except those rated at or under L.10. The rate may be redeemed by payment of 14 years purchase of amount assessed. The sums certified as chargeable in each town were —Clonmel, L.341; Cork, L.3324; Drogheda, L.288; Dublin, L.9868; Kilkenny, L.307; Kinsale, L.74; Limerick, L.310; Waterford, L.940: total, L.15,452.

The annual revenue of the Established Church in Ireland during three years ending 1831, was returned to parliament as—

Archbishops and Bishops	L.151,128
Deans and Chapters	1,043
Economy Estates of Cathedrals	11,056
Other subordinate corporations	10,526
Dignities and Prebends without cure of souls	34,482
Glebe lands	92,000
Tithes	555,000
Ministers' Money	10,300
	L.865,535

The revenues of the church have since undergone a considerable diminution, and, exclusive of the funds vested in the Board of Ecclesiastical Commissioners, now amount to about

Statistics. L.600,000, of which L.401,114 is tithe rent charge; L.66,437 the net revenues of the sees of archbishops and bishops; L.95,000 glebe lands, and the remainder in ministers' money, &c.

The Roman Catholic hierarchy consists of four archbishops, one to each province, whose sees are in Armagh, Dublin, Cashel, and Tuam, and 24 bishops. The bishops are nominated by the Pope, generally out of a list of names submitted to him by the bishops of the province and the clergy of the vacant diocese. In case of expected incapacity from age or infirmity, the bishop names a coadjutor, who is usually confirmed by the pope. Every diocese has a dean or a vicar-general, the former appointed by the cardinal-protector at Rome, the latter by the bishop; but these dignitaries are without jurisdiction or emolument. The whole of the clergy are supported solely by the voluntary contributions of their flocks. The episcopal emoluments arise from the parish in which the bishop officiates, from marriage licenses and other official acts, and from the cathedraticum, an annual sum varying from L.2 to L.10, paid by each incumbent in the diocese. The average amount of a bishop's income may be stated at about L.500 per annum. The parochial clergy are nominated exclusively by the bishop. The number of priests in Ireland in 1854 was 2291, of whom 1222 were educated at Maynooth College. Their incomes, entirely derived from their parishioners, arise from fees on marriages, baptisms, funerals, and prayers for the dead, on Easter and Christmas dues, varying from one to ten shillings, and from incidental voluntary contributions, either in money or labour. The total sum raised and contributed in the parish is usually considered a common fund for the maintenance of the parish priest and his curates, either by a certain proportion or otherwise. All the places of public worship are built by subscriptions. There are numerous monasteries and convents; the latter are supported partly by sums, usually from L.300 to L.500, paid by those who take the vows in them, and partly by the fees for the education of the daughters of respectable Roman Catholics. The friars and nuns also devote themselves to the gratuitous education of the children of the poor. Candidates for clerical ordination, formerly under the necessity of obtaining their education in continental colleges, are now educated at home; the principal clerical colleges are those of St Patrick and Maynooth, supported by grants of public money and by pensions from the students, and those of Carlow and Tuam, by voluntary contributions.

The Presbyterians of Ireland, who are very numerous in most parts of Ulster, are formed into congregations, each of which is under the ecclesiastical government of a court called a session, consisting of the minister and elders of the congregation. An indefinite number of the ministers of these congregations, with a lay elder for each, constitutes a presbytery, which has the charge of the congregations represented in it. Delegates from each of these presbyteries, consisting of all the ministers, with a lay elder for each, constitute the general assembly, which is presided over by a moderator chosen annually, and regulates the ecclesiastical concerns of the body. The first presbytery in Ireland was formed at Carrickfergus in 1642, and gave rise to the *Synod of Ulster*. The *Presbyterian Synod of Munster* was formed about 1660. The *Presbytery of Antrim* separated from the Synod of Ulster in 1727, and the *Remonstrant Synod* in 1829. A number of Seceders formed themselves into the *Secession Synod of Ireland* about 1780. In 1840 the General and Secession Synods having united, assumed the named of the *General Assembly of the Presbyterian Church in Ireland*, comprising in 1854, 488 congregations, arranged under 36 Presbyteries. The ministers are supported by voluntary contributions, the rents of seats or pews, and a portion of the parliamentary grant (*Regium Donum*), which in 1853 amounted to L.33,661.

The *Remonstrant Synod of Ulster* was formed in 1830, in consequence of the separation of seventeen ministers, with their congregations, from the General Synod of Ulster, on the ground that, contrary to its usages and code of discipline, it required from its members in 1827 and 1828, submission to certain doctrinal tests and overtures of human invention. There are 4 presbyteries and 27 congregations in this Synod, which in 1853 received L.1996 of the parliamentary grant.

United Presbytery or Synod of Munster.—This body was formed in 1809 by the junction of the Southern Presbytery of Dublin with the Presbytery of Munster, and is one of the three non-subscribing Presbyterian bodies of Ireland; the other two being the *Presbytery of Antrim*, and the *Remonstrant Synod of Ulster*. A few years ago these three bodies united to form the "General Non-Subscribing Presbyterian Association of Ireland," for the promotion of their common principles, the right of private judgment, and non-subscription to creeds and confessions of faith. From the annual parliamentary grant in 1853 the Synod of Munster received L.937, and the Presbytery of Antrim, L.900. Statistics.

The *Reformed Presbyterian Synod of Ireland*, consisting of 4 presbyteries and 25 congregations, is unconnected with the *General Assembly*, and does not participate in the parliamentary grant.

The *Regium Donum*, or Royal Gift, was first granted in 1672 by Charles II., who gave L.600 of "secret service money" to be distributed annually, in equal portions, among the Presbyterian ministers. The grant was discontinued towards the close of his reign and during that of James II., but was renewed by William III., who augmented it to L.1200 a-year. In 1784 the amount was increased to L.2200; in 1792 to L.5000; and in 1803 a classification was made according to the number of families in each congregation and the amount of the minister's voluntary stipend, by which those of the 1st class received L.100 annually; of the 2d, L.75; and of the 3d, L.50. In 1831 the system of classification was altered, and 37 ministers now receive L.100 each, and 425 L.75 each per annum, late Irish currency. As the 37 ministers in the L.100 class die, their successors will only receive L.75 each. The amount of the parliamentary grant for 1856 was L.38,953.

The Methodist body in the United Kingdom forms one connexion, the president of the British Conference being also president of the Irish one. The number of ministers in Great Britain, including superannuated and supernumerary ministers, is 1184; in Ireland, 160. Number of members in Great Britain, 270,965; in Ireland, 19,608. Of the *Primitive Methodist Society* there are 8348 members in Ireland. Baptist congregations were founded in Dublin and some other parts of the country about the year 1650-3; but as they gradually declined, a society was formed London in 1814, to "employ itinerants in Ireland, to establish schools, and to distribute Bibles and tracts, gratuitously, or at reduced prices."

The first attempt at founding a university in Ireland after the arrival of the English was made by John Leek, archbishop of Dublin, who obtained a papal bull for the purpose in 1311, which was carried into effect in 1320 by Alexander Bicknor his successor, but the establishment was soon extinguished. Another attempt was made at Drogheda; a university was founded by act of parliament in 1465, with the same privileges as that of Oxford, but soon shared the fate of its predecessor. The next attempt was more happy. In 1593 the university of Trinity College, Dublin, was opened in the buildings of the dissolved monastery of All-Hallows. The number of students on the books of the college in 1850 was 1503, and its present annual income amounts, on an average, to L.64,000; of which sum about L.30,000 arises from entrance and annual fees paid by students to the college and their tutors, the fees on degrees, and other incidental and contingent sources. In 1810 the inhabitants of Belfast opened a collegiate institution for scientific and literary instruction by private subscription. It was sanctioned by act of parliament, and receives a liberal grant of public money; but as it has not been privileged to grant degrees, it cannot be ranked as a university.

The Queen's colleges of Belfast, Cork, and Galway, were established under the 8th and 9th Vict., cap. 66, passed in 1845 and in 1850; the Queen by letters patent founded "The Queen's University in Ireland," with powers to grant degrees in the faculties of Arts, Medicine, and Law, as such are granted by other universities, to students who have completed their studies in any one of the Queen's colleges of Belfast, Cork, or Galway. The university consists of a chancellor and senate, nominated by the crown.

With respect to the second class of places of public education, an act of Elizabeth required that a grammar school should be maintained in every diocese, by the contributions of the bishop and beneficed clergy. James I. vested tracts of forfeited lands for the maintenance of similar schools. His example was followed by Charles I. Erasmus Smith, also, one of the adventurers who obtained large grants of land during

Statistics.

the time of Cromwell, applied some of his property to this purpose. Classical schools were also endowed by other private individuals. The schools of royal foundation were those of Armagh, Dungannon, Enniskillen, Raphoe, Cavan, Banagher, and Carysfort. Those of Erasmus Smith's, and other private foundations, were,—Drogheda, Galway, Tipperary, Ennis, Navan, and Ballyroan. The diocesan schools never exceeded 17 out of the 22 dioceses.

The College of Maynooth was founded in 1795, for the purpose of educating students designed for the Roman Catholic priesthood, by an act of the Irish parliament, which was an exclusively Protestant assembly. The act passed both Houses without a dissentient vote. A sum of about L.8000 was annually voted for its maintenance by the Irish, and afterwards, without objection, by the Imperial Parliament from 1795 to 1807, when L.5000 additional were voted for the enlargement of the buildings, and the grant became the subject of dispute and opposition in the legislature. The annual vote from 1808 to 1813 was L.8283, and from 1813 to 1845 it was raised to L.8928. The total amount of donations and bequests to the college, including the sums funded for bourses, was L.31,681 besides all the fee simple estates of the late Lord Dunboyne, in the county of Meath, which now return to the college L.460 per annum. The number of students increased with the enlargement of the buildings from 50 until it amounted in 1839 to 478; between 1841 and 1845 it fell to an average of 430; of these 250 were charged on the parliamentary vote; the others paid an annual pension for their maintenance. By the act of 8th and 9th Vict., cap. 25, passed during the ministry of Sir Robert Peel, the college was placed on a new footing, and permanently endowed for the maintenance and education of 500 students, and of 20 senior scholars on the Dunboyne foundation, which has been uniformly since that time the total number of students. Besides providing by an annual charge on the consolidated fund of L.30,000 for the annual cost of commons, &c., for these 520 students, of allowances to the 20 Dunboyne students, and to 250 students of the three senior classes, and of salaries to the president, superiors, and professors, the act moreover vested in the Commissioners of Public Works a sum of L.30,000 for erecting the buildings necessary to accommodate the enlarged number of students. No applicant can be received as a student of Maynooth College unless he be designed for the priesthood in Ireland, be sixteen years of age, and be recommended by his bishop.

The Roman Catholic University was established at a synodal meeting, held on the 18th May 1854.

The primary schools owe their foundation to an act of Henry VIII., which bound every incumbent of a parish by oath to maintain a school therein to teach the English language. The bond was neglected by many, and observed with culpable laxity by most others. The statute having fixed upon 40s. as the minimum of the teacher's salary at the time of its enactment, the incumbent, regardless of the great subsequent depression of the value of money, deemed his duty to be fulfilled and his conscience cleared by paying that annual stipend to his parish-clerk, or some other person who professed to teach in the parish. Soon after the Revolution, a project was started and eagerly followed up by the Established clergy, of founding schools, in which the children of the poor should be instructed in the rudiments of literature, as well as in useful works, and also maintained at the public expense. To these laudable objects was also added that of converting them to the Protestant doctrine. These schools being incorporated by act of parliament, received the name of charter-schools. They were long a favourite object of interest to the legislature, which annually voted large sums for their support, in addition to those procured by donation or bequest.

The Society for Promoting the Education of the Poor, commonly called the Kildare Place Society, originated in a voluntary institution, formed in 1811, the principles of which were stated to be "the admission of pupils, uninfluenced by religious distinctions, and the reading of the Bible or Testament, without note or comment, by all the pupils who had attained a suitable proficiency; excluding catechisms and controversial treatises; the Bible or Testament not to be used as a class book from which children should be taught to read or spell." In consequence of a recommendation made in 1812, by commissioners appointed to inquire into the state of the schools and charities of public foundation, that "no attempt should be made to influence or disturb the peculiar religious tenets of any sect or description of Christians," and of the pledge given to the same effect by the Kildare Place Society, a parliamentary grant of public money was given in 1819, which was continued and increased. But a stipulation introduced into its regulations sometime afterwards, requiring the Bible to be used as a school book, aroused the suspicions of the Roman Catholic clergy, who excited a distaste to it throughout the country, and the children of that persuasion were gradually withdrawn. Upon inquiry in 1824, it was ascertained that out of 400,348 children whose parents paid for their education, there were 81,060 Protestants, and 319,288 Roman Catholics: while out of 56,201 children educated in the Kildare Place schools, 26,237 were Protestants, and only 29,964 Roman Catholics. The commissioners consequently recommended that the grants of public money for the education of the poor should be vested in a board nominated by the government, under arrangements calculated to prevent any apprehension of interference with peculiar religious tenets. The recommendation was reported to the House of Commons by a committee in 1828, and on the subject being again referred to a committee in 1830, it was reported on favourably, and the annual grant to the Kildare Place Society was withdrawn, since which period the schools gradually declined; in 1854, the Dublin model schools of the society were put under the management of the Church Education Society.

Statistics.

In 1833, the grants of public money for the education of the poor were placed under the superintendence of "The Commissioners of National Education." The principles on which the commissioners act are,—that the schools shall be open alike to Christians of every denomination; that no pupil shall be required to attend at any religious exercise, or to receive any religious instruction which his parents or guardians do not approve; and that sufficient opportunity shall be afforded to the pupils of each religious persuasion to receive separately, at appointed times, such religious instruction as their parents or guardians think proper. This system of united education is one which does not exclude children of any denomination, while it admits to a participation of its benefits those of every religious creed who may wish for instruction without interfering with any conscientious scruples. The duty of the commissioners consists, therefore, in guarding against any infraction of these fundamental principles from any quarter, and in establishing regulations as to details, so as best to secure the general efficiency of the system.

In 1845 the commissioners were incorporated under the name of *The Commissioners of National Education in Ireland.*

The following return gives the number of schools and pupils under the superintendence of the commissioners since the commencement of the system, and the amount of parliamentary grants annually voted for its maintenance:—

Years.	No. of Schools.	Number of Pupils.	Parly. Grants.	Years.	No. of Schools.	Number of Pupils.	Parly. Grants.
1833	789	107,042	L.25,000	1844	3153	395,550	L.75,000
1834	1106	145,521	35,000	1845	3426	432,344	85,000
1835	1181	153,707	35,000	1846	3637	456,410	100,000
1836	1300	166,929	35,000	1847	3825	402,632	120,000
1837	1384	169,548	50,000	1848	4109	507,469	125,000
1838	...	Included in the next.	50,000	1849	4321	480,623	120,000
				1850	4547	511,239	140,000
1839	1581	192,971	50,000	1851	4704	520,401	164,577
1840	1978	232,560	50,000	1852	4875	544,604	182,073
1841	2337	281,849	57,000	1853	5023	550,631	193,040
1842	2721	319,792	55,000	1854	5178	551,110	215,200
1843	2912	355,320	55,000				

The above figures represent the total number of pupils on the rolls of the schools in each year. The number, however, in attendance, and receiving instruction at any particular date, does not exceed one-half of those here given, and was ascertained by the Census Commissioners to amount, in 1851, to 215,974 during the week to which their inquiries extended.

The schools under the superintendence of the Board of National Education are all those whose patron, in consideration of grants and other advantages, are willing to have conducted under the regulations of the Commissioners and the inspection of their officers.

The Church Education Society, supported wholly by voluntary contributions, was instituted in 1839. The number of schools and pupils, with the amount of the annual receipts of the society, appears in the following summary:—

Statistics.

Years.	Schools.	Pupils.	Receipts.
1839	825	43,627	L.8,470
1840	1015	59,067	14,482
1841	1219	69,643	19,050
1842	1372	86,102	27,874
1843	1729	102,528	28,065
1844	1812	104,968	35,772
1845	1811	100,755	39,499
1846	1809	96,815	41,639
1847	1859	116,968	40,410
1848	1861	120,202	37,296
1849	1868	111,877	39,648
1850	1882	108,450	38,258
1851	1885	103,878	40,718
1852	1858	105,387	40,724
1853	1880	99,234	44,280
1854	1860	95,483	44,529

Statistics.

The official returns exhibiting the progress of Education for the whole of the population receiving instruction in public schools, give the following results. The numbers stated in 1824 and 1834 are those on the rolls of the schools; the others, those in actual attendance:—

Census Return	1821	394,813
Commissioners of Education	1824	509,150
Commissioners of Public Instruction	1834	681,000
Census Return	1841	592,650
Census Return	1851	504,382

The following Abstract shows the Numbers and Denominations of Schools in the Rural and Civic Districts of Ireland in 1851.

Schools.	Rural Districts.				Civic Districts.				Total.			
	No. of Schools.	No. of Pupils.			No. of Schools.	No. of Pupils.			No. of Schools.	No. of Pupils.		
		Males.	Females.	Total.		Males.	Females.	Total.		Males.	Females.	Total.
University of Dublin	...	...	...	...	1	650	...	650	1	650	...	650
Maynooth College	1	505	...	505	...	...	...	...	1	505	...	505
Queen's College, Galway	1	65	...	65	...	...	...	...	1	65	...	65
National	3232	93,433	77,972	171,405	269	19,877	24,692	44,569	3501	113,310	102,664	215,974
Church Education	851	14,984	14,382	29,366	62	2,196	1,942	4,138	913	17,180	16,324	33,504
London Corporations	24	645	621	1,266	...	...	...	...	24	645	621	1,266
Diocesan	11	169	88	257	11	448	51	499	22	617	139	756
Endowed	110	3,332	1,982	5,314	53	2,450	1,555	4,005	163	5,782	3,537	9,319
Schools of Design	...	...	...	...	3	305	184	489	3	305	184	489
Boarding	56	1,200	682	1,882	167	3,272	2,559	5,831	223	4,472	3,241	7,713
Private	1945	31,110	22,464	53,574	1128	20,309	12,877	33,186	3173	51,419	35,341	86,760
Parochial	458	8,311	6,540	14,851	106	5,649	4,000	9,649	564	13,960	10,540	24,500
Free	264	4,884	5,806	10,690	120	6,335	6,260	12,595	384	11,219	12,066	23,285
Industrial	24	68	820	888	2	2	82	84	26	70	902	972
Mission	209	3,571	4,319	7,890	34	1,962	786	2,748	243	5,533	5,105	10,638
Military	9	512	160	672	25	1,494	407	1,901	34	2,006	567	2,573
Royal Hibernian	1	318	20	338	...	...	...	...	1	318	20	338
Boarding, Charitable	14	396	273	669	19	166	324	490	33	562	597	1,159
Do. Agricultural	3	110	23	133	...	...	...	...	3	110	23	133
Workhouse	181	27,633	24,585	52,218	78	11,745	16,637	28,382	259	39,378	41,222	80,600
Gaol	9	712	102	814	27	1,960	492	2,452	36	2,672	594	3,266
Total	7403	191,958	160,839	352,797	2105	78,820	72,848	151,668	9508	270,778	233,687	504,465

The population from five to fifteen years of age, the number attending and not attending school, and the proportion per cent. of the latter, in 1851, was:—

	Males.	Females.	Total.
Population	951,342	919,646	1,870,988
Numbers attending school	246,991	213,604	460,595
Numbers not attending school	704,351	706,042	1,410,393
Proportion per cent. at each age not attending school	74	77	75

It appears that during the week to which the foregoing abstract refers there were 504,465 persons of all ages receiving instruction in schools in Ireland, of whom 270,778 were males, and 233,687 females; the number in attendance on schools during the week ended the 6th of June 1841, as returned by the Census Commissioners, was 502,950; there was, therefore, an increase in 1851 of 1515 persons in the total number attending school. Taking into account the greatly diminished population, these numbers represent a considerable increase in the proportion under education. Of the entire population in 1841, 61 in every 1000 were attending school, whilst in 1851 there were 76 in every 1000. (H. S—R.)

Irenæus. IRENÆUS, SAINT, a celebrated bishop of Lyon of the second century. His birth is commonly assigned to the year A.D. 120, though some make it as late as A.D. 140. It is not known with certainty what country gave him birth, yet from his modes of thought, as discernible in the fragments of his writings which have come down to us, it has been conjectured, with probability, that he was a Greek. That he possessed so little skill in writing Greek may be explained by the fact that he had mostly to speak another language. From the mention which he makes of his having been in youth the disciple of Polycarp, it is supposed that he may have been a native of Asia Minor. After the valuable training which he received from such a preceptor as the venerable Bishop of Smyrna, he was sent on a mission to Pothinus, Bishop of Lyon, in Gaul—upon what occasion is unknown. He was elevated to the sacerdotal office in A.D. 177, and sent by the churches of Vienne and Lyon on some ecclesiastical business, to Eleutherus, Bishop of Rome. Meanwhile the flames of persecution raged, and Pothinus having suffered martyrdom, Irenæus was appointed bishop in his place. He is represented as a zealous preacher of the gospel amongst the surrounding idolaters, and a wise ruler amongst his own flock. When external peace was restored to the church, there sprang up violent controversies with Gnostics, Valentinians, and whole hosts of visionaries. These occasioned Irenæus great uneasiness, for he was of a pacific disposition. He did not, however, refrain from entering the lists against error; and the only one of his works which has come down to us is that *Against Heresies*. The original Greek of it has nearly all perished, and the uncouth Latin translation which we have was made, according to Dodwell, near the end of the fourth century. It consists of five books, which were published, apparently, at different times. Irenæus was well qualified to write such a work, as he has been considered to have possessed a more extensive acquaintance with heathen mythology, literature, and philosophy, than any other man of his day. In combating Gnosticism, he takes the common view, that it sprang from philosophy, and in opposition he appeals chiefly to tradition and the consent of the church. He regards piety and love as of far more importance than mere knowledge; and, indeed, as a general characteristic of our author, it may be noticed, that he stands distinguished above his successors in Christian philosophy for the pre-eminence which he assigns to the ethical over the physical element in man. He was the first of the fathers to place in a clear light the truth that the *education* of man consists in acquiring the knowledge of God, "Vita hominis autem visio Dei." All things reveal Him, but the process is gradual, and the Gnostics err in repining at the slowness of the growth of their knowledge. The permission of evil itself is connected with the education of the species. Man, as possessing *liberty*, is good or bad, not from nature, but from choice. Whatever difficulties may be raised about the possibility of our knowing God, Irenæus, on the other side, takes the ground that our reason tells us there *is* a God; nor can this Deity be dispensed with by the fiction of an endless succession of beings, for however long the series may be, we must ultimately come to the one on which all the others depend. He charges the Gnostics with making a greater God than God, and then denying his existence. He stated very clearly the doctrine of the resurrection like Plato; and with his characteristic horror of the unmeasured, he held that only a limited and definite number were chosen to life. Irenæus is the first church teacher in whom we find any allusion to infant baptism, and with him it is seen as the medium through which the principle of sanctification, imparted by Christ to human nature from its earliest development, became appropriated to children. The child born in a Christian family was, according to him, to have this advantage above others, that he did not first come to Christianity out of heathenism or the sinful life of nature; but from the first dawning of consciousness unfolded his powers under the imperceptible preventing influence of a sanctifying ennobling religion. In such a life regeneration did not constitute a new crisis beginning at a definable moment, but it was to begin imperceptibly, and so to proceed through the whole life. Hence baptism was to be administered to a child at the very outset. His views on this subject were combated by Tertullian. Irenæus.

Besides his work *Against Heresies*, Irenæus wrote a letter to Florinus, entitled, *Monarchy, or God not the Author of Evil*. Florinus had imbibed first the errors of the Gnostics, and then those of the Valentinians. These latter were refuted by Irenæus in a work called *Ogdoad*, or the Number Eight. Against Blastus he wrote his treatise *On Schism*, in which he entered into the controversy about the time of the celebration of Easter. He also wrote a letter remonstrating with Victor, the haughty Bishop of Rome, for his anathemas against the churches in Asia. The divisions regarding Easter at this time were painful to Irenæus, for to him the unity of the church was of paramount importance. Being himself originally from Asia, he formed in this and in the Gnostic controversies, as it were, a bridge between the East and the West. From the school of John in Asia Minor, there had gone forth an influence which tended to purge the church from the caprice of Gnostic theosophy, and sought faithfully to preserve the peculiar fundamental doctrines of Christianity. This tendency Irenæus transfused into the conflicting rush of opinions which then threatened to oversweep the Christianity of the West. He formed the link of connection between Asia Minor and Rome, and in many respects represented in himself what was peculiar to them both. With a sober practical spirit, and a peculiarly sound and discriminating tact in determining what was of living moment in all doctrines, his humility and good sense presented a remarkable contrast to the arrogant pretensions of the Gnostic teachers, and the extreme views of the followers of Montanus. It was not, however, till Tertullian arose that the absorbing interest of practical Christian life found a scientific expression, and the devoutly living element in Christianity being projected upon a scientific plan was lifted a step higher above the shifting tides of popular philosophy. Besides the foregoing works, Eusebius mentions one *On Knowledge*, against the Gentiles, two addressed to Marcian, *On the Preaching of the Apostles*, and a collection of discussions of various subjects.

The weak point in the writings of Irenæus is his extravagant regard for traditions. He carefully collected these, and plumed himself on having seen and known many who had been personally acquainted with the apostles themselves. Some of the absurd notions which he entertained regarding the millennium may be seen in Middleton's *Free Inquiry*. It ought not, however, to be forgotten that with all the sensuousness which clouded his view on this and other subordinate points, there was blended a love of holiness purely spiritual, and an exalted idea of the supreme blessedness of fellowship with God. The thousand years' reign, with all its sensuous accessories, he regarded as only a preparatory step for the righteous, who were there to be trained for a more exalted heavenly existence in which they were afterwards to reap a full manifestation of the divine glory.

The time and circumstances of his death are not known. It has been asserted, that along with 9000 confessors to the truth in the district of Lyon, he received the crown of martyrdom in the beginning of the third century. But to this there is an insuperable objection in the total silence of Eusebius, Tertullian, and all the early historians. His life has been written by Gervaise in 2 vols. 12mo, Paris, 1723. His works were published by Erasmus in 1526, and by Fenardent in 1596. These were reprinted by Grabe, at Oxford, in 1702. In 1710 appeared René Massuet's edi-

Ireton ‖ Irkutsk.

tion in Paris, and shortly afterwards that of Pfaff with the newly discovered fragments, which, however, have been considered spurious. See Lardner's *Credibility*, &c., Dodwell *On Irenæus*, Tillemont and Fleury's *Eccles. Hist.*

IRETON, Henry, a distinguished general and statesman of the English Commonwealth, was the eldest son of German Ireton of Attenton, in Nottinghamshire, and was born in 1610. He was intended for the English bar, and after graduating at Oxford, entered the Middle Temple as a student of law. But the outbreak of the civil war completely altered his plan of life. He offered his sword to the parliament, and through the interest of Cromwell, whose daughter Bridget he had married, he obtained rapid promotion. At Naseby he commanded the left wing of the parliamentary troops, and though he fought both bravely and skilfully, he was completely overpowered by the furious onset of Rupert, and taken prisoner. Cromwell, however, with his Ironsides, retrieved the fortunes of the day, and Ireton regained his freedom some hours after he had lost it. In the subsequent proceedings of the parliament he took a leading part, was one of those who clamoured most loudly for the death of the king, and, when it was decided upon, signed the warrant for his execution. He next accompanied Cromwell into Ireland, aided him zealously and effectively in all the military operations, and when his chief was called away to the campaigns against Scotland, remained behind to complete the reduction of Ireland with the title and powers of lord-deputy. In this office success attended his diplomatic as well as his military plans; and his character for severity, or, as his enemies called it, cruelty, contributed not a little to terrify his foes into submission wherever he went. In the midst of his victorious progress he was cut off by the plague at Limerick, November 15, 1651. His death was sincerely regretted, and his loss deeply felt by his party, who revered him as a good soldier, an able statesman, and a saint. His body was embalmed and conveyed to England, where it was buried in Henry the Seventh's chapel in Westminster Abbey. After the Restoration his remains were disinterred, exposed on the scaffold, and afterwards publicly burned at Tyburn. By Bridget Cromwell (who after his death became the wife of Fleetwood) he had one son and four daughters, who all survived him.

Ireton's abilities both in peace and war are not denied even by the keenest partisans of the monarch whose death he had a "main finger" in bringing about. Cromwell, whose insight into character was unerring, had great faith in his judgment, and entrusted him with drawing up all the more important public acts, memorials, and documents of his party. The legal skill and knowledge which these displayed gained for their author the surname of "the scribe." Hume and the royalist historians are fond of describing Ireton as artful, designing, unscrupulous, and hypocritical; but they hold similar and even more offensive language towards Ireton's master, and posterity has now reversed their verdict in both cases.

IRIDIUM, a metal discovered in 1803. See Chemistry, 56, *Platinum*.

IRIS. See Botany, Nat. Ord. 236, *Iridaceæ*.

IRISH SEA is that part of the Atlantic lying between Great Britain and Ireland, between N. Lat. 51. 40. and 54. 30., and having St George's Channel on the S. and the North Channel on the N. It contains the Isles of Man and Anglesea, with Holyhead and some smaller islets.

IRKUTSK, the capital of the government of that name, is situated on the River Angara (here 330 yards broad), opposite the mouth of its tributary the Irkut, in N. Lat. 52. 17., and E. Long. 104. 20., and 4000 miles E. of St Petersburg. The town stands on a plain 1270 feet above the sea level, and has a dry climate although exposed to the extremes of temperature. During the 15 years from 1830 to 1845, the mean temperature of the place was—in spring 33° 34′, in summer 61° 28′, in autumn 30° 29′, and in winter 1° 18′ below zero; the mean temperature of the year being 31° 3′. Irkutsk is well laid out, and its streets, although not paved, are kept very clean. The houses, about 2000 in number, are mostly of wood. The public offices are, however, all stone buildings. They consist of the governor-general's palace, the American Company's hall, the public library (containing 5000 volumes), the museum, and the medical, military, and naval schools. There are also a handsome cathedral, 9 churches, and a large bazaar. Irkutsk is the see of an archbishop, as well as the chief residence of the Governor-General of Eastern Siberia. The commerce of Irkutsk is considerable, as it forms one of the principal stations on the great Chinese caravan route. At the yearly market, which commences on the 13th of December and lasts for a month, the finer goods of the west are exchanged for the raw materials of the East. Tea from China, and furs from the Pacific settlements, are exchanged for European manufactures from St Petersburg and Moscow. There is also a considerable trade in grain, wool, and minerals, from the surrounding country. Manufacture is here confined to woollen stuffs, glass, leather, and iron. There are here 7 public government schools, in one of which the sons of exiles are trained. After going through the usual course of study, they are drafted into the army. Of the other schools two are for girls, one is allotted to the clergy, a third to the merchants, and the remaining two form a gymnasium and college. The average number of students in the latter is 150, with 1 rector and 14 professors, who also teach in the gymnasium. Pop. (1853) 14,454.

Iron Crown ‖ Iron Mask.

IRON CROWN is the name by which is known the celebrated diadem used at the coronation of the Lombard kings. Though called the iron crown, it consisted of a broad band of gold set with jewels, and only a thin circlet of iron inside the band. But to this iron circlet great interest was attached, for it was considered to be one of the nails used at the crucifixion of our Saviour, brought from Palestine by the Empress Helena, and beaten out into a narrow ring. It was thus that the name originated by which the crown has for centuries been known. It has been used at the coronation of 34 different monarchs, including Charlemagne, Charles V., and Napoleon. It was worn by the last of these at his second coronation *i.e.*, in 1805, as King of Lombardy. When placing it on his own head he exclaimed, "God has given it to me, woe to him who touches it!" This curious relic of antiquity is preserved in the Cathedral of St John at Monza, in the north of Italy. It is kept in a chapel on the right-hand side of the high altar.

IRON MASK, The Man of the, was the designation applied to a remarkable personage whose real name was unknown. He was so called because of a black mask which completely concealed his face. This mask was of black velvet, and so constructed by means of springs that the wearer never required to take it off, not even while eating. He was kept in the Castle of Pignerol, from which he was taken (in 1681) to Exelles; thence (in 1687) to the island of St Marguerite; and lastly (in 1698) to the Bastile in Paris. At each of these places he was attended by the same keeper, M. de St Mars. When taken from place to place, armed attendants on horseback were ready to despatch him if he made any attempt to escape, or even to show his face. That the prisoner thus guarded was a person of no small importance is evident from the precautions taken to keep him from being recognised. During his captivity in the Bastile, he was always treated with the greatest consideration. His fare was sumptuous, and his accommodation was the best that could be obtained in the prison. He had a great predilection for lace and extremely fine linen, which were supplied him; indeed he got whatever he asked. He read extensively, and was a good player on the guitar. The physician who attended him at the Bastile

Iron Mask. describes him (according to Voltaire) as remarkably well made, with skin rather brown, and tone of voice interesting from the fact that he never complained of his fate, nor dropped any hint of what he might be. The physician at times examined his tongue and various parts of his body, but never saw his countenance. Besides these incidents, there are some interesting anecdotes, showing how important it was considered to keep the man with the mask unknown. It is related that while he was at St Marguerite, he carved with a knife some words on a silver plate, which he threw from a window upon the shore. The plate was picked up by a fisherman, who brought it to the governor of the jail. The words must have contained a complete revelation of the mystery connected with the prisoner, for the governor of the jail (M. de St Mars) detained the fisherman to ascertain whether he had shown the plate to any one. The fisherman assured him that he had not, but it was equally important that he should not have read the words himself; accordingly, the jailer did not let him go till he was certain of the man's inability to read at all. Upon setting him at liberty, M. de St Mars said to him—"It is well for you that you cannot read!" Upon another occasion, the man with the mask had covered a shirt with writing, and got it somehow thrown into the water. It was picked up by a boy and brought to the governor. The boy was asked if he had read any of the writing, but he denied having done so. However, in a few days afterwards he was found dead in his bed. According to another anecdote, a prisoner confined in the apartment immediately above that of the man with the mask, succeeded in carrying on a conversation with him by means of the chimneys. When pressed to tell who he was, the mask replied that his life, and not only his, but the lives of all who might become possessed of the secret, would be sacrificed should he make known the mystery. When about to be removed from St Marguerite to the Bastile, he inquired of his keeper (M. de St Mars) if his life were in danger. The keeper was overheard to answer, "No, *Prince*, your life is safe," &c. This accords with the respect uniformly paid him, for his governor never sat in his presence. The mysterious individual died in the Bastile on the 19th November 1703. He fell suddenly ill one day after attending mass, and at 10 o'clock on the evening of the following day he died. He was buried on the next day, in the cemetery of St Paul, under the false name of Marchialy. He was considered as being about 45 years of age. Everything belonging to him, his clothes, bed, &c., were committed to the flames. The apartment in which he had been kept was searched to see that he had not concealed any notice by which he might be identified. The walls were scraped and whitewashed anew, and the tiles of the floor changed. To discover the person who was for so many years concealed behind the black mask, was one of the most curious problems in history. All the possible (and some impossible) personages have been successively declared to be the same as this great unknown. In an anonymous book published at Amsterdam in 1745, under the title *Secret Memoirs for the History of Persia*, the man with the mask was declared to be the Duke of Vermandois, the natural brother of the dauphin. The duke was represented as having given a personal affront to the dauphin, for which offence he was condemned to perpetual imprisonment. These so-called secret memoirs were in reality a history of the intrigues of the French court after the death of Louis XIV., and the persons who figured in the book were disguised under imaginary and Persian names. In 1746 another book appeared with the title of *The Man with the Iron Mask*, and although it contained an enumeration of adventures not at all applicable to the person of whom we have been speaking, yet from this time he became specifically designated by the title as given above. In 1751 Voltaire's work, *The Age of Louis XIV.*, appeared at Berlin, and contained an account of the unknown person with the mask. The leading particulars of this account, relating to treatment in the Bastile, Iron Mask. &c., we have already given. Voltaire takes credit to himself as being the first who had given any proper historical account of the man with the mask. He draws attention to the important fact that, at the time when St Mars and his charge went to St Marguerite, no person of distinction had disappeared in Europe. In 1759, Lagrange-Chaucel endeavoured to show that the unknown was the Duke de Beaufort. In 1768, St Foix threw out the conjecture that the person concerned was the Duke of Monmouth, who was openly executed in London! In 1769 some particulars were brought to light by Griffet in the discovery of the manuscript journal of Dujonca, a *lieutenant du roi* in the Bastile in 1698. These particulars related to the death, burial, &c., of the unknown, which we have given already. In 1770 an attempt was made by Baron d'Heiss to identify him as Matthioli, secretary to the Duke of Mantua, who had been seized and confined in the Castle of Pignerol. Voltaire appeared again on the subject in the seventh edition of the *Dictionnaire Philosophique*, in which he corrected some inaccuracies into which he had formerly fallen, but throws no new light on the subject. It has, indeed, been asked how Voltaire should come to know so much about the man with the mask as he pretends? It has been suggested that he was the author of the *Persian Memoirs*, although he afterwards called it a contemptible and obscure tract; and that his inaccuracies regarding dates, &c., in his *Age of Louis XIV.* (which was published under the assumed name of Francheville), were intentional, his purpose being, if possible, to draw out such as might possess any authentic documents on the subject. If so, in failing to clear up one mystery, he seems willing to have created another, for he concludes the notice of which we are speaking by the remarkable sentence—"He who writes this perhaps knows more about the subject than Father Griffet, and will say no more about it." The editor of the said dictionary suggests that the unknown may have been an elder brother of Louis XIV.—an illegitimate son of Anne of Austria, by Cardinal Mazarini or the Duke of Buckingham, brought up secretly in order to prevent scandal in the royal family and dissensions in the kingdom. In 1789 a document was passed off as having been discovered at the Bastile, oracularly settling the question by the words, "Foucquet arriving from St Marguerite with an iron mask . . .," in a mass of unintelligible notes. Cubière suggested that the unknown prisoner was a twin-brother of Louis XIV., and in 1790 appeared the *Memoirs of Cardinal Richelieu*, which contained a document with the following title:—"Account of the birth and education of the unfortunate Prince, abducted from society by the Cardinals Richelieu and Mazarin, and confined by order of Louis XIV.; drawn up by the governor of this Prince on his death-bed." According to the narrative the Prince, who was educated secretly by order of his father, one day saw a portrait of Louis XIV., and at once perceived its likeness to himself. He was immediately masked and imprisoned as before described. It need scarcely be added that there is great difficulty in the way of accepting the document under consideration as authentic. In 1800 the claims of Matthioli were revived by Roux-Fazillac, and defended by Delort in 1825. Several of the persons already mentioned were also again successively supposed to be the mysterious prisoner; new names, however, such as that of Henry Cromwell, being added to the list. In 1837 some able researches were published by Jacob, in which the belief is supported that the statesman Foucquet was the prisoner. It is contended that the prosecutions taken in the case of Foucquet were precisely similar to those taken in the case of the prisoner with the mask; and that it was immediately after the pretended death of Foucquet that the prisoner with the mask appeared. More recently Lord Dover took up the subject, and supported the belief that Count Matthioli, before-mentioned, was the mysterious unknown.

IRON.

Iron manufacture.

IRON, on account of its abundance, working qualities, and tenacity, is probably the most useful and valuable of metals. According to Dr. Ure, "it is capable of being cast into moulds of any form, of being drawn into wire of any desired length or fineness, of being extended into plates or sheets, of being bent in every direction, of being sharpened, or hardened, or softened at pleasure. Iron accommodates itself to all our wants and desires, and even to our caprices; it is equally serviceable to the arts, the sciences, to agriculture, and war; the same ore furnishes the sword, the ploughshare, the scythe, the pruning-hook, the needle, the graver, the spring of a watch or of a carriage, the chisel, the chain, the anchor, the compass, the cannon, and the bomb. It is a medicine of much virtue, and the only metal friendly to the human frame." In its primitive position it is commingled with the earth's strata in bountiful profusion; it is found in various combinations and conditions in every formation, and it is a constituent element of both animals and vegetables.

In treating of the manufacture, properties, and production of this most important material, it will conduce to perspicuity to arrange the subject under five distinct heads, viz.—I. The History; II. The Ores and Fuel; III. The Manufacture; IV. The Strength and other Properties of Iron; V. The Statistics of the Iron trade.

I. *History of the Iron Manufacture.*

The History.

Malleable iron appears to have been known from a remote antiquity. Its obvious utility and great superiority over the softer metals, then commonly used, combined with the expense of its reduction, caused it to be highly prized, though the extreme difficulty of working it by the rude methods then employed greatly restricted its application.[1] There are notices in Homer and Hesiod of the arts of reducing and forging iron, but cast-iron was then unknown, an imperfectly malleable iron being produced at once from the ores in the furnace. It is probable that the Greeks obtained most of their iron through the Phœnicians from the shores of the Black Sea, and from Laconia.

It would be interesting to trace the gradual advances which have been made in the reduction of iron from its discovery to the present time; to inquire into the circumstances which led to the successive changes in the processes, and into the principle on which those changes were founded; to examine into the differences in the products which from time to time ensued, and to notice the influence of these conditions on the extent and progress of the manufacture. Our knowledge of these changes, however, is scanty and imperfect, and we can only conjecture what was probably its early progress.

The furnaces which were first employed for smelting iron were probably similar to those now called *air-bloomeries*. They were probably simple conical structures, with small openings below for the admission of air, and a large one above for the escape of the products of combustion, and would be erected on high grounds in order that the wind might assist combustion. The fire being kindled, successive layers of ore and charcoal would be placed in it, and the heat regulated by opening or closing the apertures below.

The process of reduction would consist of the de-oxidation of the ore and the cementation of the metal by long continued heat. The temperature would never rise sufficiently high to fuse the ore, and the product would therefore be an imperfectly malleable iron, mixed with scoriæ and unreduced oxide. It would then be brought under the hammer, and fashioned into a rude bloom, during which process it would be freed from the greater portion of the earthy impurities.

The History.

By such a process as this the Romans probably worked the iron ores of our own island; scoriæ, the refuse of ancient bloomeries, occur in various localities, in some cases identified with that people by the coincident remains of altars dedicated to the god who presided over iron. Mungo Park saw a rude furnace of this kind used by the Africans, and, indeed, with some modifications, it is still retained in Spain, and along the coasts of the Mediterranean, where rich specular ores are worked.

The advantages of an artificial blast would soon become manifest, and a pair of bellows or a cylinder and piston would soon be applied to the simple construction mentioned above. Homer represents Hephæstus as throwing the materials from which the shield of Achilles was to be forged into a furnace urged by 20 pairs of bellows (φῦσαι). The inhabitants of Madagascar smelt iron in much the same way, their blowing apparatus, however, consisting of hollow trunks of trees, with loosely fitting pistons.

The furnace corresponds to the *blast*-bloomery, and has by successive improvements developed into the blast furnace, now almost universally used, and into the *Catalan forge*, still employed in some districts. The application of the blast would offer considerable advantages; it would obviate the necessity of an elevated site, place the temperature more immediately under the direction of the smelter, and render the whole process more regular and certain. The method of reduction remained the same as before, but the product would differ considerably, for whenever the blast was sufficiently powerful, the iron would be *fused*, a partial carburation would take place, and the resulting metal would be a species of steel, utterly useless to the workmen of those days; hence, it seems necessary to infer, that a rude process of refining was invented, the metal being again heated with charcoal, and the blast directed over its surface, the carbon would be burnt out, and the iron become tough and malleable. The processes might perhaps form two successive stages of one operation, as at present practised with the Catalan forge.

The increasing demand for iron, and the progress of internal communication, would lead the smelter to increase the size and height of his bloomery, and this probably would lead to a very unexpected result. The greater length through which the ore had to descend would prolong its contact with the charcoal, and a higher state of carburation would ensue, the product being cast-iron—a compound till then perhaps unknown.

From the time that cast-iron became the product of the smelting furnace, the refining would be made a separate process, requiring a separate furnace and machinery. It would soon be found also that, as the furnace increased in height, the pressure of the superincumbent mass would render the materials so dense as to retard the ascent of the blast, and thus cause it to become soft and inefficient; hence the internal buttresses called *boshes* were

[1] This is shown by the epithet πολύμητος (much-wrought), applied to it by Homer—*Iliad*, vi. 48.

The History.

first introduced to support the weight of the charge, relieving the central parts from the pressure, and permitting the free ascent of the blast. Whilst the good quality of the iron and the regularity of the process were thus ensured, increase of quantity was the result of improvements in the blowing apparatus, which was now enlarged and worked by water-power. With these modifications, the furnace was the same essentially as the blast-furnace now employed, though not so large; indeed, until the introduction of coke at a much later period, the blast-furnace seldom exceeded 15 feet in height by 6 at the widest diameter. The more perfect operation of the blast furnace allowed the reduction of the heaps of scoriæ, which had been gradually accumulating during the period that the blast bloomeries had been in operation, and which contained 30 to 40 per cent of iron. A new species of property was thus created, extensive proprietorships of Danish and Roman cinders were formed; large deposits of scoriæ which for ages had lain concealed beneath forests of decayed oak, were dug up, and in Dean Forest it is computed that 20 furnaces, for a period of upwards of 300 years, were supplied chiefly with the bloomery cinders as a substitute for iron ore.

At what period the complete transformation of the blast-bloomery into the blast furnace was effected, it is impossible to say. It was probably in the early part of the 16th century, as we find that in the 17th the art of casting had arrived at a considerable degree of perfection, and in the reign of Elizabeth there was a considerable export trade of cast-iron ordnance to the Continent. In the forest of Dean are the remains of two blast-furnaces, which formerly belonged to the kings of England, but they have been out of blast since the commencement of the struggle between Charles I. and his Parliament. Calculating from the quantity of scoriæ accumulated in their immediate neighbourhood, which appear to have lain undisturbed for the last two centuries, Mr Mushet has attempted to deduce the period of their erection, which he conceives to have been about the year 1550, in the time of Edward VI.

Up to this period wood charcoal was the only material employed in smelting operations, but the wants of a constantly increasing population, not less than the great consumption of the blast furnaces themselves, created a scarcity of this essential material, and gave a check to the manufacture. To such an extent had the wood been destroyed, that the cutting down of timber for the use of the iron-works was prohibited by special enactments; and the forests of Sussex alone appear to have been exempt from the general decree of conservation. The number of furnaces in blast decreased three-fourths, and the annual production, which but a short time before is said to have been 180,000 tons, was in 1740 reduced to only 17,350 tons.

James I. granted patents to ironmasters in various parts of the kingdom for using pit-coal in the manufacture of iron. The obstacles to its introduction, however, were numerous, and not easily overcome. The comparatively incombustible nature of coke, and its feebler chemical affinities, rendered a more powerful blast and a longer subjection to the heat indispensable to its successful adoption. Ignorance of the causes of failure operated long and seriously, but all difficulties were at length surmounted. An enlargement of the height of the furnace prolonged the contact of the ore and coke, and at last the employment of the steam-engine and improved blowing apparatus rendered the blast much more powerful and regular, and gave that impetus to the manufacture which has caused Great Britain to take the first rank in this branch of industry.

The History.

The first great improvement on the blowing apparatus was the substitution of large cylinders, with closely fitting pistons, for the bellows. The earliest of any magnitude were probably those erected by Smeaton at the Carron Iron-Works, in 1760.

In 1783-4, Mr Cort of Gosport introduced the processes of puddling and rolling, two of the most important inventions connected with the production of iron since the employment of the blast furnace. (See Addenda, A.)

About this time the steam-engine of James Watt came into use, and along with it commenced a new era in the history of the iron trade and every other branch of industry. Its immense power, economy, and convenience of application, brought it at once into general employment. It was soon applied to pumping, blowing, and rolling; it enabled the mines to be sunk to a greater depth; refractory ores to be reduced with facility, and the processes of rolling, forging, &c., to be effected with a rapidity previously unknown.

Of late years, Scotland has made considerable progress in the iron manufacture. The introduction of railway communication, and the invention of the hot-blast, have given a stimulus to the trade which has raised Glasgow into importance as an iron district, and few towns possess greater facilities for the sale of their produce, than this central depot of the mineral treasures of the country by which it is surrounded.

The hot-blast process, for which a patent was taken out by Mr Neilson in 1824, has effected an entire revolution in the iron industry of Great Britain, and forms the last era in the history of this material. This simple but effective invention has given such facilities for the reduction of refractory ores, that between three and four times the quantity of iron can be produced weekly, with an expenditure of little more than one-third the fuel; and, moreover, the coal does not require to be coked, or the ores to be calcined.

In conclusion, we may add that there appear to have been five distinct epochs in the history of the iron trade.

The *first* dating from the employment of an artificial blast to accelerate combustion.

The *second* marked by the employment of coke for reduction, about the year 1750.

The *third* dating from the introduction of the steam-engine, and on account of the facilities which that invention has given for raising the ores, pumping the mines, supplying the furnace with a copious and regular blast, and moving the powerful forge and rolling machinery, we may safely attribute this era to the genius of James Watt.

The *fourth* epoch is indicated by the introduction of the system of puddling and rolling, very soon after the employment of the steam-engine.

The *fifth*, and last—though not the least important epoch in the history of this manufacture—is marked by the application of the hot-blast—an invention which has increased the production of iron fourfold, and has enabled the ironmaster to smelt otherwise useless and unreducible ores; it has abolished the processes of coking and roasting, and has given facilities for a large and rapid production, far beyond the most sanguine anticipations of its inventor. Manufacturers taking advantage of so powerful an agent, have not hesitated to reduce improper materials, such as cinder-heaps and impure ores, and by unduly hastening the process, and attending to quantity more than to quality, have produced an inferior description of iron, that has brought the invention into unmerited obloquy.

II. *The Ores.*

The Ores.

The ores of iron are found in profuse abundance in every latitude, embedded in or stratified with every

The Ores.

formation. They occur both crystallized, massive, and arenaceous, lying deep in strata of vast extent, filling veins and faults in other rocks, and scattered over the surface of the ground. Sometimes, but rarely, found native; usually as oxides, sulphurets, or carbonates, more or less mingled with other substances. Of these ores there are perhaps twenty varieties, many of which are, however, rare; others are combined with substances which unfit them for the manufacture of iron, so that the remainder may be classed under the following general heads; their composition, however, varies greatly:—

1. The magnetic oxides, in which the iron occurs, as $Fe_3 O_4$ or $Fe_2 O_3 + Fe O$. This is the purest ore which is worked, the best Swedish metal is manufactured from it. It is found in primitive rocks, and is widely diffused over the globe.

2. Specular iron ore, peroxide of iron, $Fe_2 O_3$. This is rich and valuable ore, and has been worked from a remote antiquity in Elba and Spain. It is found chiefly in primary and transition rocks.

3. Red and brown hæmatites, hydrated peroxide of iron. These ores occur in botyroidal radiating masses, in Cumberland, Ireland, America, and other places.

4. Carbonate of iron. This ore occurs mixed with large quantities of argillaceous, carbonaceous, and silicious substances, forming the large deposits of clay-ironstone and blackbands, from which most of the iron of this country is obtained. These strata are generally found in close proximity to the coal measures.

All the above ores are more or less mixed with silica, alumina, oxide of manganese, &c., and it may not be uninteresting to glance at their geographical distribution in Europe and America.

The iron ores of the United Kingdom.

This country possesses peculiar and remarkable advantages for the manufacture of iron. The ores are found in exhaustless abundance, usually interstratified with the coal for their reduction, and in close proximity to the mountain limestone, which is used as a flux. In few countries do these three essential materials occur in such abundance, or so near together as to give the necessary facilities for a large and profitable production.

The ores principally employed are the clay-ironstones and carbonates of blackbands, which are found interstratified with the coal fields of Ayrshire, Lanarkshire, Shropshire, South Wales, and other parts, and these vary in richness in different localities, according to position and the amount of silica clay and other foreign matter with which they are associated. The chemical composition of three varieties of the ore used in Lanarkshire is given by Dr. Colquhoun, as follows:—

	No. 1.	No. 2.	No. 3.
Protoxide of iron	53·03	47·33	35·22
Carbonic acid	35·17	33·10	32·53
Silica	1·40	6·63	9·56
Alumina	0·63	4·30	5·34
Lime	3·33	2·00	8·62
Magnesia	1·77	2·20	5·19
Peroxide of iron	0·23	0·33	1·16
Bituminous matter	3·03	1·70	2·13
Sulphur	0·00	0·22	0·62
Oxide of Manganese	0·00	0·13	0·00
Moisture and loss	1·41	2·26	0·00
	100·00	100·00	100·37

The carbonic acid in the above ores may be partly combined with the lime as carbonate of lime, as well as with the protoxide of iron.

M. Berthier gives, according to Dr. Ure, the following analyses of the English and Welsh ironstones of the coal measures:— The Ores.

	Rich Welsh Ore.	Poor Welsh Ore.	Dudley Rich Ore or Gubbin.
Loss by ignition	30·00	27·00	31·00
Insoluble residuum	8·40	22 03	7·66
Peroxide of iron	60·00	42 66	58 33
Lime	0·00	6·00	2·66
	98·40	97·69	99·65

Calculating the amount of carbonate of iron and metallic iron indicated by the above analyses, we have:—

Carbonate of iron	88·77	65·09	85 20
Metallic iron	42·15	31·38	40 45

The richness of the above ironstones would be about 33 per cent of iron. In the process of roasting, 28 per cent of the ore is dissipated.

Mr Mitchell gives also the following assays of clay-ironstone and blackband ore, as under:—

	Clay Ironstone, Leitrim, Ireland.	Blackband Carbonate Ore.
Protoxide of iron	51·653	20·924
Peroxide of iron	3·742	·741
Oxide of Manganese	·976	1·742
Alumina	1·849	14·974
Magnesia	·284	·987
Lime	·410	·881
Potash	·274	trace.
Soda	·372	trace.
Sulphur	·214	·098
Phosphoric acid	·284	·114
Carbonic acid	31·142	14·000
Silica	6·640	26·179
Carbonaceous matter	2·160	16·940
Loss		2·420
	100·000	100·000

In North Lancashire and Cumberland, the red hæmatite ores are now extensively worked, and great quantities are yearly shipped from Whitehaven, Ulverstone, &c., to Staffordshire, South Wales, and Scotland, for mixing with the poorer argillaceous and blackband ores. In Cumberland and North Lancashire, no less than 546,998 tons were raised in 1854 for this purpose, and the greater portion was exported from those districts.

In addition to these exports, about 25 to 30,000 tons are smelted by the hot blast at Cleator, in the neighbourhood of Whitehaven. It produces a strong and ductile iron, considered highly valuable for mixing with the weaker irons. These ores have been carefully analysed, and contain:—

Peroxide of iron	90·3
Silica	5·0
Alumina	3·0
Lime	trace.
Magnesia	trace.
Water	6·0
	104·3

Or about 62 per cent of metallic iron.

In IRELAND there are vast deposits of iron ore of great richness, though as yet but little worked. Some of these, such as the ores worked at the Arigua mines, and the Kidney ores of Balcarry Bay, yield as much as 70 per cent of iron. If these mines were worked more extensively, and if peat fuel were used in the smelting opera-

The Ores.

tions, the iron would probably be of the very best quality, and might rival the famed Swedish charcoal metal. Of this there is now every reason to hope, as the establishment of railway communication, with almost every part of Ireland, will open out the immense peat bogs of that country, and facilitate the introduction of vegetable fuel for the reduction of the ores, and create a large and important addition to other branches of Irish industry. In a communication to the writer from Mr M'All, dated Scrabby, he states—"I have sent you samples of two kinds of iron ore, one is the red, the other the purple hæmatite. There are strata which are inexhaustible, and the ore can be raised and delivered at the furnace for less than a shilling a ton; the peat or vegetable carbon is equally cheap and abundant. Limestone of the purest quality is also close at hand, and can be delivered at the furnace at ninepence per ton. On account of the purity of these materials, iron of the greatest strength and ductility can be made, which, from its non-liability to corrode, would be admirably adapted for naval and marine purposes." Ireland is, therefore, according to Mr M'All and others, in a condition to supply large quantities of excellent iron.

The iron ores of France.

France possesses an abundant supply of iron ore, but on account of the scarcity of coal, the manufacture has been greatly restricted in extent. The introduction of railway communication is, however, rapidly removing this difficulty, and the operations of smelting are greatly on the increase. The railroad has enabled the French ironmaster to substitute coal for charcoal in the reduction of the iron ores, and in consequence an immense increase has taken place in the production of pig and manufactured iron. The ores are found in beds or strata in the Jura range; accumulated in kidney-shaped concretions in the fissures of the limestone; or dispersed over the surface of the ground, and but slightly covered with sand or clay.

They are found in the departments of the Yonne, the Meuse, and the Moselle, and indeed may be traced from the Pas de Calais on the north to the Jura on the south, indicating throughout an abundant and ample supply.

The present increased production of iron in France is chiefly due to the introduction of coal in smelting, but it may also be traced in some measure to the encouragement given by the Government to that branch of industry, and to the enterprise of such men as M. de Gallois and M. Dufrènoy, who have exerted themselves to extend its manufacture in that country. M. de Gallois resided in England for several years, immediately subsequent to the peace of 1815, and having obtained admission into the different iron-works here, he returned to France and established the works at St. Etienne, now probably the largest and most extensive in that country.[1] The production of crude pig-iron in France is now little short of 1,000,000 tons annually, but the demand for railways, rolling-stock, bridges, iron ships, girders, and other constructions is so great that large quantities of iron are still annually imported from this country.

The iron ores of Prussia.

Valuable deposits of the blackband and clay carbonate ores are found interstratified with the great coal-field of Ruhr; and the bog-iron and hæmatite ores are found in considerable profusion in Rhenish Prussia and other parts. In Upper Silesia, on the Vistula and the Oder, large deposits of coal and iron are found in juxtaposition, and are worked to a considerable extent.

The consumption of iron is not so great as in France, though it is increasing rapidly, as may be seen from returns recently given by the British Chargé d'Affairs at Berlin. These returns show that the amount of iron ore raised in Prussia has increased from 1,495,516 tons in 1853, to 2,144,509 tons in 1854; this has taken place in nearly all the producing districts, but chiefly on the Rhine, where the demand has increased from 719,684 to 1,068,656 tons; in Westphalia, from 146,320 to 330,014 tons; in Silesia, from 563,739 to 650,369 tons; in Lower Saxony and Thuringia, from 51,963 to 70,676 tons; in Prussian Brandenburgh, from 8,084 to 12,731 tons; and in the Upper Zollverein from 6,736 to 12,063 tons.

The Ores.

The iron ores of Austria, Sweden, &c.

In AUSTRIA, all the iron is smelted with charcoal or carbonised peat, and is in consequence of the finest quality; it may be applied to every description of manufacture, from the most ductile wire to the hardest steel. The production is, however, small. The ores are found in Hungary, Styria, Moravia, and Upper Silesia.

In BELGIUM, both coal and iron are found in equal abundance, and are worked at Charleroi, Liege, and at other places. The ores, which are chiefly hæmatite, are derived from the limestone at the base of the coal measures. (See Addenda, B.)

The superiority of the SWEDISH iron has long been acknowledged, and till recently it has been unrivalled. This arises not only from the purity of the ore—the magnetic oxide of iron—but in consequence of its being smelted with charcoal only. The quantity is, however, restricted, as the ironmasters are allowed by law only a certain number of trees per annum, in order that the forests may not be totally destroyed. Coal does not exist in either Sweden or Norway.

In 1844 some experimental researches were undertaken by Mr Fairbairn of Manchester, at the request of the Sublime Porte, in regard to the properties of iron made from the ores of Samakoff in Turkey. The ores were strongly magnetic, and contained, according to Dumas and others, 62 to 64 per cent of iron. They consisted of:—

One atom iron	28	+ one atom oxygen	8	=	36
Two atoms iron	56	+ three atoms oxygen	24	=	80
Iron .	84	Oxygen .	32		116

Some of these ores have been smelted with charcoal, and some very fine specimens of iron and steel produced. The manufacture is, however, in a languid state in Turkey, and although smelting furnaces, blowing apparatus, forges, rolling mills, &c., were prepared and sent out from this country, they are to a great extent useless among a people who have deeply rooted prejudices and habitual inactivity to overcome, and everything to learn in all those habits of industry which indicate the rising prosperity of an energetic and an active people.

The iron ores of America.

Both the magnetic, hæmatite, and clay-ironstones abound in the United States. The magnetic ores worked in New England, New York, and New Jersey; the hæmatite in Pennsylvania, New York, New Jersey, and other localities; but the greater part of the manufacture must eventually establish itself in the valley of the Mississipi, west of the Alleghany range, where vast deposits of coal and iron exist, though at present but imperfectly known or developed. The ores in most of these districts are smelted with a mixture of charcoal and anthracite, and the usual limestone flux, and produce a very excellent quality of iron.

[1] The universal exhibition of last year (1855) fully justifies the remarks in reference to the great increase of the iron trade of France. Any person in the least conversant with the imperfect machinery and processes of the iron manufacture as it existed in France some years since, could not have been otherwise than struck with the improved character of those exemplified in the Paris Exhibition. In no country (probably not excepting even this) has so great progress been made in so short a time, in advancing from a state of comparative rudeness to one of considerable perfection, as in France.

The Ores. In Nova Scotia some of the richest ores yet discovered occur in exhaustless abundance. The iron manufactured from them is of the very best quality, and is equal to the finest Swedish metal. The specular ore of the Acadian mines, Nova Scotia, is said by Dr. Ure to be a nearly pure peroxide of iron, containing 99 per cent of the peroxide, and about 70 per cent of iron. When smelted, 100 parts yield 75 of iron, the increase in weight being due to combined carbon. The red ore Dr. Ure states to be analogous to the kidney ore of Cumberland, and to contain :—

	(1)	(2)
Peroxide of iron . . .	85·8	84·4
Silica	8·2	8·0
Water	6·0	7·6
	100·0	100·0

The Acadian ores are situated in the neighbourhood of large tracts of forests, capable of supplying almost any quantity of charcoal for the manufacture of the superior qualities of iron and steel. Several specimens of iron from these mines have been submitted to direct experiment, and the results prove its high powers of resistance to strain, ductility, and adaptation to all those processes by which the finest description of wire and steel are manufactured.

The difficulties which the Government have had to encounter, during the last two years, in obtaining a sufficiently strong metal for artillery, are likely to be removed by the use of the Acadian pig-iron. Large quantities have been purchased by the War Office, and experiments are now in progress, under the direction of Lieutenant-Colonel Wilmot, Inspector of Artillery, and of Mr Fairbairn, which seem calculated to establish the superiority of this metal for casting every description of heavy ordnance.

There are also some very rich ores at the Nictau mines, as the following analyses by Dr. Jackson shew. They contain impressions of Silurian tentaculites, spirifers, &c.—

	Brown Ore, somewhat magnetic.	Red Iron Ore.
Peroxide of iron . .	70·20	64·40
Silica	14·40	19·20
Carbonate of Lime .	5·60	5·40
Carbonate of Magnesia	2·80	3·20
Alumina	6·80	1·20
Oxide of Manganese .	·40	4·40
Water	·00	2·40
	100·20	100·20
* Gain from oxygen. † Over-run, probably carbonic acid from carbonate of lime.	·20*	·20†
	100·00	100·00

As our limits are circumscribed, it will not be necessary to extend this section further; suffice it therefore to observe, that in all countries nature has, with a beneficent purpose, interlaid and interstratified the whole surface of the globe with this useful and indispensable material, and it would ill bespeak that high intelligence with which man is endowed if he did not avail himself of, and turn to good account, the immense stores of mineral treasures which are so profusely laid at his feet.

The Fuel.

The enquiry into the properties and composition of the ores of iron, and the processes employed for their reduction and subsequent conversion into bars and plates, would be incomplete unless accompanied by descriptive analyses of the fuel by which they are fused. Indeed the results of the operations of smelting, puddling, &c., are so intimately dependent on the quality of the fuel employed, as to render a knowledge of its constituents essential to the manufacture of good iron. The Fuel.

Charcoal was at first universally employed in the manufacture of iron, and on account of its purity compared with other kinds of fuel, and its strong chemical affinities and consequent high combustibility, it is of very superior value where it can be obtained in large quantities at a moderate cost. This, however, is rarely the case, and hence its use is restricted within very narrow limits in most countries. Charcoal is the result of several processes, in each of which the object is to increase the amount of fuel in a given bulk. The wood being cut into convenient lengths, and piled closely together, in a large heap, the interstices being filled with the smaller branches, and the whole covered with wet charcoal powder, is then set on fire. Care is taken that only sufficient air is admitted to consume the gaseous products of the wood, so as to maintain the high temperature without needlessly consuming the carbon. After the whole of the gaseous products have been separated, and the carbon and salts only are left, the access of air is prevented, and the heap allowed to cool.

Another and better process is to throw the wood into a large close oven or furnace, heated either by the combustion within it, or by a separate fire conducted in flues around it. By this process, not only is the yield greater and of better quality, from the slower progress of the operation, but the products of the distillation may be preserved and employed for a great variety of purposes. The following results of some experiments by Karsten, shew the difference in yield of very rapid and very slow processes :—

Wood.	Charcoal produced by quick carbonization.	Charcoal produced by slow carbonization.
Young Oak . . .	16.54	25·60
Old „ . . .	15·91	25·71
Young Deal . . .	14·25	25·25
Old „ . . .	14·05	25·00
Young Fir . . .	16·22	27·72
Old „ . . .	15·35	24·75
Mean . .	15·38	25.67

These, on the average, give for the quick process 15·3, and for the slow 25·6, being in the ratio of 1 : 1.67, or 0·67 in favour of the quick process.

Peat.—This material seems likely to come into use for smelting iron in countries such as Ireland, where neither coal nor wood are found in abundance. It is purer and less objectionable than coal, and if properly dried, compressed, and carbonized, would prove a very valuable fuel for the reduction of such ores as we have already described in the section on the iron ores of Ireland. It is carbonized in the same way as the charring of wood.

Coke.—Before the introduction of the hot-blast, this material was used to a very great extent in the manufacture of iron; it is prepared from coal in the same way that charcoal is prepared from wood, the operation being called the coking or desulphurizing process. The heaps do not require so careful a regulation of the admission of air as those of charcoal, on account of the comparatively incombustible character of the coke. Sometimes the heaps are made large, with perforated brick chimnies, to increase the draught through the mounds; at other times they are formed into smaller heaps, and the conversion takes place without the intervention of flues. The more usual and economical plan is, however, the employment of close ovens, by which process a great saving is effected, the yield being from 30 to 50 per cent in the one case,

The Fuel. and from 50 to 75 in the other, according to the nature and quality of the coal.

Coal.—The hot-blast has enabled the ironmasters to use raw coal in the blast furnaces, the great heat of the ascending current of the products of combustion coking it as it falls in the furnace. The sulphur, however, and other deleterious ingredients, do not appear to be so completely got rid of as when the coal is used in the shape of coke; and it appears probable, that even with the hot blast, the separate process of coking might be advantageously used, on account of the greater purity of the iron produced. The Fuel.

The following tables, selected from various sources, give the composition of the different kinds of fuel, all of which are applicable to the reduction and fusion of the iron ores:—

Fuel.	Locality.	Specific Gravity.	Carbon.	Hydrogen.	Oxygen and Nitrogen.	Ashes in 100 parts.	Authority.
Splint Coal		1.290	75.00	6.25	18.75	...	Thomson.
,,		1.266	70.90	4.30	24.80	...	Ure.
,,	Newcastle, Wylam.	1.302	74.823	6.180	5.085	13.912	Richardson.
,,	Glasgow.	1.307	82.924	6.491	10.457	1.128	Richardson.
Cannel Coal		1.272	64.72	21.56	13.72	...	Thomson.
,,		1.228	72 22	3.93	23.85	...	Ure.
,,	Lancashire, Wigan	1 319	83.753	5.660	8.039	2.545	Richardson.
,,	Edinburgh, *Parrot coal.*	1.318	67.597	5.405	12.432	14.566	Richardson.
Cherry Coal		1.263	74.45	12.40	13.15	...	Thomson.
,,	Newcastle, Jarrow	1.266	84.846	5.048	8.430	1.676	Richardson.
,,	Glasgow.	1.286	81.208	5.452	11.923	1.421	Richardson.
Caking Coal	Newcastle, Garesfield.	1.280	87.952	5.239	5.416	1.393	Richardson.
,,	Durham South Hetton.	1.274	83.274	5.171	3.036	1.519	Richardson.
,,		1.269	75.28	4.18	20.54	4.670	Thomson.
Anthracite	Swansea,	1.348	92.56	2.330	2.530	1.720	Regnault.
,,	,,	1.270	90.58	2.600	4.100	...	Jacquelin.
,,	South Wales,		94.05	3.380	2 570	...	Overman.
,,	Pennsylvania,	1.462	90.45	2.430	2.450	4.670	Regnault.
,,	,,	...	94.89	2.550	2.560		Overman.
,,	Massachussets, Worcester.	...	28.35	0.920	2.150	68.65	Overman.
Peat	Vulcaire,	...	57 03	5.630	31.760	...	Regnault.
,,	Long,	...	58.09	0.930	31.370	...	Regnault.
,,	Camp de Feu,	...	57.79	6.110	30.770	...	Regnault.
,,	Cappage,	...	51.05	6.85	39.55	2.55	Dr. Kane.
,,	Kilbeggan,	...	61.04	6.67	30.46	1.83	Dr. Kane.
,,	Kilbakan,	...	51.13	6.33	34.48	8.06	Dr. Kane.

According to Knapp, peat contains from 1 to 33 per cent its weight of ash. In coal we have the following from Mr Mushet's analyses:—

	Specific gravity.	Carbon.	Ashes.	Volatile matter.
Welsh furnace coal	1·337	88 068	3·432	8·300
,, ,, ,,	1·393	89 709	2·300	8·000
,, slaty ,,	1·409	82·175	6·725	9·100
Derbyshire furnace coal	1·264	52·882	4·288	42.830
,, cannel coal	1·278	48 362	4 638	47.000

And again the analyses, from Overman, of the ash of coal, may be quoted, as shewing the constituents comtained in the ashes derived from combustion:—

Sulphate of lime	80·3	3·6
Lime	3·8	2·5
Silex	14·2	85·7
Oxide of iron	1·7	0·0
Alumina	0·0	8·2
	100·0	100·0

The following table of the heating power of various kinds of fuel, from Knapp's Chemical Technology, is not without interest; in practice, however, only a portion of the absolute heating power is made available:—

	Authority.	Lbs. of water heated from 0° to 100° centig. by 1 lb. of fuel.
Charcoal—		
Average	Berthier	68·0
Peat from Allen in Ireland, Upper	Griffith	62·7
Lower	Griffith	56 6
Pressed	Griffith	28·0
Peat charcoal—		
Essone	...	50·7
Framont and Champ de Feu	Berthier	58·9
Coke—		
St. Etienne	Berthier	65·6
Besseges	Berthier	64·3
Rive de Gier	Berthier	58·9
Brown coal—		
Mean of 7 varieties	Berthier	50·3
Cannel coal, Wigan	Berthier	64·1
Cherry, Derbyshire	Berthier	61·6
Cannel, Glasgow	Berthier	56·4
,, Lancashire	Berthier	53·2
Durham	Berthier	71·6
Gas coke, Paris—	Berthier	50·3
Anthracite	Berthier	69·1
Pennsylvania	Berthier	67·4
Mean of 5 varieties	Berthier	

The Fuel. In concluding the observations on fuel, we may notice that the various kinds of coal are classed by mineralogists as the bituminous, and stone or anthracite coal. The first class is chiefly employed for the purpose of smelting, though, since the introduction of the hot-blast, anthracite is coming largely into use both in this country and America. Mr Crane of South Wales was the first who attempted the reduction of iron ores by anthracite, and Mr Budd, at his works at Ystalyfera, followed successfully in the same path. To these two gentlemen the public are indebted for having surmounted the obstacles to the employment of this fuel for smelting iron.

On the occasion of a visit to Mr Crane's works, nearly twenty years ago, the writer had an opportunity of inspecting some specimens of anthracite, which had passed through the furnace and been in contact with the minerals at the temperature of fusion for 48 hours, without having suffered decomposition, and were found to be charred to a depth of only three-fourths of an inch, the interior being of a perfectly shining and black colour, and quite unaffected by the heat of the furnace.

THE MANUFACTURE OF IRON.

The processes for the manufacture of iron, as we have already pointed out, are of two distinct kinds, those of cementation and those of smelting; the product of the former is imperfectly malleable iron, that of the latter, cast-iron, or iron combined with more or less carbon.

Process with the Catalan hearth. The first and older process is uncertain in its results, involves considerable expense, and as there are no efficient means of getting rid of the earthy impurities, it necessitates the employment of rich magnetic, specular, or hæmatite ores; on account of these defects, it is now seldom employed. The ores to be reduced by this process were heated with charcoal in open furnaces like the Catalan hearth, the fire being urged by a blast. The oxygen, water, and volatile substances were driven off, and the iron—carburized and partially fused—sunk to the bottom of the hearth. The blast was then directed downwards, so as to play over the surface of the iron, and oxidized the greater part of the combined carbon; during this operation the iron became tough and malleable, and fit for the hammer.

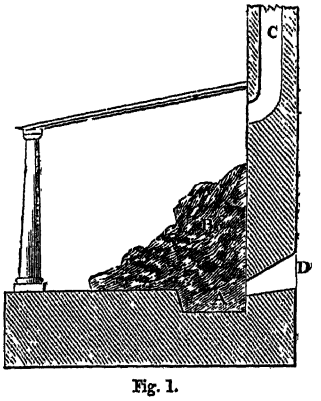


Fig. 1.

The annexed section (fig. 1) shews the disposition of the Catalan hearth during the process of reduction. The fuel and ore B, are piled over the hearth A, and ignited; the blast to urge the fire is applied at D, and the gaseous products of combustion pass off by the chimney C.

Mr Clay's process. A similar process has lately been invented by Mr Clay, which appears to reduce the rich ores with great advantage, and to be free from the defects of the older process. Mr Clay mixes the ore with four-tenths of its weight of coal, and grinds it so small that it will pass through a screen of one-eighth of an inch mesh; it is then put into the hopper A (fig. 2), from which it falls upon the preparatory bed B, at the side of the puddling furnace C. While in this position, the ore is heated, and

The manufacture of iron.

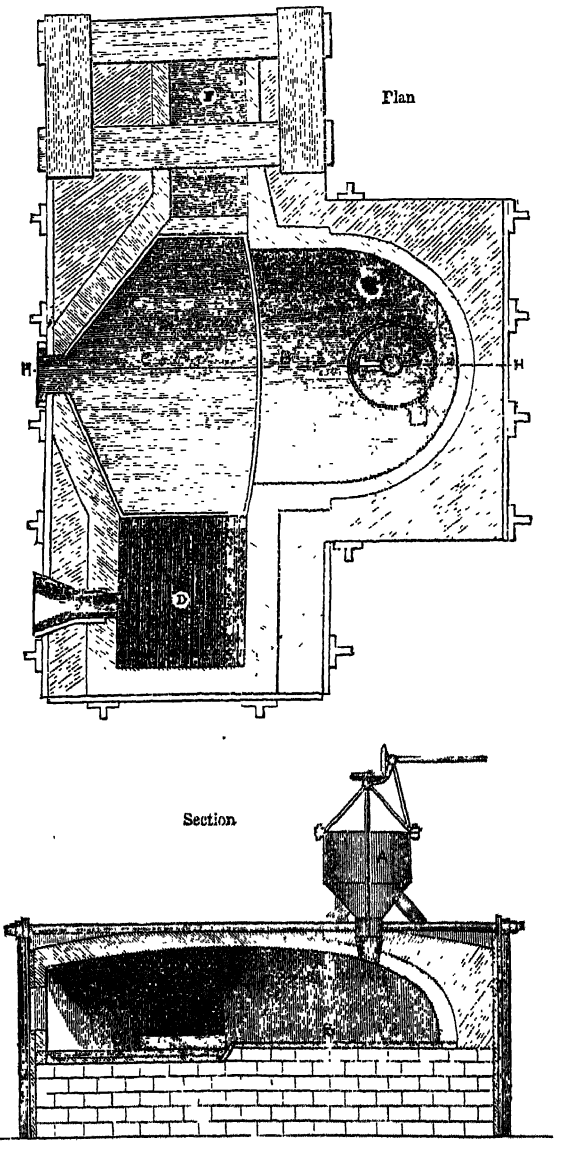


Fig. 2.

partly decomposed, and the coal coked. The charge is then drawn forward into the reverberatory furnace C, where it is fused by the heat of the gaseous products passing from a fire at D to the chimney F, and is puddled and balled in the ordinary way. The cinder produced contains 50 to 55 per cent of iron, is free from phosphorus, and is very suitable for smelting in the blast furnace. This process is said to produce puddled bars equal to those made by the four operations of calcining, smelting, refining, and puddling, under the old system, and appears to be peculiarly adapted for the reduction of those rich ores which cannot be smelted advantageously in the blast furnace, because the small quantity of slag which is formed does not protect the metal from the oxidizing effects of the blast.

Smelting The process of smelting in the blast furnace is now almost universally adopted for the reduction of iron ores, and for the cheapness and working qualities of the metal

The manufacture of iron.

produced, as well as for the rapidity of the manufacture, it is decidedly superior to all others.

Calcination of the ores.

Ores which contain much carbonic acid, water, or volatile matter, were at one time invariably subjected to a preparatory process of calcination, but, since the introduction of the hot-blast, they are now frequently employed in the raw state. The calcination is sometimes effected in the open air, by stacking the ore with coal, setting fire to it, and allowing it to burn out; but this method is liable to serious objection. It is impossible to keep the temperature uniform throughout the heap, and in consequence, while some portions are scarcely affected, others are fused together into large masses, which cannot be smelted without difficulty, even when broken up. Apart from the irregularity and uncertainty of the open air process, it appears to be more expensive than the calcination in kilns, when the admission of air is entirely under command. These ovens or kilns are usually built of masonry, and are placed, if possible, on a level with the charging platform of the smelting furnace. The argillaceous ores lose, during this process, 20 to 30 per cent; the carbonaceous, 30 to 40 per cent of their weight. (See Addenda, C).

The blast furnace.

The blast furnace consists of a large mass of masonry, usually square at the base, from which the sides are carried up in a slightly slanting direction, so as to form, externally, a truncated pyramid. In the sides there are large arched recesses, in which are the openings into the furnace for the admission of the blast, and for running out the metal and cinder; at the top of the furnace is a cylindrical erection of brickwork, called the tunnel-head, for protecting the workmen from the heated gases rising from the furnace, and having one or more doors through which the charges of ore, fuel, and flux are thrown into the furnace. In front, protected by a roof, is the casting-house, where the metal is run from the furnace into moulds.

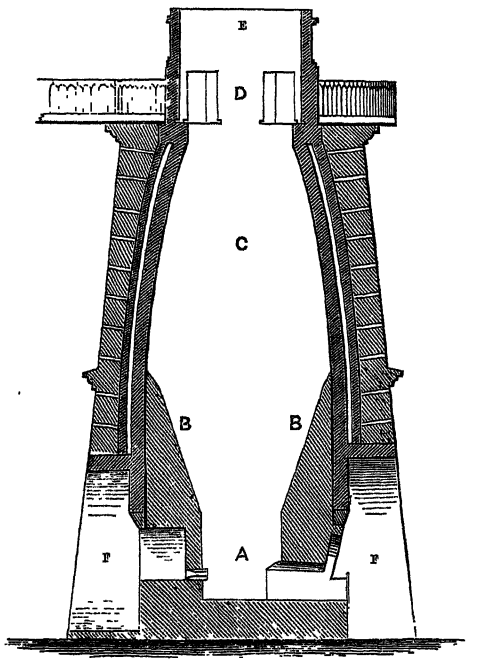


Fig. 3.

Fig. 3 is a vertical section, and fig. 4 a plan of one of the furnaces at the Dowlais Iron Works, which belong to the representatives of the late Sir J. Guest. Mr Truran, in a recently published and elaborate work on iron, has figured and described it. He states that it is one of the largest class, 38 feet square at the base, diminishing upwards 3 inches for every vertical foot, till it attains a height of 25 feet, where the square form ends with a moulded cap; above this, the form is circular, diminishing in diameter at a similar rate, and finishing at top with a plain moulded cornice, as a support for the charging platform. In the section and plan A is the hearth, 8 feet high and 8 feet in diameter. BB the boshes, rising to a height of 15 feet, and 18 feet wide at their greatest diameter. From the top of the boshes the body of the furnace contracts, in a barrel-shaped curve, so that at the charging platform D, at a height of 50 feet, it is only ten feet in diameter; E is the tunnel-head, with doors of iron, to admit the charges of ore and fuel; FFF the tuyere-houses, arched over and spread outwards, with the openings into the furnace for admitting the blast. G, the opening through which the iron is run from the furnace. The exterior is generally built of stone, and requires to be strongly bound with iron hoops, to prevent fracture from the expansion of the interior by the heat. The interior is lined with fire-brick set in fire-clay, a space of 2 or 3 inches being left between the two courses, to allow the expansion of the inner course. The hearth and boshes were usually constructed of refractory sandstone grit, or conglomerate, but fire-bricks are now chiefly used, and although they do not last so long, they are, in the end, more economical, and may be replaced whenever the furnace is blown out. The proper inclination of the boshes is a point of much importance, so that the materials, whilst smelting, may neither press too heavily downwards, nor yet be so retarded as to adhere in a half-liquid state to the brick-work, and cool there, thus forming what are known by the name of *scaffolds*, the removal of which is a source of great inconvenience.

The manufacture of iron.

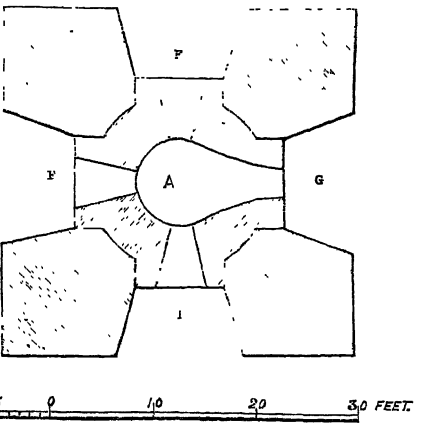


Fig. 4.

The cupola furnace.

Another form of furnace is occasionally used for smelting, called the cupola, and built much more slightly than the blast furnace. Its form is circular, and from the boshes upwards it is constructed of fire-brick, one, or sometimes two, courses in thickness. It is strongly bound together with wrought-iron hoops, and pillars of cast-iron, bolted at each end to imbedded rings of the same metal, rise through the foundation to the summit of the tuyere arches, giving considerable firmness and stability to the structure. Cheapness and facility of construction are much in its favour, and although objections have been made to the thinness of its sides, as permitting great loss of heat by radiation, it has met with very general adoption.

In addition to the cupola furnace, another of the same character has of late years been introduced. It consists

The manufacture of iron.

of a truncated cone, composed entirely of boiler-plates rivetted together, as per annexed fig. 5. On the four

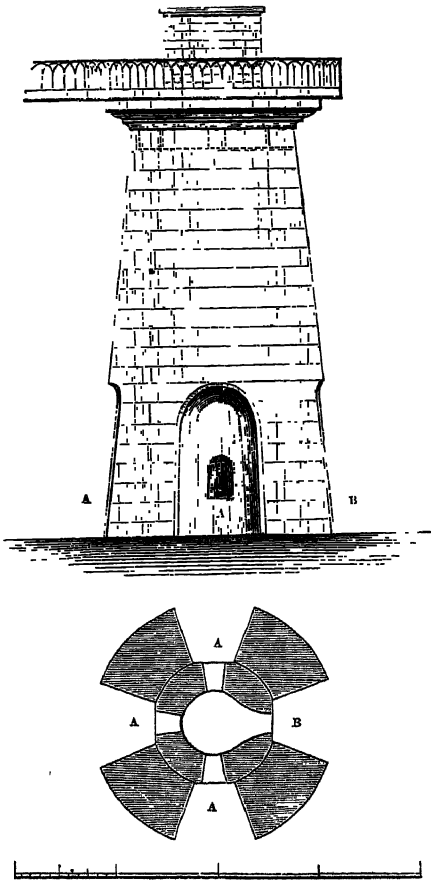


Fig. 5.

opposite sides recesses are cut to admit the tuyeres and the opening from the hearth into the casting-house. The interior of the furnace is lined with fire-brick and fire-clay in the usual way, and this plate furnace is not only perfectly secure, as regards the expansion and contraction, but it is found to be economical and to answer every purpose in common with the large stone and iron-bound furnaces.

Fig. 5 exhibits a plan and elevation of this description of furnace, the parts AAA being the tuyere-houses, and B for the discharge of the metal from the furnace.

The blast.

The blast is usually created by a steam engine; a piston being attached to the extremity of the beam, working in a cylinder of large diameter, and forcing the air through proper valves into a large spherical reservoir, constructed of boiler-plate, whence its own elasticity causes it to flow in a regular unintermitting stream into the furnace. A cylindrical vessel, open at bottom, and immersed in a pit of water, has sometimes been used to regulate the pressure of the blast, but the water evaporated is detrimental to the working of the furnace. The nozzles by which the blast is directed into the furnace are made of cast or wrought-iron, and sometimes a current of water is conveyed round their extremities to keep them cool. The number of blow-pipe nozzles to each furnace varies at different works; the usual number is three, one for each of the tuyere houses, but sometimes six, eight, or twelve are employed; it, however, appears questionable whether this is not objectionable, as the density and penetrating power of the blast is considerably diminished by this system of diffusion. This, however, is a point which can only be decided by practice, and must be left to the judgment of the smelter. The usual pressure of the blast as it enters the furnace is about $3\frac{1}{2}$ lbs. per square inch, but in some cases it is as much as 5 lbs. per square inch. (See Addenda, D).

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Elevation of the materials to the tunnel-head.

The communication between the ground and the tunnel-head is effected in various ways. In South Wales the furnaces are usually built on a declivity, which affords ready means of access from behind; sometimes an incline is constructed, or other contrivances, such as the balance and pneumatic lifts, are resorted to for the elevation of the materials.

Capacity of furnace, volume of blast, and consumption of materials.

The dimensions and form of the blast furnace vary greatly, according to the fashion of the district, and the notions of the builder. Yet so much does the quantity and quality of the iron depend upon the size of the furnace and strength of the blast, that we may venture to assert that the production varies in the ratio of the cubical contents of the furnace, and the volume of air admitted. Mr Truran gives the following particulars of the Dowlais Foundry iron furnace:—"The capacity is 275 cubic yards. It is blown with a blast of 5390 cubic feet of [cold] air per minute. The materials charged at the top consist of calcined argillaceous ore, coal, and limestone. The yield or consumption averages 48 cwts. of calcined ore, 50 cwts. of coal, and 17 cwts. of broken limestone, to 20 cwts. of crude iron obtained. The weekly make of iron is occasionally over 130 tons. The weekly product of cinder amounts to 250 tons. For the production of white iron for the forge, in furnaces of the same capacity as the foregoing, a larger volume of blast is employed, along with a different burden of materials. The blast averages 7370 feet per minute. The consumption of materials to one ton of iron averages 28 cwts. of calcined argillaceous ore, 10 cwts. of hæmatite, 10 cwts. of forge and finery cinders, 42 cwts. of coal, and 14 cwts. of limestone. With these materials the weekly produce amounts to 170 tons of crude iron, and 310 tons of cinder."

Action within the blast furnace.

The action which takes place in the blast furnace is as follows:—The contents being raised to an intense heat by the combustion of the fuel, are brought into a softened state; the limestone parts with its carbonic acid, and combining with the earthy ingredients of the ironstone, forms, with them, a liquid slag, whilst the separated metallic particles, descending slowly through the furnace, are deoxidized and fused; in their passage they imbibe a portion of carbon, and at last settle down in the hearth, from whence they are run off into pigs about every twelve hours; the slag, being lighter, floats upon the surface of the liquid metal, and is constantly flowing out over a notch in the dam-plate, level with the top of the hearth. This slag indicates, by its appearance, the manner in which the furnace is working; thus, if the cinder is liquid, nearly transparent, or of a light greyish colour, and has a fracture like limestone, a favourable state of the furnace is indicated. Tints of blue, yellow, or green are caused by a portion of oxide of iron passing into the slag, and shew that the furnace is working cold. The worst appearance of the cinder is, however, a deep brown or black colour, the slag flowing in a broad hot rugged stream, and indicating that the supply of coke is not sufficient to deoxidize the whole of the iron.

Indications of the state of the furnace.

During the process of smelting, the interior of the furnace requires to be very carefully watched. The stream of air constantly rushing in at the tuyeres, exerts a chilling agency on the melted matter directly opposed to it at its entrance. The consequence of this is the formation of rude perforated cones of indurated scoriæ, stretching from either side horizontally into the furnace, each one having its base directly over the embouchure of a blast-pipe. When these project only to a certain

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extent, they are favourable to the working of the furnace, as the blast is thrown right into the centre, and prevented from passing up the sides and burning the brickwork. Sometimes, however, when the furnace is driving cold and slow, these conduits of slag become so strong, and jut out so far as to meet in the middle, and thus cause a great obstruction to the entrance and ascent of the blast. When this happens, there is usually no remedy but to increase the burden, that is, to increase the quantity of *mine* or ore to the charge. This causes an intense heat, the furnace is said to work hot, and the conduits of slag drop off from the sides. This, however, is followed by bad as well as good consequences; the brickwork is frequently melted, and, for a time, the iron produced is small in quantity, and of the worst quality. To bring the furnace again to its proper state, the burden must be reduced; the sides then become cool, new tubes of slag are formed, and the iron produced is good.

Running off the reduced metal.

At the end of every twelve hours, more or less, the furnace is tapped, that is to say, the aperture in the dam-stone, which, at the commencement, had been stopped up with a mixture of loam and sand, is re-opened, and the metal contained in the hearth allowed to flow out into moulds, made in the sand of the cast-house floor, thus forming a cast or sough of pigs. When this operation ceases, the dam-stone is again secured, and the work proceeds as before. In this manner a furnace is kept continually going, night and day, and never ceases to work until repairs are necessary. Incessant action has even been thought necessary to the successful carrying on of an iron-work, but the example of perhaps the largest ironmaster in South Wales has shewn, contrary to general practice in that district, that smelting may be discontinued for at least one day in the week without any very serious derangement of operations.

Thus far we have confined our observations to the production of iron by the cold-blast process; we have now to consider the changes introduced by the employment of a heated blast.

Hot-blast process.

In the year 1828, Mr J. Beaumont Neilson, a practical engineer at Glasgow, took out a patent for an "improved application of air to produce heat in fires, forges, and furnaces, where bellows or other blowing apparatus are required." Mr Neilson proposed to pass the current of air through suitably shaped vessels, where it was to be heated *before it entered the furnace*. In this simple substitution of a hot-blast, heated in a separate apparatus, for a cold-blast heated in the furnace itself, consists the whole invention.

Like most other improvements, the progress of this was at first slow. Retarded by practical difficulties, which beset all new processes in their first use—stopped every now and then by the prejudices of custom and ignorance, which cling with inveterate tenacity to maxims of established practice, and repel indiscriminately innovations which improve and those which modify without improving,—the invention was more than once on the point of being abandoned. A great part of the interest in its possible remuneration was transferred by the inventor to strangers, whose combined efforts and influence were necessary to insure its success. But though thus tardy in its first steps and feeble in its early efforts, the hot-blast process is now adopted at the greater number of the iron-works of Great Britain, and other parts of Europe and America.

It is perhaps not generally known that practical men, previous to Mr Neilson's invention, universally believed that the colder the blast the better was the quality and quantity of the iron produced; and this opinion appeared to be confirmed by the fact that the furnaces worked better in winter than in summer. Acting on such views, the ironmaster actually resorted to artificial means of refrigeration, to reduce the temperature of the blast before it

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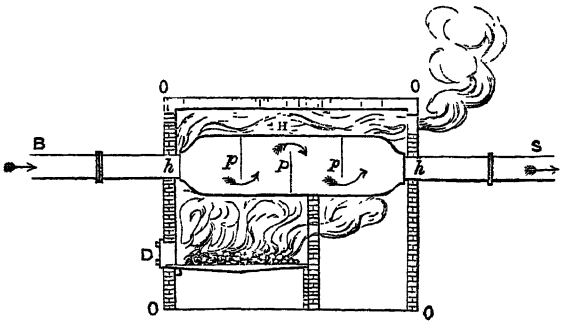


Fig. 6.

entered the furnace. The fact of the improved action of the furnace in winter may perhaps be explained as a

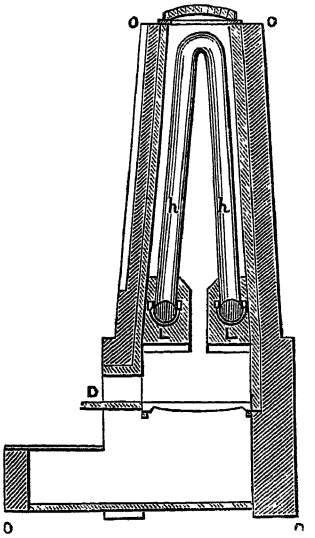


Fig. 7.—End Elevation.

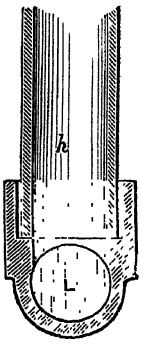


Fig. 10.—Joint of Heating Pipe in Lying Pipe.

consequence of the diminished amount of aqueous vapour contained in the atmosphere in cold weather; and the

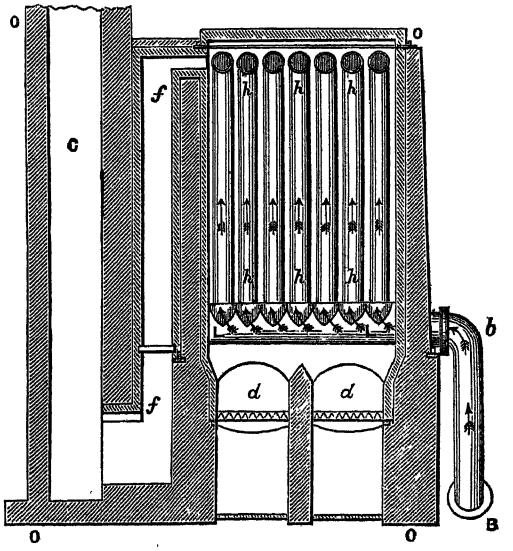


Fig. 8.—Elevation.

opinion that the low temperature is the cause of the alleged increase of production has been shewn to be wrong by the success of Mr Neilson's invention.

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This simple invention affects only the transit of the air from the blowing cylinder to the furnace, an oven or

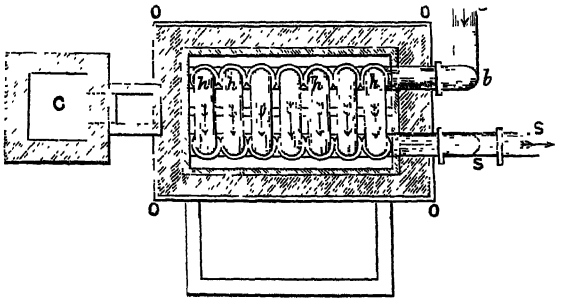


Fig. 9.—Plan.

stove being interposed, through which, in appropriately shaped vessels, the air is conducted, and in which it is heated to 600° or 800° Fahr., or to any other temperature adapted for the purpose of smelting.

Earliest apparatus for heating the blast.

The earliest and simplest plan by which the blast was heated is shewn in the sketch, fig. 6 (p. 547). In

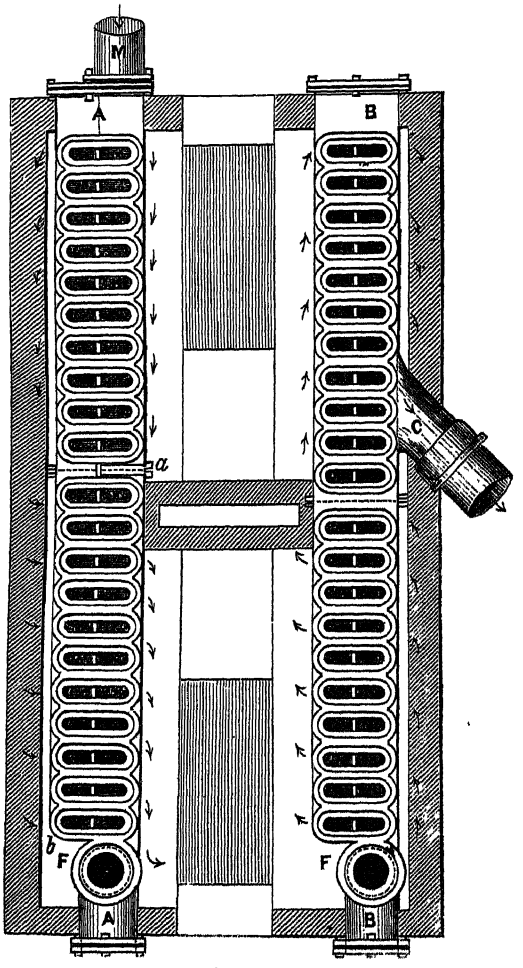


Fig. 11.

an oven of brickwork 0000, with a fire fed by the door D, a large cylindrical tube or receiver *h h*, made of rivetted boiler-plate, about 3 feet in diameter, and 8 or 10 feet long, was placed. The pipes, B and S, attached to the receiver *h h* at the opposite ends, communicated with the blowing-cylinder and smelting-furnace respectively. Lunular shaped partitions *p p p*, projecting from opposite sides on the interior of the receiver, caused the air passing through it to impinge alternately first on one side and then on the other, in order that the temperature might be uniformly and effectively communicated from the metal to the blast. By this means a moderate current of air has been heated up to 300° or 400° Fahr.

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Calder heating apparatus.

Figs. 7, 8, 9, and 10, shew the apparatus first employed, we believe, by Mr Dixon at Calder, and hence generally called the Calder pipes. As erected at the Butterley Iron-Works, Derbyshire, the apparatus consists of two parallel horizontal pipes LL, fig. 7, called technically the "lying pipes," one communicating with the cold-blast inlet pipe B, the other with the hot-blast outlet pipe S, fig. 9. Into sockets formed in these, the ends of the arched heating pipes *h h h* fit tightly, as shewn in fig. 7 and in fig. 10, upon a larger scale. The air, therefore, entering the inlet pipe B, figs. 8 and 9, passes over the transverse arched pipes *h h*, where it is exposed to the

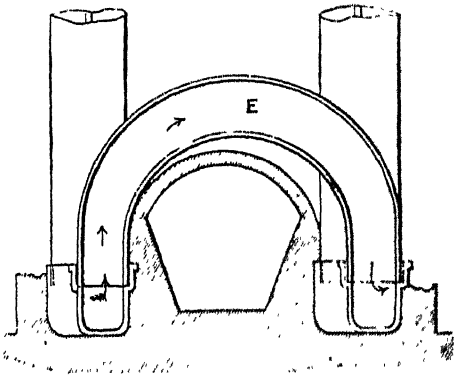


Fig. 13.

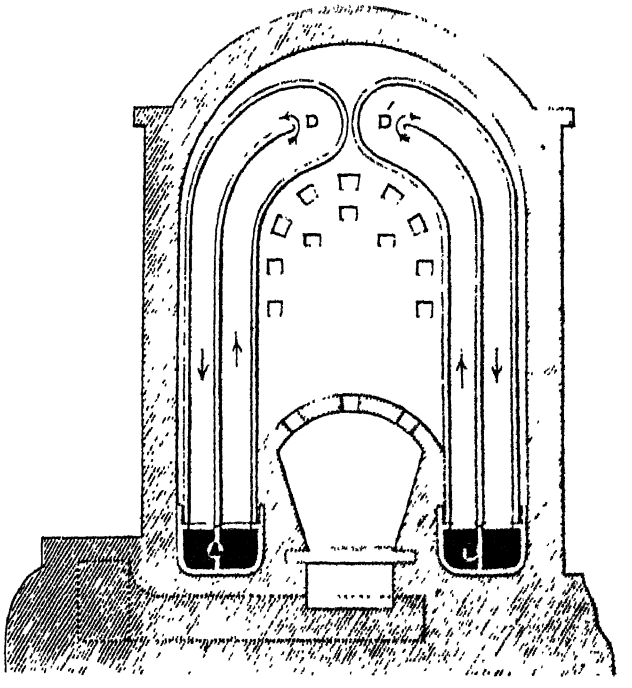


Fig. 12.

action of a large surface of heated metal, and is delivered into the hot-blast pipe S, which conveys it at the required temperature into the blast furnace. The whole apparatus is enclosed in the oven or furnace 0000, as shewn in the figs. 7, 8, and 9.

The figures of the transverse pipes vary considerably at different iron-works. Sometimes they rise up and form a large semicircular arch over the fire, 8 or 10

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feet perpendicularly, and are then connected by an arch at the top; sometimes they cross the fire in the form of a pointed arch, variously acuminate, or a single large tube is used, traversing the furnace in a long spiral direction. Their cross-section is as various as the form in which they are bent; pipes of circular, flattened elliptical, rectangular, heart-shaped, and other sectional forms have been employed, in order to increase the heating surface in proportion to the volume of the blast. All these forms of apparatus, although admirably adapted for heating the air, are liable to fracture, from the unequal expansion of the metal.

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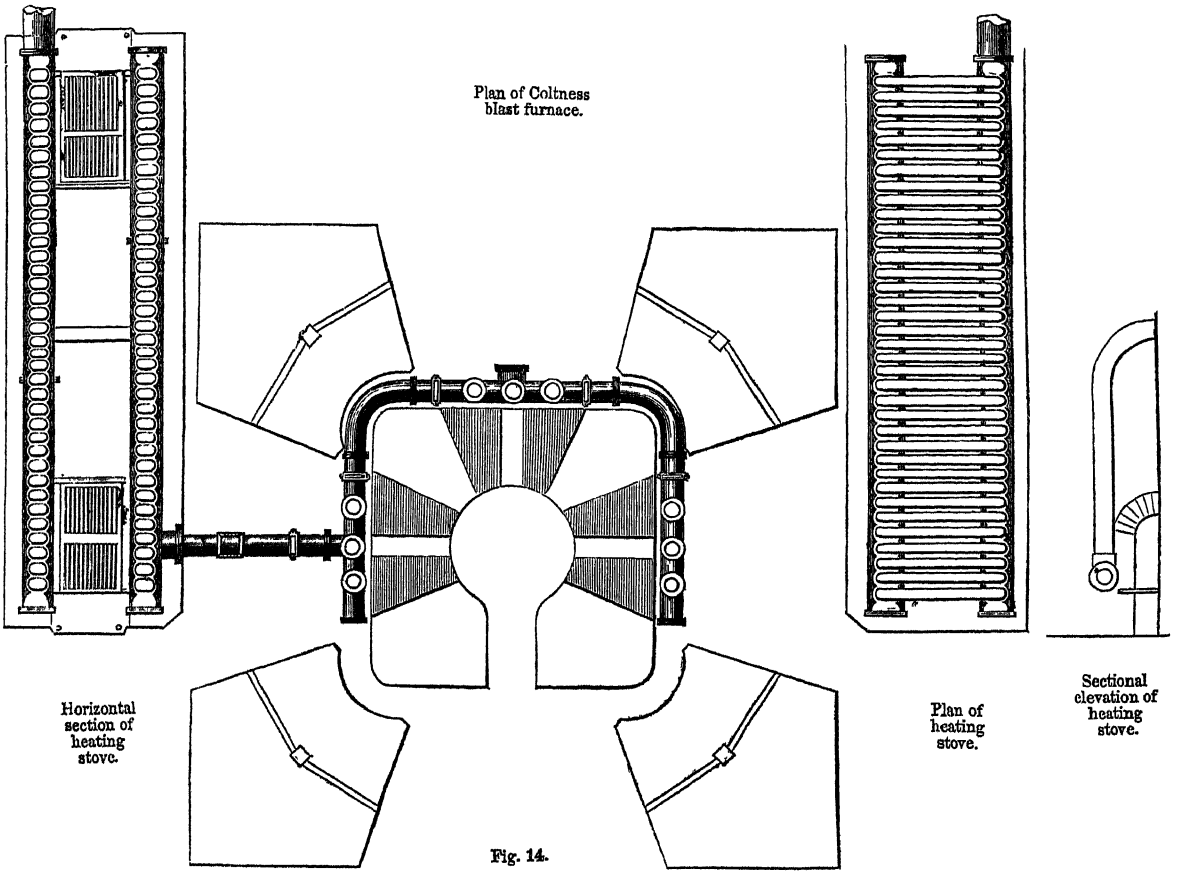


Fig. 14.

One other form of apparatus, represented in the preceding figures, Nos. 11, 12, and 13, demands notice, on account of its great heating power. The cold air enters by the pipe M into one side of the lying pipe A A, which is divided down the centre by a partition or diaphram, and then passes up one side of the heating pipes, which are also divided by partitions; it then turns round at the top, as shewn at D (fig. 12), and descends in the direction of the arrows into the lying pipe AA on the other side to that which it entered. It is thence conveyed by the arched pipe E, fig. 13, into the second divided pipe BB, through another series of heating pipes, and ultimately escapes by the outlet pipe C, at a high temperature, to the smelting furnace. The diaphram pipes are, however, not generally used.

The ordinary arrangement is exhibited in the drawing of one of the furnaces and heating apparatus of the Coltness Works, kindly furnished by Mr Hunter, the intelligent managing partner of that establishment. The drawings, figs. 14 and 15, represent a sectional elevation and plan of a very successful and regular working furnace, but the size and form, as already observed, require to be governed by the quality and nature of the materials that are to be used.

The more difficult the reduction of the ironstone the smaller must be the diameter of the hearth, so as to enable the blast to penetrate and circulate throughout the whole of its contents. In other conditions, where the ores are easily reduced, hearths of 9 feet diameter have been introduced with great advantage, and that without detriment to the quality of the iron produced. The diameter of the body of the furnace is likewise regulated by the quality of the materials used, and in cases where the coal is not bituminous and the ore hard, a large diameter is found to work very irregularly; and the results have been, where furnaces have been erected 18 feet diameter, to have them reduced to only 6 feet.

The height of the furnace is also regulated by the nature of the materials and the strength of the blast by which they are reduced. Sometimes, when the coal is soft and crushes by the superincumbent pressure, it is bound or compressed to such an extent as to prevent the blast penetrating the mass, and causes an irregular working of the furnace; and, moreover, under these conditions, it makes what is called white or silvery iron.

The pressure of the blast requires also to be regulated to suit the materials, and, according to the workings at Coltness (shewn in figs. 14 and 15), the pressure is about 4 lbs. on the square inch, and as much as 10,000 cubic feet of air is discharged into the furnace per minute. The temperature of the blast is 594° Fahr., and the area of the heating surface of the apparatus for raising that temperature is 3500 square feet.

The quantity of materials to make a ton of iron at these works varies in some relative proportion to their densities; but the following may be taken as a fair average of the consumption of fuel, ore, limestone, &c.:—

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Ton	Cwt.	
1	10	of raw coal.
1	17	of calcined ironstone.
0	12	of broken limestone.
0	4	of coal for heaters.
0	4	of „ for blowing engine.

With the above charges the furnaces will produce from 168 to 170 tons per week, or 8,700 tons of good iron per annum.

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Hot-blast furnace.

Fig. 15 shews the general arrangement and the disposition of a hot-blast furnace, and the apparatus connected with it. J is the blowing cylinder, from which the air is forced into the receiver K, made of wrought-iron boiler plate; from this it passes by the pipe L into the heating ovens, one of which is shewn in section at M, and the pipe N conducts it, when heated, to the furnace. PPP are the tuyeres, FF the charging doors, E the tunnel-head.

With regard to the advantages and defects of the hot-blast process, much has been said on both sides, and the question does not appear by any means exactly settled. It is asserted, on the one hand, that iron reduced by the hot-blast loses much of its strength, whilst, on the other, it is contended that the quality of the iron is richer, more fluid, and better adapted for general purposes than that produced by the cold-blast. The advocates of the hot-blast say that the process has increased the production and diminished the consumption of coal three or four fold; and the upholders of the cold-blast maintain that the same effects may be produced, to almost the same extent, by a judicious proportion of the shape and size of the interior of the furnace, a denser blast, and greater attention on the part of the superintendent to the process.

On these points it appears to us that although the hot-blast has enabled the manufacturer to smelt inferior ores, cinder-heaps, and other improper materials, and to send into the market an inferior description of iron; this is no reason for its rejection, but rather an argument in its favour. It is true that when a strong rigid iron is required for such works as bridges or artillery, the somewhat uncertain character of hot-blast metal renders it objectionable, but this appears to be due rather to the carelessness or want of attention in the manufacture than to the use of heated air or defects in the process. On the other hand, the hot-blast, by maintaining a higher temperature in the furnace, ensures more effectually the combination of the carbon with the iron, and produces a fluid metal of good working qualities, generally superior to cold-blast iron, in cases where great strength is not required; and, moreover, we have yet to learn why even the strongest and most rigid iron cannot be made by this process. The comparative strength of hot and cold blast iron will, however, be given in another part of this article; for the present it is sufficient to observe that the results of the experiments are not unfavourable to the hot-blast

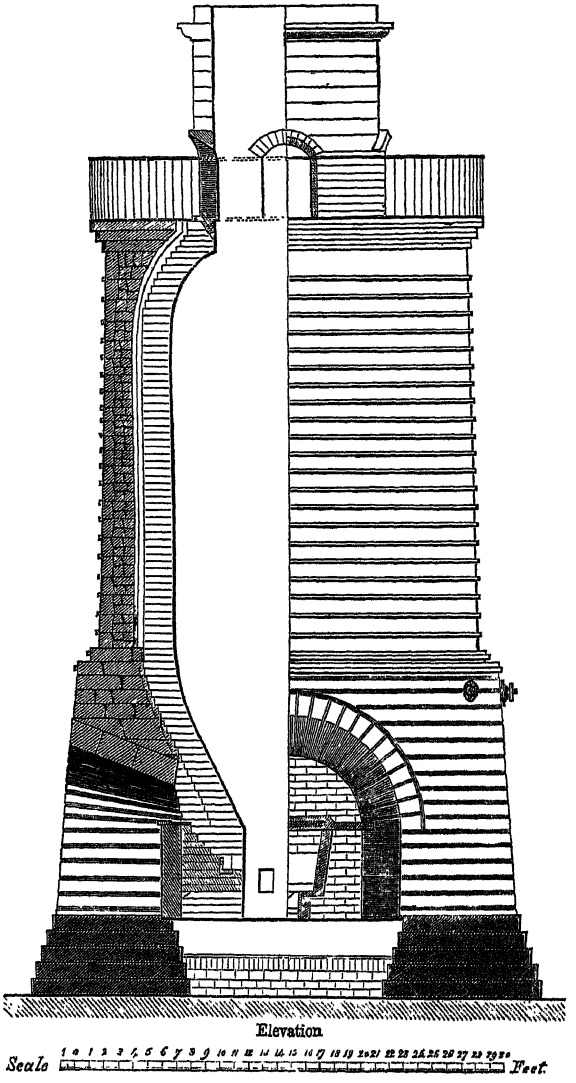


Fig. 15.

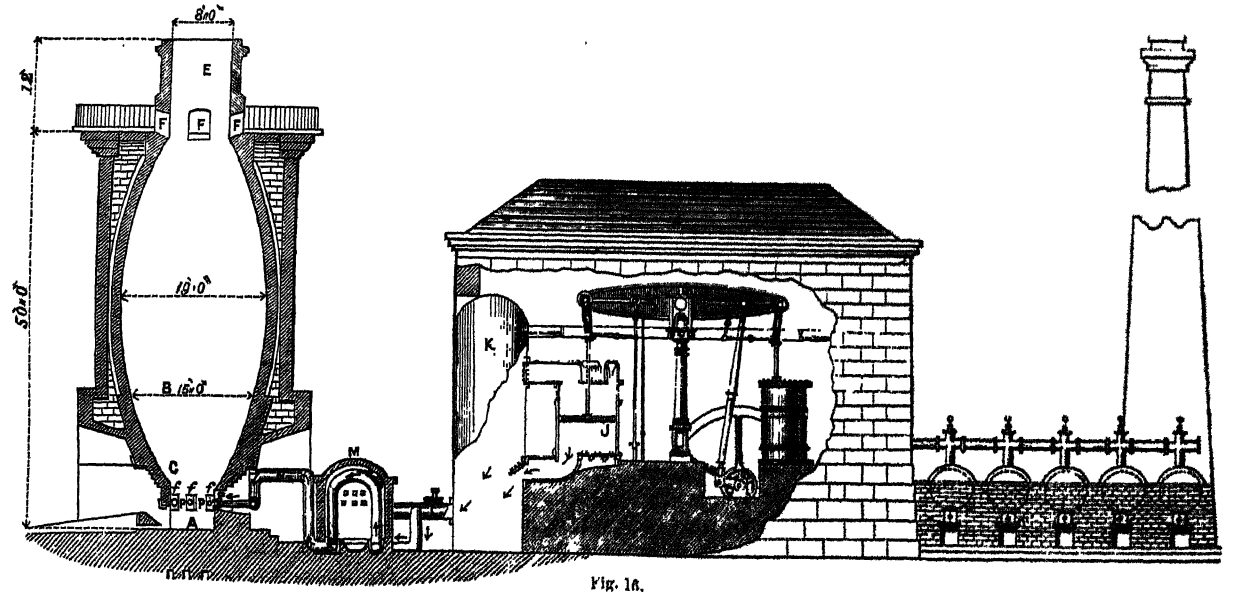
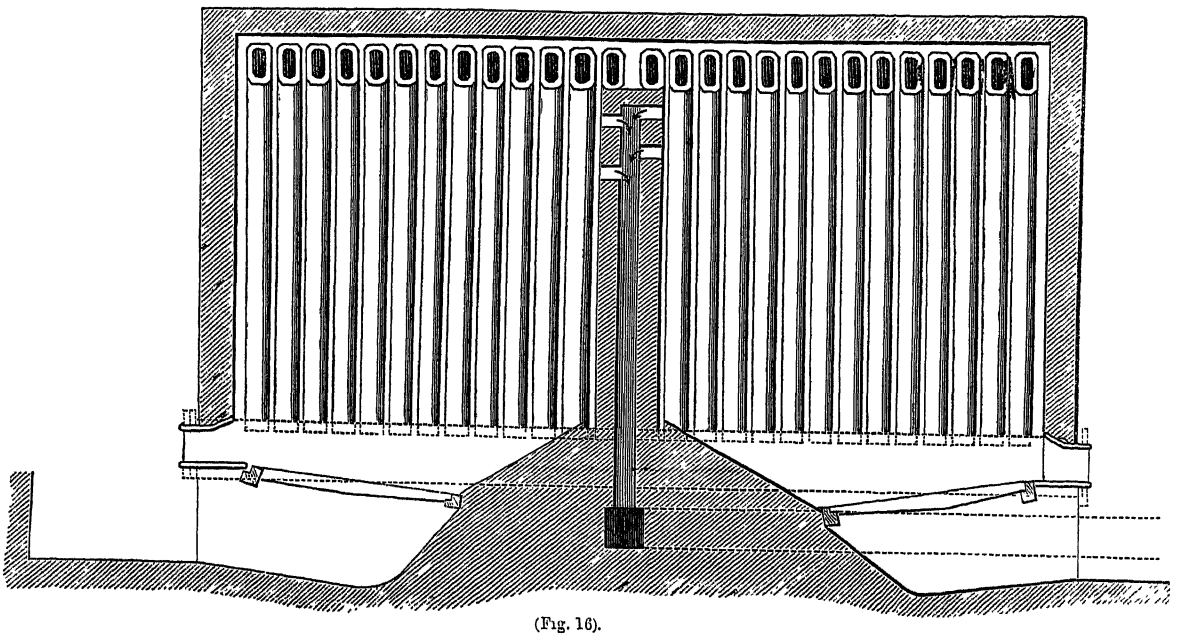


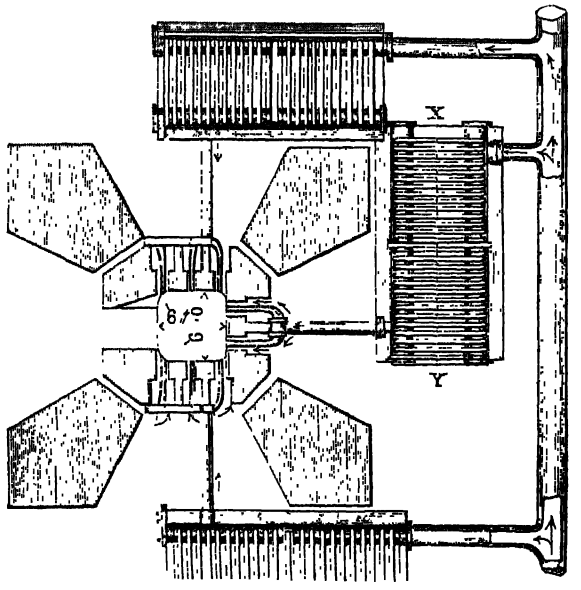
Fig. 16.

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(Fig. 16).



(Fig. 16).

iron, either as regards its resistance to a transverse strain, or its power to resist impact.

Dr. Clark, Professor of Chemistry in the University of Aberdeen, investigated the merits of the hot and cold-blast process in regard to the consumption of fuel, as early as 1834-5. He states, that after the hot-blast had been brought fully into operation at the Clyde Iron-Works, "during the first six months of the year 1833, one ton of cast-iron was made by means of 2 tons 5¼ cwt. of coal, which had not previously to be converted into coke; adding to this 8 cwt. of coal for heating, we have 2 tons 13¼ cwt. of coal required to make one ton of iron. In 1829, when the cold-blast was in operation, 8 tons 1¼ cwt. of coal had to be used. This being almost exactly three times as much, we have from the change of the cold-blast to the hot, combined with the use of coal instead of coke, three times as much now made from the same quantity of coal." Dr. Clark adds the following statistics of the Clyde Iron-Works:—

In 1829, the weekly produce of three furnaces, cold air and coke being used, was 110 tons 14 cwt.; and the average of coal to one ton of iron was 8 tons 1 cwt. 1 qr.

In 1830, the weekly produce of three furnaces, coke, and air at 300° Fahr. being used, was 162 tons 2 cwt.; and the average of coal to one ton of iron was reduced to 5 tons 3 cwt. 1 qr.

In 1833, the weekly produce of four furnaces, *raw coal*, and air heated to 600° being used, was 245 tons; and the average of coal to one ton of iron was reduced to 2 tons, 5 cwt. 1 qr.

"On the whole then, the application of the hot-blast has caused the same fuel to reduce three times as much iron as before, and the same blast twice as much."

This decrease in the amount of fuel and blast required for the reduction of iron, Dr. Clark accounts for by shewing, that in an ordinary furnace, "2 cwt. of air a minute or 6 tons an hour are injected into the furnace." This he considers "a tremendous refrigeratory passing through the hottest part of the furnace," and to a great extent repressing the temperature which is necessary for the complete and rapid reduction of the iron.

Mr Truran considers that "writers on the hot-blast have greatly exaggerated the effects of this invention on the iron manufacture of this country. If we are to believe the majority of them, the great reductions which have been effected within the last 25 years, in the quantities of fuel and flux to smelt a given weight of iron, and the large increase of make from the furnaces, is entirely owing to the use of this invention. That the hot-blast, under certain circumstances, has effected a saving in the consumption of fuel, and also augmented the weekly make, we freely admit. But the saving of fuel, and increase of make due to its employment, is not generally one-fourth of the quantity which writers have asserted." Here Mr Truran is at issue with Dr Clark, and denies the cooling effect of a cold-blast. He attributes the effects of a heated-blast, "first, to the caloric thrown into the furnace along with the blast, enabling a corresponding quantity of coal to be withdrawn from the burden of materials, with a proportionate reduction in the volume of blast, the effects of which are seen in an augmentation of the make, but do not result in any saving of fuel; secondly, to the reduced volume of blast and large proportion of caloric which it carries into the furnace, causing a diminished consumption of fuel in the upper parts of the furnace." Although we do not agree with all Mr Truran's strictures on the hot-blast, the consumption of fuel in the throat is, nevertheless, a question well worthy of investigation. The combustion

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is of course largely increased by the narrow form of throat given to furnaces, which greatly increases the effect of the blast there, and accounts for the difficulty of using those kinds of coal, in the raw state, which splinter if rapidly heated. If Mr Truran's conjectures be correct, and it be found, that by increasing the area of the throat, raw coal and anthracite can be advantageously used with a cold-blast, the superiority of the hot-blast will not be so decidedly marked. This must, however, be determined by practice; as at present, certainly, it is well known that the anthracite and splint coal can be used most effectively and economically with the hot-blast.

We quote from one more authority on this subject. M. Dufrénoy, in his report to the Director-General of Mines in France, states, that upon heating the air proceeding from the blowing cylinder up to 612° Fahr., a considerable saving in fuel was effected by the use of raw coal instead of coke, and that this caused no derangement of the working of the furnace or deterioration of the iron produced. On the contrary, "the quality of the metal was improved, and a furnace which, when charged with coke, produced only about half No. 1 and half No. 2 pig-iron, gave a much larger proportion of No. 1 after the substitution of raw coal. Besides this, the quantity of limestone was considerably diminished." This last circumstance, according to M. Dufrénoy, is due to the increased temperature of the furnace, which fuses more readily the earthy matter and other impurities in combination with the ores.

To show the saving effected, M. Dufrénoy gives the quantities used in each of the experiments at the Clyde Iron-Works:—

In 1829, the combustion being produced by cold air, the consumption for one ton of iron was—

	Tons.	Cwt.	Tons.	Cwt.
Coal—for fusion, 3 tons of coke, corresponding with	6	13		
„ for blowing engine	1	0		
Total coal used			7	13
Limestone			0	10½

In 1831, the furnaces being blown with air heated to 450° Fahr.—

	Tons.	Cwt.	Tons.	Cwt.
Coal—for fusion, 1 ton 18 cwt. coke, corresponding with	4	6		
„ for the hot air apparatus	0	5		
„ for blowing engine	0	7		
Total coal used			4	18
Limestone			0	9

In July 1833, the temperature of the blast being raised to 612° Fahr., and the fusion effected by *raw coal*, the consumption per ton of iron was—

	Tons.	Cwt.	Tons.	Cwt.
Coal—for fusion	2	0		
„ for the hot air apparatus	0	8		
„ for blowing engine	0	11		
Total coal used			2	19
Limestone			0	7

Since that time, the employment of a blast heated to 800° or 900° has still further increased the weekly production and saving of fuel.

Collection of the waste gases.

The Waste Gases.—From the description that we have given of the smelting operations, it is evident that a large volume of gaseous products are constantly escaping at the top of the blast-furnace. These are found to contain a large proportion of unconsumed inflammable gas, capable of developing heat, and in countries where fuel is expensive, it is of great importance that these should be applied to useful purposes, and not be wasted in the atmosphere. Various contrivances have been adopted for this purpose, and in some places, particularly on the Continent, they have been utilized with great economy.

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To enable the waste gases to be collected and applied to raising steam, heating hot-blast stoves, &c., without detriment to the working of the blast-furnace, it is necessary to withdraw them at an elevation where they have completed their work, yet at such a distance from the mouth of the furnace that they may be extracted in a dry state, and before they come into contact with the atmosphere, so as to cause combustion. This may be effected, either by increasing the height of the blast-furnace, withdrawing a portion of the gases through

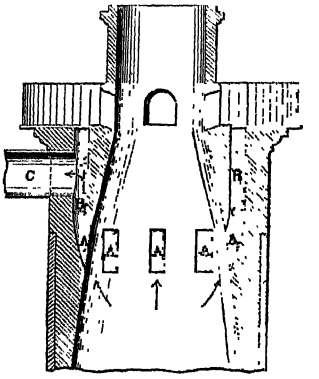


Fig. 17.

apertures in the side, or, if the furnace be not too large, by closing the top of the furnace with a moveable door. Fig. 17 shews the first plan; AA are the apertures through which the gases escape by the chamber BB into the pipe C, which conveys them to the place where they are burnt. The requisite pressure for causing the gases to escape at AA is obtained by heaping the charges of fuel and ore to some height above them. Fig. 18 shews

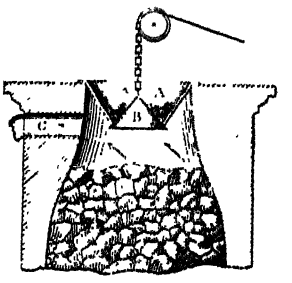


Fig. 18.

another contrivance for the same purpose; a casting AA in the shape of a truncated cone is fixed at the top of the furnace, the small diameter downwards; the aperture in the bottom of this is closed by another conical casting B, supported by a chain and counterpoise weight; this evidently shuts the mouth of the furnace, and the gases pass off by the pipe C. When a charge is to be thrown in, it is emptied into the cone hopper AA. When the charge is complete, the moveable cone B is lowered so as to enable the charge to pass between it and the edges of the hopper when it is again raised, and the operations of the furnace proceed as before.

In this country sufficient attention has not been paid to this economical practice, as compared with what has been done in other countries where fuel is expensive. It is no excuse that fuel is cheap, as in most cases the gases can be applied with economy, and their combustion tends to abate the serious nuisance of smoke.

The Conversion of Crude into Malleable Iron.

Nature of converting operations.

The conversion of the carburised crude iron, obtained from the blast furnace, into malleable or wrought iron is

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effected by several operations of an oxidising character, in which it is sought to separate, in the gaseous state, the carbon contained in the iron, by combining it with oxygen, whilst the other metals alloyed with the iron and the phosphorus pass into the slag.[1]

Methods of conversion with charcoal and coke iron.

In reference to subsequent operations, the iron produced in the smelting furnace may be divided into two kinds—that reduced by charcoal and that reduced by coke or raw coal. When charcoal iron has to be converted by charcoal, as in Sweden, it is decarburised in the charcoal refinery, with or without an intervening process. Where coal can be obtained, however, it is now usually converted by the process of puddling. Pig iron produced by coke or coal is converted into malleable iron either by decarburation in the refinery or oxidising hearth, and subsequent puddling, or it is converted at once in the puddling furnace by the process of boiling, which is equally effective, and is now more generally practised.

Messrs Rushton & Eckersley's works.

This last process, as the one most generally adopted in this country, deserves a special notice, and we are fortunate in having before us the particulars of the manner in which it is conducted by Messrs Rushton and Eckersley of Bolton, kindly furnished by Mr Rushton, the senior partner of the firm. This establishment is probably one of the most modern and complete of the kind in the kingdom; it is one that has spared no expense in the application of useful inventions, and has kept pace with every improvement that has taken place in the manufacture of bar and plate iron for the last fifteen years.

The machinery and appliances at these works consist of:—

6 Steam engines, of 180 total nominal HP.
2 Five-ton and 2 fifty-cwt. steam hammers.
3 Helve hammers.
1 Set of puddled iron rolls.
1 Set of boiler plate rolls.
1 Merchant train and balling mill.
16 Puddling furnaces.
14 Balling and scrap furnaces.
And other machinery, such as plate and bar shears, lathes, &c.

Mixing of hæmatite ore with iron to be converted.

At Messrs Rushton and Eckersley's works, a small proportion of the Cumberland haematite ore is mixed with the crude pig iron to be converted, as it is found to assist in the process of boiling in the puddling furnace, and in other respects to facilitate the process and improve the quality of the iron.

Classification of various kinds of iron.

The crude pig iron is assorted according to the degree and uniformity of its carburisation, and classed as Nos. 1, 2, 3, &c.; No. 1 being most highly carburised, No. 2 less so, and so on to No. 4, which contains much more oxygen than the others. The carbon combined with iron gives it fusibility and fluidity, but deprives it of ductility. To render it malleable and capable of being welded, it must be deprived as far as possible of all the extraneous substances which have been mixed with it in the blast furnace, more especially of the carbon. *Primâ facie*, therefore, it would appear that the highly carburised pig iron is the most suitable for casting, whilst that containing least carbon is best adapted for conversion into malleable iron; hence, in the trade, the crude iron is divided into foundry and forge pigs.

Difficulties in the way of converting highly carburised iron.

The pigs, however, in which carbon most predominates, and which, as a rule, have been most effectually separated from all *other* impurities during the process of smelting, are in many respects preferable for the manufacture of wrought iron; up to this time, however, great practical difficulties have attended the decarburisation of iron containing so much carbon, and the white or forge iron is almost always preferred, measures having been taken for depriving it of the metals and earthy impurities not separated in the blast furnace.

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The refining process

With regard to the process of refining, we may observe, that the crude iron is melted in a hollow fire, and partially decarburised by the action of a blast of air forced over its surface by a fan or blowing engine. The carbon having a greater affinity for the oxygen than for the iron, combines with it, and passes off as gaseous carbonic oxide or carbonic acid. During this process, a portion of the silicum, &c., is fused out, and separated from the iron. It is obvious from the above that the iron to be refined, being placed in contact with fuel at a high temperature, is liable to be deteriorated by the admixture of sulphur and other impurities of the fuel; and as the iron is only partially exposed to the action of the blast, the operation is necessarily, under these circumstances, imperfect. From the refinery the metal is run out into large moulds, and is then broken up into what is technically distinguished as "*plate metal.*"

The puddling process.

The process of puddling succeeds that of refining; and in this operation the reverberatory furnace is employed, with the fire separated by a partition or bridge from the hearth, on which is placed the metal to be puddled. By this arrangement the flame is conducted over the surface of the metal, creating an intense heat, though the deleterious portions of the fuel cannot mix with the iron. In this furnace the iron is kept in a state of fusion, whilst the workman, called the "puddler," by means of a rake or *rabble*, agitates the metal so as to expose, as far as he is able, the whole of the charge to the action of the oxygen passing over it from the fire. By this means the carbon is oxidised, and the metal is gradually reduced to a tough, pasty condition, and subsequently to a granular form, somewhat resembling heaps of boiled rice with the grains greatly enlarged. In this condition of the furnace the cinder or earthy impurities yield to the intense heat, and flow off from the mass over the bottom in a highly fluid state.

The iron at this stage is comparatively pure, and quickly becomes capable of agglutination; the puddler then collects the metallic granules or particles with his *rabble*, and rolls them together, backwards and forwards, over the furnace bottom, into balls of convenient dimensions (about the size of thirteen-inch shells), when he removes them from the furnace to be subjected to the action of the hammer or mechanical pressure necessary to give to the iron homogeneity and fibre. These processes of refining and puddling have universally been employed till recently; but improvements have rendered it simpler, and the refining process is now very generally abolished.

Employment of crude iron in puddling

Shortly after the employment of the puddling process, it was found advantageous to mix a portion of crude iron with the refined plate metal, the expense of the process of refining being saved upon the iron used in the crude state; and trusting to the decarburising effects of the puddling furnace, it was found that the refining process might be altogether dispensed with, if the crude iron containing a proportion of oxygen and very little carbon was employed. In this single process it is to be observed, that as all the carbon has to be got rid of in the puddling furnace, the evolution of gas is much more violent, the fluid iron boiling and bubbling energetically during the period of its disengagement, and hence the operation has acquired the popular name of the "boiling" process.

The process of boiling.

[1] See Mr. Blackwell's paper, On the Iron Industry of Great Britain, read before the Society of Arts.

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Its advantages and defects.

In this operation the pig iron when melted is more fluid, on account of containing a greater proportion of carbon than the metal from the refinery, and requires more labour in stirring it about and submitting it to the action of the current of air; the process, moreover, is attended by a greater waste of iron than puddling either plate, or crude iron and plate mixed, but not so great a loss as in the two operations of refining and puddling. It must, however, be admitted that the superior fluidity of the iron in the boiling process has a more injurious action on the furnace. Notwithstanding these objections, the system of boiling without the intermediate process of refining has been gaining ground for the last ten years, and in many places has entirely superseded the use of the refinery; recent events have therefore led to the conclusion, that in a short time the refining process will have become a thing of the past.

Mr. Nasmyth's patent for using steam.

Numerous attempts have been made to secure a more scientific and perfect decarburisation of the crude iron, but without success. One improvement, however, recently patented by Mr James Nasmyth, gives promise of making the boiling process as nearly perfect as we may hope to see it. It has been in use for two years at the Bolton Iron Works, and from its constant employment in the puddling furnaces of that establishment, it has given direct proof of its utility, and is gradually extending itself among the large manufacturers as its advantages become known.

The invention consists of the introduction of a small quantity of steam at about 5 lbs. pressure per square inch, into the molten metal as soon as it is fused, as the oxygen of the steam has at that high temperature a greater affinity for carbon than for the hydrogen with which it is combined or for the iron, the carbon is rapidly oxidised off. The liberated hydrogen has no affinity for the iron, but unites with sulphur, phosphorus, arsenic, &c.—substances very injurious to the quality of the iron, if present even in minute quantities, and yet frequently found in the ores and fuel.

Mode of operating.

The mode of operating is as follows:—The steam is conveyed from the boiler to a vertical pipe fixed near the furnace door, having at its lower end a small tap or syphon, to let off the condensed steam, and prevent its being blown into the furnace. A cock with several jointed pieces of pipe are fastened to the flange of the vertical pipe, so as to form, as it were, jointed bracket pipes, somewhat similar to those of gas pipes, which

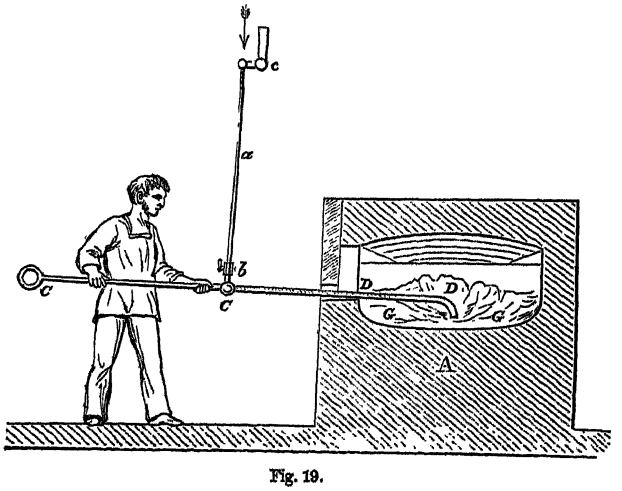


Fig. 19.

allow free motion in every direction, as in the annexed sketch, in which A, fig. 19, is the reverberatory furnace, *a* the vertical steam pipe communicating with the boiler, *b* the tap or steam cock, *cc* the elbow-jointed tubes, CC the handle, and DD the steam tube or rabble, bent at the end, so as to inject the steam on the liquid metal GG. This apparatus is introduced into the furnace immediately the iron is melted, the puddler moving it slowly about in the molten iron, while the steam pours upon it through the bent end of the tube. In the course of from five to eight minutes the mass begins to thicken, the steam pipe is withdrawn, and the operation finished in the ordinary way with the common iron *rabble*. The time saved by this process in every operation or *heat*, as it is technically called, averages from ten to fifteen minutes, and that during the hottest and most laborious part of the operation.

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By means of this apparatus, the highly carburized pig iron, which is the most free from impurities, is rendered malleable in one furnace operation, without the deteriorating adjuncts of the refining and puddling process as ordinarily practised; in this operation no deleterious substance can combine with the iron, whilst in the refinery process the mixture of the fuel and metal is liable to deteriorate the latter with sulphur, silicum, &c. This new process, it is affirmed, has a beneficial effect in purifying the iron with greater economy and rapidity than any other process with which we are acquainted.

Advantages of this process.

Irrespective of the improvements just described, there is another which is extensively used on the Continent, denominated the Silesian gas furnace. For a drawing and explanation of this furnace we are indebted to Mr Anderson, inspector of machinery at the arsenal, Woolwich. The following drawing, fig. 20, will explain the new Silesian furnaces which are used in the manufacture of iron in that country, in place of our reverberatory air furnaces, and are said, on good authority, to be a very great improvement, not only in regard to the entire prevention of smoke and the economy of fuel, but also in simplifying the wrought-iron manufacture, and enabling a less skilled class of workmen to manage the furnaces.

The chief feature is the gas generator, which may be described as a close brick chamber with an opening at the bottom for the admission of air from a fan, by means of which the gases are driven out of the chamber into the furnace amongst the iron to be heated. At the point where the gases enter the furnace, a series of tuyeres are provided for the admission of air from the same fan. The pipes that convey the air and the gas from the retort to the tuyeres are both provided with valves, in order that the attendant may modify the quantity from either source, so as to produce any intensity of flame the work may require, and also to produce perfect combustion, thus placing the entire action of the furnace under complete control. It is about eleven years since these furnaces were first introduced, and notwithstanding the prejudices that were naturally raised against them, they are said to be now extensively adopted in the Silesian district, and in great favour with both the master and the workmen.

In this description of furnace there appear to be three great advantages over the air furnace—

1*st*, The entire absence of smoke, in consequence of complete combustion.

2*d*, The saving of upwards of 33 per cent in fuel, from the whole of the gaseous products being made available, and there being no necessity for the flame to pass up the chimney to produce draught, as in the case of the reverberatory furnace, which requires an inordinate supply of fuel as compared with what is wanted to work the fan.

3*d*, The absolute control the attendant has over the

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furnace, as regards the temperature and the simplicity with which it can be worked. Its operations in this respect are, according to those who have seen it at work, so perfect as to be as precise in its action as a machine.

From this description it would appear that the iron-masters of this country have not made themselves acquainted with these improvements, but having some knowledge of the efficiency and existence of this process,

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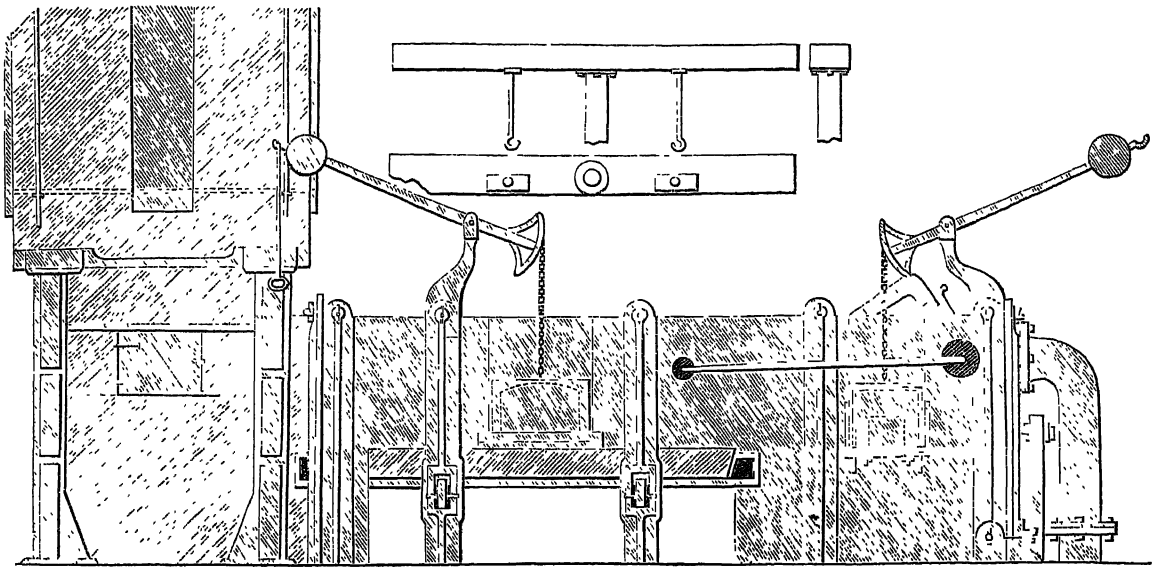


Fig. 20.

we would earnestly recommend it to their attention, as an invention in more respects than one entitled to consideration.

Bessemer's process.

Since the above was written, an apparently new light has been thrown on the conversion of iron, by a paper read by Mr H. Bessemer at the last meeting of the British Association for the advancement of science, held at Cheltenham in August last (1856). In this paper the author announces to the world the discovery of an entirely new system of operations for the manufacture of malleable iron and steel. The crude metal is converted, by one simple process, directly as it comes from the blast furnace. We should detract from its clearness did we attempt to curtail the lucid description in which Mr Bessemer has recommended his invention to the manufacturers and the public; we therefore give the account in his own words:—

Mr Bessemer states that "for the last two years his attention has been almost exclusively directed to the manufacture of malleable iron and steel, in which, however, he had made but little progress until within the last eight or nine months. The constant pulling down and rebuilding of furnaces, and the toil of daily experiments with large charges of iron, had begun to exhaust his patience, but the numerous observations he had made during this very unpromising period, all tended to confirm an entirely new view of the subject, which at that time forced itself upon his attention, viz.—that he could produce a much more intense heat, without any furnace or fuel, than could be obtained by either of the modifications he had used, and consequently, that he should not only avoid the injurious action of mineral fuel on the iron under operation, but that he would, at the same time, avoid also the expense of the fuel. Some preliminary trials were made on from 10 lbs. to 20 lbs. of iron, and although the process was fraught with considerable difficulty, it exhibited such unmistakeable signs of success, as to induce him at once to put up an apparatus capable of converting about 7 cwt. of crude pig iron into malleable iron in thirty minutes. With such masses of metal to operate on, the difficulties which beset the small laboratory experiments of 10 lbs. entirely disappeared. On this new field of inquiry, he set out with the assumption that crude iron contains about 5 per cent. of carbon; that carbon cannot exist at a white heat in the presence of oxygen without uniting therewith, and producing combustion; that such combustion would proceed with a rapidity dependent on the amount of surface of carbon exposed; and, lastly, that the temperature which the metal would acquire would be also dependent on the rapidity with which the oxygen and carbon were made to combine, and consequently, that it was only necessary to bring the oxygen and carbon together in such a manner that a vast surface should be exposed to their mutual action, in order to produce a temperature hitherto unattainable in our largest furnaces. With a view of testing practically this theory, he constructed a cylindrical vessel of three feet in diameter, and five feet in height, somewhat like an ordinary cupola furnace, the interior of which was lined with fire-bricks, and at about two inches from the bottom of it he inserted five tuyere pipes, the nozzles of which were formed of well-burnt fire clay, the orifice of each tuyere being about three-eighths of an inch in diameter; they were put into the brick lining from the outside, so as to admit of their removal and renewal in a few minutes, when they were worn out. At one side of the vessel, about half way up from the bottom, there was a hole made for running in the crude metal, and in the opposite side was a taphole, stopped with loam, by means of which the iron was run out at the end of the process. In practice, this converting vessel may be made of any convenient size, but he prefers that it should not hold less than one or more than five tons of fluid iron at each charge. The vessel should be placed so near to the blast furnace as to allow the iron to flow along a gutter into it; a small blast cylinder is required, capable of compressing air to about 8 lbs. or 10 lbs. per square inch. A communication having been made between it and the tuyeres before mentioned, the converting vessel will be in a condition to commence work; it will, however, on the occasion of its first being used, after relining with fire-bricks, be necessary to make a fire in the interior with a few baskets of coke, so as to dry the brickwork

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and heat up the vessel for the first operation, after which the fire is to be carefully raked out at the tapping hole, which is again to be made good with loam. The vessel will then be in readinesss to commence work, and may be so continued until the brick lining, in the course of time, is worn away, and a new lining is required. The tuyeres, as before stated, were situated nearly close to the bottom of the vessel, the fluid metal therefore rose some eighteen inches or two feet above them. It was therefore necessary, in order to prevent the metal from entering the tuyere holes, to turn on the blast before allowing the fluid crude iron to run into the vessel from the blast furnace. This having been done, and the fluid iron run in, a rapid boiling up of the metal was heard going on within the vessel, the iron being tossed violently about, and dashed from side to side, shaking the vessel by the force with which it moved. Flame, accompanied by a few bright sparks, immediately issued from the throat of the converting vessel. This state of things lasted for about fifteen or twenty minutes, during which time the oxygen in the atmospheric air combined with the carbon contained in the iron, producing carbonic acid gas, and at the same time evolving a powerful heat. Now as this heat is generated in the interior of, and is diffusive in innumerable fiery bubbles throughout the whole fluid mass, the vessel absorbs the greater part of it, and its temperature becomes immensely increased, and by the expiration of the fifteen or twenty minutes before named, that part of the carbon which appears mechanically mixed and diffused through the crude iron has been entirely consumed. The temperature, however, is so high that the chemically combined carbon now begins to separate from the metal, as is at once indicated by an immense increase in the volume of flame rushing out of the throat of the vessel. The metal in the vessel now rises several inches above its natural level, and a light frothy slag makes its appearance, and is thrown out in large foam-like masses. This violent eruption of cinder generally lasts about five or six minutes, when all further appearance of it ceases, a steady and powerful flame replacing the shower of sparks and cinders which always accompanies the boil. The rapid union of carbon and oxygen which thus takes place, adds still further to the temperature of the metal, while the diminished quantity of carbon present allows a part of the oxygen to combine with the iron which undergoes a combustion, and is converted into an oxide. At the excessive temperature that the metal has now acquired, the oxide, as soon as formed, undergoes fusion, and forms a powerful solvent of those earthy bases that are associated with the iron. The violent ebullition which is going on mixes most intimately the scoriæ and metal, every part of which is thus brought into contact with the fluid oxide, which will thus wash and cleanse the metal most thoroughly from the silica and other earthy bases, which are combined with the crude iron, while the sulphur and other volatile matters, which cling so tenaciously to iron at ordinary temperatures, are driven off, the sulphur combining with the oxygen, and forms sulphurous acid gas. The loss in weight of crude iron during its conversion into an ingot of malleable iron, was found, on a mean of four experiments, to be 12½ per cent, to which will have to be added the loss of metal in the finishing rolls. This will make the entire loss probably not less than 18 per cent instead of about 28 per cent which is the loss on the present system. A large portion of this metal is, however, recoverable by treating with carbonaceous gases the rich oxides thrown out of the furnace during the boil. These slags are found to contain innumerable small grains of metallic iron, which are mechanically held in suspension in the slags, and may be easily recovered. It has already been stated that after the boil has taken place, a steady and powerful flame succeeds, which continues without any change for about ten minutes, when it rapidly falls off. As soon as this diminution of flame is apparent, the workman knows that the process is completed, and that the crude iron has been converted into pure malleable iron, which he will form into ingots of any suitable size and shape, by simply opening the tap hole of the converting vessel, and allowing the fluid malleable iron to flow into the iron ingot moulds placed there to receive it. The masses of iron thus formed will be perfectly free from any admixture of cinder oxide, or other extraneous matters, and will be far more pure, and in a forwarder state of manufacture, than a pile formed of ordinary puddle bars. And thus, by a single process, requiring no manipulation or particular skill; and with only one workman, from three to five tons of crude iron passes into the condition of several piles of malleable iron, in from thirty to thirty-five minutes, with the expenditure of about one-third part the blast now used in a finery furnace with an equal charge of iron, and with the consumption of no other fuel than is contained in the crude iron. To those who are best acquainted with the nature of fluid iron, it may be a matter of surprise that a blast of cold air forced into melted crude iron is capable of raising its temperature to such a degree as to retain it in a perfect state of fluidity, after it has lost all its carbon, and is in the condition of malleable iron, which, in the highest heat of our forges, only becomes a pasty mass. But such is the excessive temperature that may be arrived at, with a properly shaped converting vessel, and a judicious distribution of the blast, that not only may the fluidity of the metal be retained, but so much surplus heat can be created as to remelt the crop ends, ingot, runners, and other scrap, that is made throughout the process, and thus bring them, without labour or fuel, into ingots of a quality equal to the rest of the charge of new metal. For this purpose, a small arched chamber is formed immediately over the throat of the converting vessel, somewhat like the tunnel-head of the blast furnace. This chamber has two or more openings in the sides of it, and its floor is made to slope downwards to the throat. As soon as a charge of fluid malleable iron has been drawn off from the converting vessel, the workman will take the scrap intended to be worked into the next charge, and proceed to introduce the several pieces into the small chamber, piling them up round the opening of the throat. When this is done, he will run in his charge of crude metal, and again commence the process. By the time the boil commences, the bar ends or other scrap will have acquired a white heat, and by the time it is over, most of them will have melted and run down into the charge. Any pieces, however, that remain, may then be pushed in by the workman, and by the time the process is completed, they will all be melted and intimately combined with the rest of the charge; so that all scrap iron, whether cast or malleable, may thus be used up without any loss or expense. As an example of the power that iron has of generating heat in this process, Mr Bessemer mentions that when trying how small a set of tuyeres could be used, the size he had chosen proved too small, and after blowing into the metal for one hour and three-quarters, he could not get up heat enough with them to bring on the boil. The experiment was therefore discontinued, during which time two-thirds of the metal solidified, and the rest was run off. A larger set of tuyere pipes were then put in, and a fresh charge of fluid iron run into the vessel, which had the effect of entirely remelting the former charge; and when

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the whole was tapped out it exhibited, as usual, that intense and dazzling brightness peculiar to the electric light.

"To persons conversant with the manufacture of iron, it will be at once apparent that the ingots of malleable metal which are produced by this process, will have no hard or steely parts, such as are found in puddled iron, requiring a great amount of rolling to blend them with the general mass, nor will such ingots require an excess of rolling to expel the cinder from the interior of the mass, since none can exist in the ingot, which is pure and perfectly homogeneous throughout, and hence requires only as much rolling as is necessary for the development of fibre; it therefore follows that instead of forming a merchant bar or rail by the union of a number of separate pieces welded together, it will be far more simple, and less expensive, to make several bars or rails from a single ingot; doubtless this would have been done long ago had not the whole process been limited by the size of the ball which the puddler could make.

"The facility which the new process affords, of making large masses, will enable the manufacturer to produce bars that, on the old mode of working, it was impossible to obtain; while, at the same time, it admits of the use of some powerful machinery, whereby a great deal of labour will be saved, and the process be greatly expedited. Mr Bessemer merely mentions this in passing, without entering into details, as the patents he has obtained for improvements in this branch of the manufacture are not yet specified. He next points out the perfectly homogeneous character of cast-steel—its freedom from sand cracks and flaws—and its greater cohesive force and elasticity, compared with the blister steel from which it is made, qualities which it derives solely from its fusion and formation into ingots—all of which properties malleable iron acquires in like manner, by its fusion and formation into ingots in the new process. Nor must it be forgotten that no amount of rolling will give to blistered steel (although formed of rolled bars) the same homogeneous character that cast-steel acquires, by a mere extension of the ingot to some ten or twelve times its original length.

"One of the most important facts connected with the new system of manufacturing malleable iron is, that all the iron so produced will be of the quality known as charcoal iron, not that any charcoal is used in its manufacture, but because the whole of the processes following the smelting of it are conducted entirely without contact with, or the use of any mineral fuel; the iron resulting therefrom will, in consequence, be perfectly free from those injurious properties which that description of fuel never fails to impart to iron that is brought under its influence. At the same time, this system of manufacturing malleable iron offers extroadinary facility for making large shafts, cranks, and other heavy masses; it will be obvious that any weight of metal that can be founded in ordinary cast-iron, by the means at present at our disposal, may also be founded in molten malleable iron, and be wrought into the forms and shapes required, provided that we increase the size and power of our machinery to the extent necessary to deal with such large masses of metal. A few minutes' reflection will shew the great anomaly presented by the scale on which the processes of iron-making are at present carried on. The little furnaces originally used for smelting ore have, from time to time, increased in size, until they have assumed colossal proportions, and are made to operate on 200 or 300 tons of material at a time, giving out 10 tons of fluid metal at a single run. The manufacturer has thus gone on increasing the size of his smelting furnaces, adapting to their use the blast apparatus of the requisite proportions, and has by this means lessened the cost of production, in every way ensuring a cheapness and uniformity of production, that could never have been secured by a multiplicity of small furnaces. While the manufacturer has shewn himself fully alive to these advantages, he has still been under the necessity of leaving the succeeding operations to be carried out on a scale wholly at variance with the principles he has found so advantageous in the smelting department. It is true that, hitherto, no better method was known than the puddling process, in which from 4 cwt. to 5 cwt. of iron is all that can be operated upon at a time, and even this small quantity is divided into homeopathic doses of some 70 lbs. or 80 lbs., each of which is moulded and fashioned by human labour, carefully watched and tended in the furnace, and removed therefrom, one at a time, to be carefully manipulated and squeezed into form. The vast extent of the manufacture, and the gigantic scale on which the early stages of its progress is conducted, it is astonishing that no effort should have been made to raise the after processes somewhat nearer to a level commensurate with the preceding ones, and thus rescue the trade from the trammels which have so long surrounded it. Mr Bessemer then adverts to another important feature of the new process, the production of what he calls semi-steel. At the stage of the process immediately following the boil, the whole of the crude iron has passed into the condition of cast-steel of ordinary quality; by the continuation of the process the steel so produced gradually loses its small remaining portion of carbon, and passes successively from hard to soft steel, and from softened steel to steely iron, and eventually to very soft iron; hence, at a certain period of the process, any quality may be obtained; there is one in particular, which, by way of distinction, he calls semi-steel, being in hardness about midway between ordinary cast-steel and soft malleable iron. This metal possess the advantage of much greater tensile strength than soft iron; it is also more elastic, and does not readily take a permanent set, while it is much harder, and is not worn or indented so easily as soft iron. At the same time it is not so brittle or hard to work as ordinary cast-steel. These qualities render it eminently well adapted to purposes where lightness and strength are specially required, or where there is much wear, as in the case of railway bars, which, from their softness and lamellar texture, soon become destroyed. The cost of semi-steel will be a fraction less than iron, because the loss of metal that takes place by oxidation in the converting vessel is about 2½ per cent. less than it is with iron, but as it is a little more difficult to roll, its cost per ton may fairly be considered to be the same as iron, but as its tensile strength is some thirty or forty per cent greater than bar iron, it follows that for most purposes a much less weight of metal may be used, so that taken in that way the semi-steel will form a much cheaper metal than any we are at present acquainted with.

"In conclusion, Mr Bessemer observes that the facts he has discovered have not been elicited by mere laboratory experiments, but have been the result of operations on a scale nearly twice as great as is pursued in the largest iron-works, the experimental apparatus converting 7 cwt. in thirty minutes, while the ordinary puddling furnace makes only 4½ cwt. in two hours, which is made into six separate balls; while the ingots or blooms are smooth, even prisms ten inches square by thirty inches in length, weighing about as much as ten ordinary puddle balls." (See Addenda, E).

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MACHINERY OF THE MANUFACTURE.

The mechanical operations connected with the manufacture of wrought-iron consist of shingling, hammering, rolling, &c., to which we may add the forging of "*uses*," that is, the forging of those peculiar forms so extensively in demand for steam-engines, railway carriages, and other works, which has lately become a large and important branch of trade.

Old processes and machinery for the manufacture of bars, plates, &c.

In tracing the whole of the processes in the manufacture of wrought iron bars and plates, it will not be necessary to enlarge on those practices which have been superseded by more modern and improved machinery. Suffice it then to observe, that formerly the puddled balls were *shingled* or fashioned into oblong slabs or *blooms* by the blows of a heavy forge hammer; during this operation, the scoriæ and impurities which adhered to the balls were separated from the blooms by the force of impact, and then by a series of blows the iron was rendered malleable, dense, and compact. The blooms were then passed through a series of grooved iron rollers, which reduced them to the form of long, slender iron bars. These were cut up and piled regularly together or *faggotted*, and brought to a welding heat in the heating or *balling* furnace, when they were again passed several times through grooved rollers, and by this latter process were made into bars or plates ready for the shears.

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In order to arrive at a clear conception of the mechanical operations employed in the manufacture of iron, it will be necessary to describe more at length the processes as at present practised, with the improved and powerful machinery now employed; and as much depends upon the application of the motive power, the steam-engine claims the first notice. Until of late years, the vertical steam-engine was invariably used for giving motion to the forge hammer and rolling mill, which were placed on one side of the fly-wheel and the crank on the other; but the high-pressure, non-condensing engine is found to be decidedly preferable, as the waste heat passing off with the products of combustion from the puddling and heating furnaces, is quite sufficient to raise the steam for working the rolls and one of Brown's bloom squeezers, as shewn in the following drawing.

The steam engine.

In this arrangement the cylinder A (figs. 21, 22, 23), is placed horizontally, and is supplied with steam from

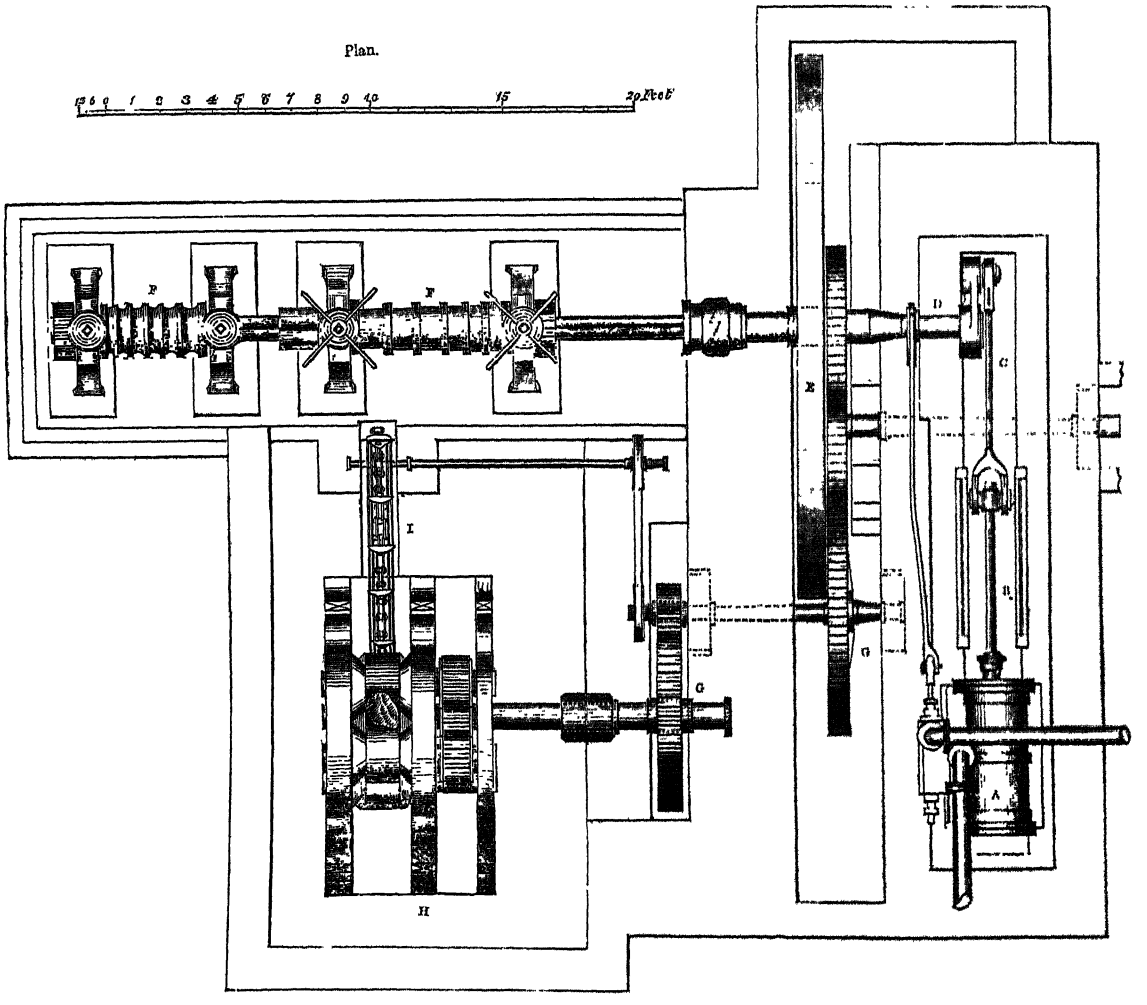


Fig. 21.

boilers near the puddling furnaces. The piston and slides B, and connecting rod C, give motion to the crank shaft D, on which is fixed a heavy fly-wheel E. The puddling rolls F are driven direct from the end of the fly-wheel shaft, and the bloom squeezers H, by a train of spur wheels GG. Under the lower rolls of the squeezers a Jacob's ladder or elevator I is fixed, for raising the block which has been deprived of its impurities, and reduced to an oblong shape by passing between the rollers of the squeezer. The block, on leaving the rollers, is carried in front of one of the projecting divisions of the ladder and thrown on to the platform in front of the rolls;

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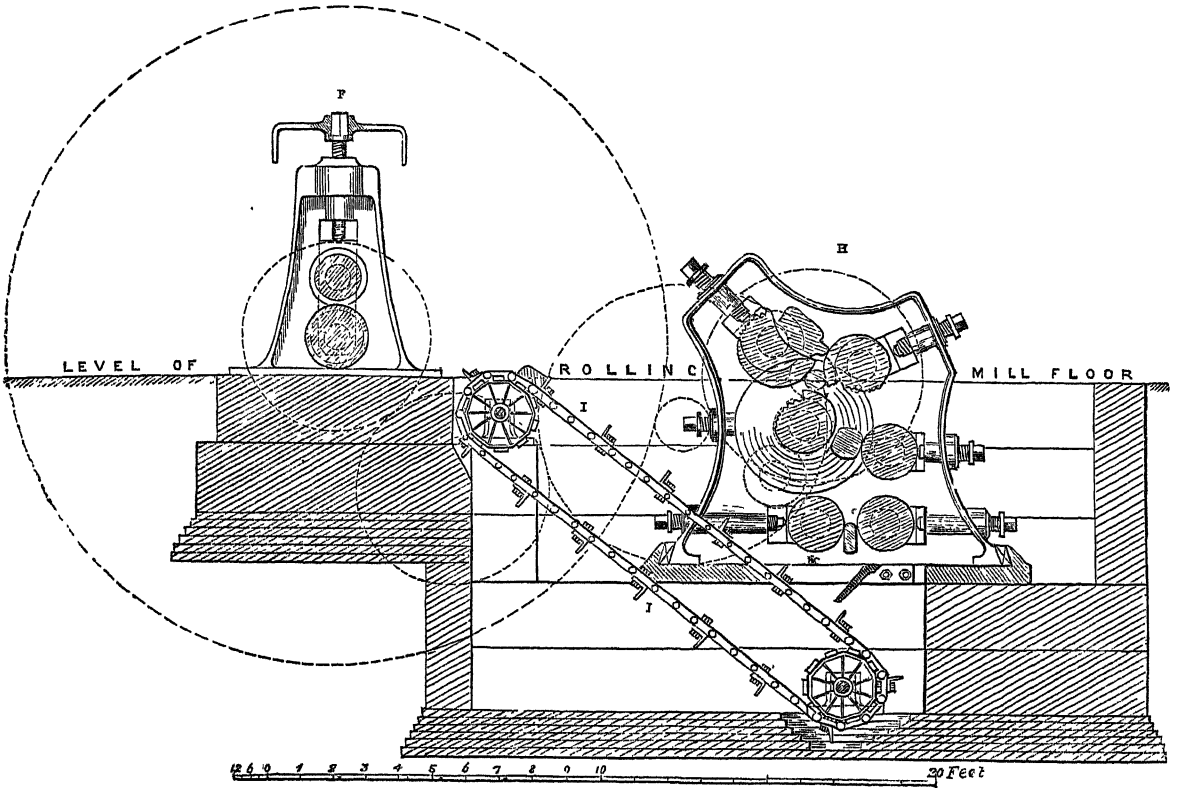


Fig. 22.

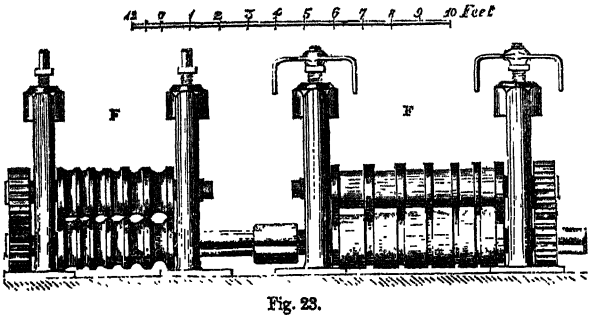


Fig. 23.

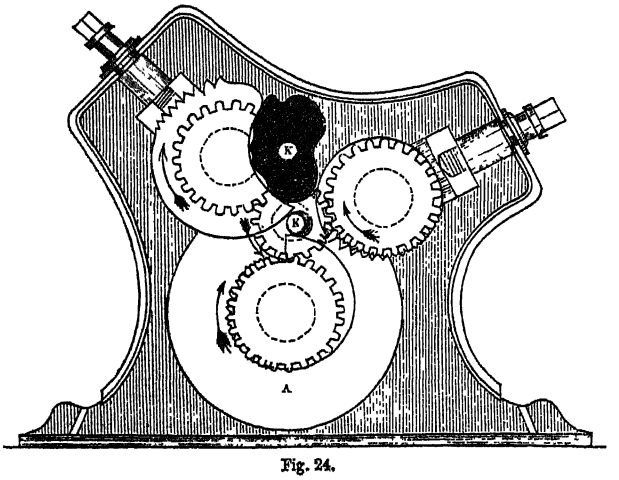


Fig. 24.

the workman then seizes it with a pair of tongs and forces it into the largest groove in the rolls; it is then passed in succession through the other grooves till it attains the required form of the bar.

Brown's bloom squeezers.

The drawings of Brown's bloom squeezers, figs. 24, 25, and 26, will sufficiently explain how the heated ball of puddled iron, K, thrown on the top, is gradually compressed between the revolving rollers as it descends and at last emerges at the bottom, where it is thrown on to the moveable "Jacob's ladder," by which it is elevated to the rolls, as already described. This machine effects a considerable saving of time; will do the work of 12 or 14 furnaces, and may be kept constantly going as a feeder to one or two pairs of rolls. There are two distinct forms of this machine, one as shewn in fig. 24, where the bloom receives only two compressions; and the other, which is much more effective, where it is squeezed four times before it leaves the rolls and falls upon the Jacob's ladder, as exhibited in figs. 25, and 26.

Horizontal squeezer.

There are two other machines for preparing the blooms by compression. One is a table firmly embedded in masonry, as shewn at AA, in fig. 27, with a ledge rising up from it to a height of about two feet, so as to form an open box. Within this is a revolving box C, of a similar character, much smaller than the last and placed eccentrically in regard to it. The ball or bloom D is placed between the innermost revolving box C and the outer case AA, where the space between them is greatest, and is carried round till it emerges at E, compressed and fit for the rolls.

The Alligator.

Another instrument, fig. 28, used for the same purpose, acts as a pair of pliers, and squeezes the iron between two flat blades AA. This machine is called the Alligator, and is probably more effective than the horizontal machine, but it requires an attendant to keep the bloom rolling about under the jaws AA, and is, in other respects, inferior to Brown's patent squeezer.

Advantages of the horizontal engine.

We have stated that the horizontal, non-condensing steam-engine, from its compact form and convenience of handling, is admirably adapted for giving motion to the machinery of iron-works. For this object, it is superior to the beam-engine, as its speed can be regulated with the

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greatest nicety, by opening or shutting the valve, so as to suit all the requirements of the manufacture, under the varied conditions of the pressure of the steam, and the power required for rolling heavy plates and bars, or those of a lighter description. It is also much cheaper in its original cost, and all its parts being fixed upon a

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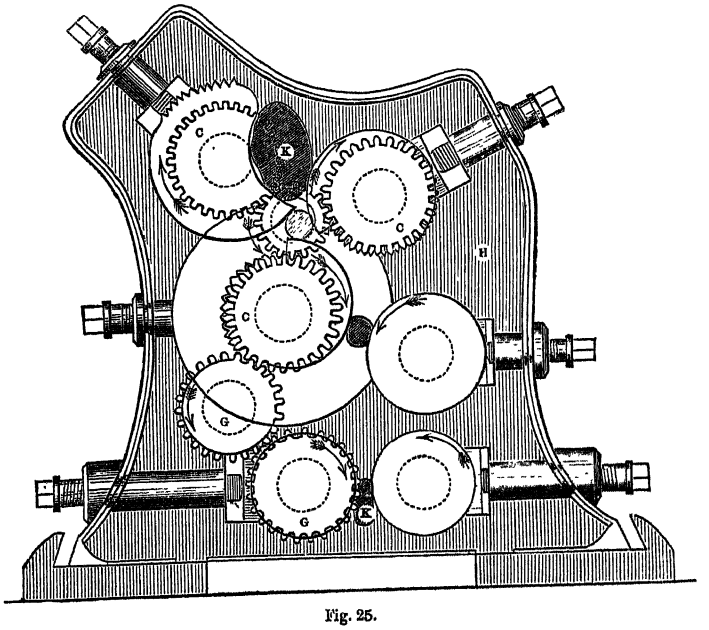


Fig. 25.

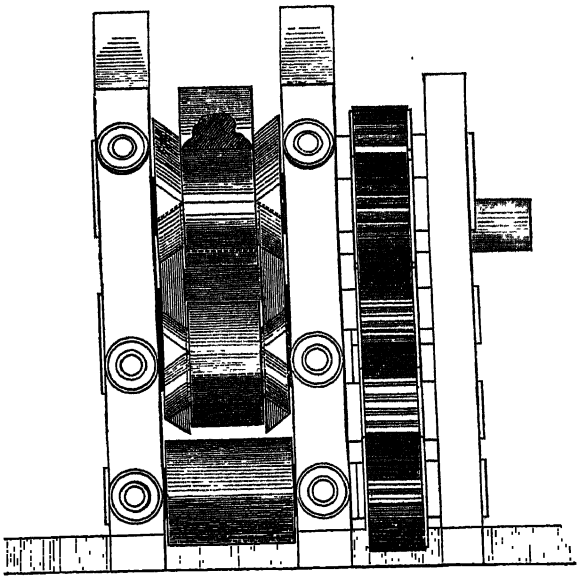


Fig. 26.

large bed-plate, require a comparatively small amount of masonry to render it solid and secure.

Rolls.

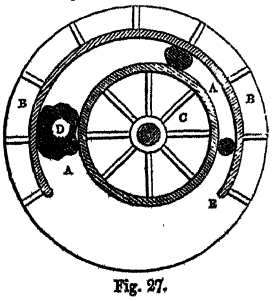


Fig. 27.

In regard to the manufacture of the rollers for the puddling, boiler-plate, and merchant train, the greatest care must be observed in the selection of the iron and the mode of casting. In Staffordshire there are roller-makers, but in general the manufacturer casts his own, and as much depends upon the metal, the strongest qualities are carefully selected and mixed with Welsh No. 1 or No. 2, and Staffordshire No. 2. This latter description of iron, when duly prepared, exhibits great tenacity, and is well adapted, either in the first or second melting, for such a purpose. In casting, the moulds are prepared in loam, and when dry are sunk vertically

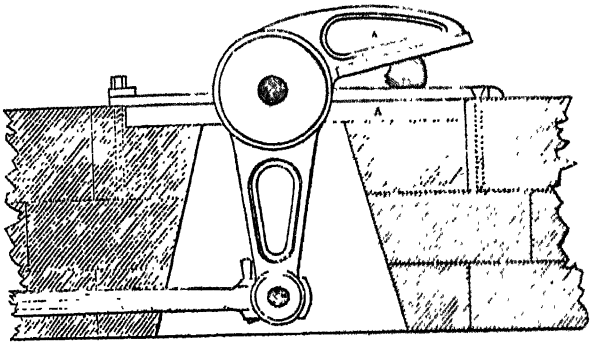
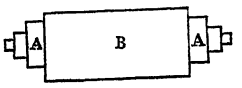


Fig. 28.

into the pit to a depth of about 5 feet below the floor. The moulding box is surrounded by sand firmly consolidated by beaters, and a second mould or head is placed above it, which receives an additional quantity of iron to supply the space left by shrinking, and keep the roll under pressure until it solidifies, and thus secures a great uniformity and density in the roller. The metal is run into the mould direct from the air furnace by channels cut in the sand, and immediately the mould is filled, the workman agitates the metal with a rod, in order to consolidate the mass and get rid of any air or gas which may be confined in the metal. This stirring with iron rods is continued till the metal cools to a semi-fluid state, when it is covered up and allowed slowly to cool and crystallize. This slow rate of cooling is necessary to favour an uniform degree of contraction, as the exterior closes up like a series of hoops round the core of the casting, which is always the most porous and the last to cool. In every casting of this kind it is essential to avoid unequal contraction, and this cannot be accomplished unless time is given for the arrangement of the particles by a slow process of crystallization. Rollers for

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boiler-plates and thin sheet-iron are difficult to cast sound on account of their large size. They are subjected to very great strain, and require to be cast from the most tenacious metals. The bearings or neck should be enlarged, or turned to the shape shewn at AA, and the cylindrical part B should be slightly concave, because, when the slab is first passed through the rollers, it comes in contact with a small portion only of the revolving surface. The central parts of the roller thus become highly heated, whilst their extremities are perfectly cool; the consequence is, that the expansion of the roller is greatest in the middle, and unless this be provided for by a concavity in the barrel, the plates become buckled, that is, both warped and uneven in thickness, and, consequently, imperfect and unfit for the purposes of boiler making. Bar rolls are generally cast in chill, and great care is required to prevent the chill penetrating too deep so as to injure the tenacity of the metal and render it brittle.



Different kinds of rolling mills.

There are different kinds of rolling mills used in the iron manufacture, and they vary considerably in their dimensions according to the work they have to perform. The first, through which the puddled iron is passed, we have already described as puddling rolls. There are others for roughing down which vary from 4 to 5 feet long, and are about 18 inches diameter; those for merchant bars, about 2 feet 6 inches to 3 feet long and 18 inches in diameter, are in constant use. The boiler-plate and black sheet-iron rolls are generally of large dimensions; some of them for large plates are upwards of 6 feet long and 18 to 21 inches in diameter; these require a powerful engine and the momentum of a large fly-wheel to carry the plate through the rollers, and not unfrequently when thin wide plates have to be rolled, the two combined prove unequal to the task, and the result is, the plates cool and stick fast in the middle. The greatest care is necessary in rolling plates of this kind, as any neglect of the speed of the engine or the setting of the rolls results in the breakage of the latter, or bringing the former to a complete stand.

The speed of the different kinds of rolling mills varies according to the work they have to perform. Those for merchant bars make from 60 to 70 revolutions a minute, whilst those of large size for boiler-plates are reduced to 28 or 30. Others, such as the finishing and guide rollers, run at from 120 to 400 revolutions a minute. In Staffordshire, where some of the finer kinds of iron are prepared for the manufacture of wire, the rollers are generally made of cast-steel, and run at a high velocity; such is the ductility of this description of iron, that in passing through a succession of rollers, it will have elongated to 10 or 15 times its original length, and when completely finished, will have assumed the form of a strong wire $\frac{3}{8}$ to $\frac{1}{4}$ of an inch in diameter, and 40 to 50 feet in length.

Temperature of the iron.

A high temperature is an indispensable condition of success in rolling. The experience of the workman enables him to judge, from the appearance of the furnace, when the pile is at a welding heat, so that when compressed in the rolls the particles will unite. Sometimes it is necessary to give a fine polish or skin to the iron as it leaves the rolls, but this can only be done when the iron cools down to a dark-red colour, and by the practised eye of an intelligent workman.

Shears.

The above operations would still be incomplete unless the ironmaster had means of cutting the bars and plates to any required size and shape. The machinery for this purpose has of late been brought to a high degree of perfection, both in regard to power and precision.

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The circular saw has been successfully applied for squaring and cutting the larger descriptions of bars, and does its work, particularly in railway bars, with almost mathematical precision. This machine consists of a cast-iron frame or bed AA, fig. 29, bolted down to a solid foundation, on the ends of which slide two frames BB to support the bar to be cut. The two circular saws or cutters CC are driven by straps passing over the pulleys DE, and rotate at the rate of 800 to 1000 revolutions per minute. The machine is set in motion by transferring the straps from the loose pulley D to the fast pulley E, and as soon as the required speed is attained, the frame BB is carried forward, and the bar FF along with it, by a lever G or eccentric motion, till the bar is cut through. The rate of cutting or pressure upon the saws may be regulated either by hand or weight; care must, however, be taken not to allow the saws to become too hot, and this is provided against by running them in a trough of water. By this process it is evident that the bar must always be cut square at the ends and correctly to the same length. (See Addenda, F).

Circular saw.

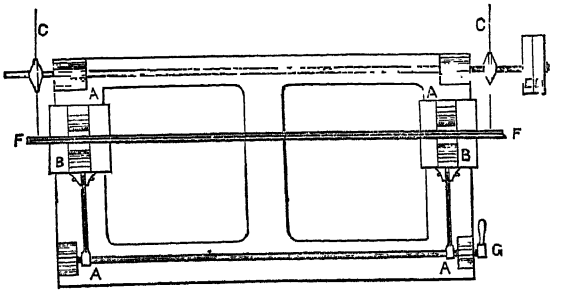


Fig. 29.

Bar and scrap iron shears.

A great variety of shears are used for cutting iron, some driven by cams or eccentrics, and some by connecting-rods and a crank on the revolving shaft. In large iron-works it is necessary to have two or three kinds, some for cutting up scrap iron and bars for piling, and others for boiler-plates. Of the first we may notice two, one shewn in fig. 30, cuts on both sides at AA, and is driven by a crank and connecting-rod B. This machine is chiefly used for cutting puddled bars from the puddling rolls, or any work required for shingling. The next machine, fig. 31, receives motion in the same manner, and also cuts on both sides, the cutters being fixed on the lever and moving with it. This is used for the same purpose as the last, and likewise for cutting scrap iron.

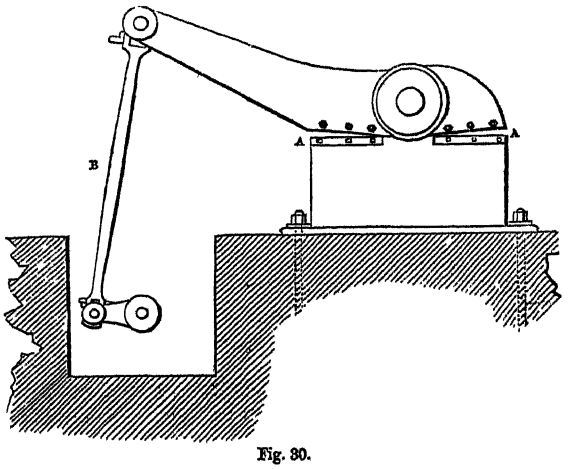


Fig. 30.

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These machines are extensively used in the manufacture of iron, and before the introduction of the plate shears, they

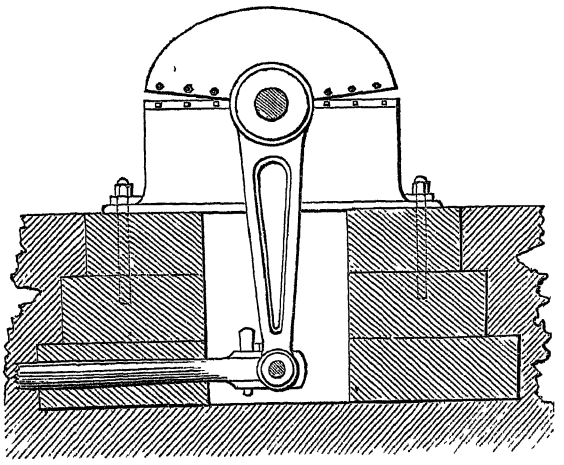


Fig. 31.

were used, with some modifications, to cut boiler-plates, but the work was very imperfectly executed.

Thorneycroft's boiler-plate shears.

The demand for plates of large dimensions and greatly increased weight, such as those for the front and tube plates of locomotive and marine boilers, and those for tubular and plate bridges, created great difficulties, not only in piling, heating, and rolling, but also in cutting the plates accurately to the required size. To meet these demands, and more particularly for the manufacture of the large plates employed in the cellular top of the Britannia and Conway tubular bridges, Messrs G. B. Thorneycroft and Co. constructed a large shearing machine which cut upwards of 10 feet at one stroke. These shears have now come into general use, and are of great importance, on account of the accuracy with which they cut plates of large dimensions, square and even. Figs. 32 and 33 represent this machine; *a a a* is the standard and table on which the plate is fixed. This table slides forward at right angles to the shears or cutters AAA*A*. The top cutter descending by the action of three eccentrics *c c c*, which press upon the top of the frame B as it revolves, and force it down, and by one stroke, the knife AA cuts through the whole length of the plate, perfectly clean and straight. The plate is then reversed, the newly cut edge being held against the slopes, and the sliding frame again moved forward to the required width of the plate, when another stroke cuts the other side as before. The rapidity with which the plates are cut is another advantage of this machine, as great as the precision of its cut, and when the immense quantity of plates daily produced at Messrs Thorneycroft and Co.'s works are considered, its importance becomes evident.

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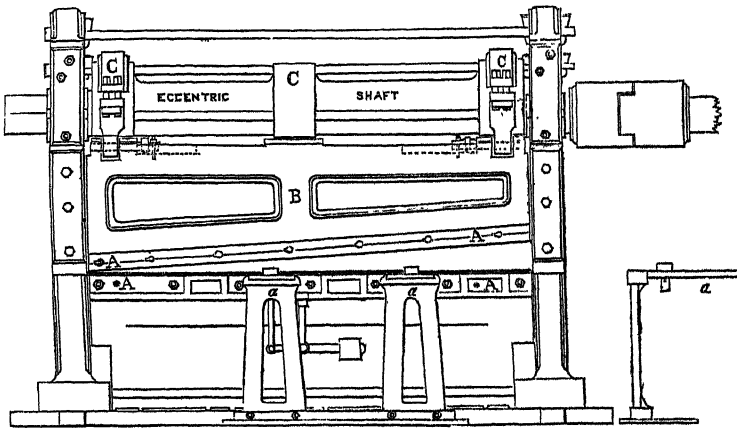


Fig. 32.—Elevation.

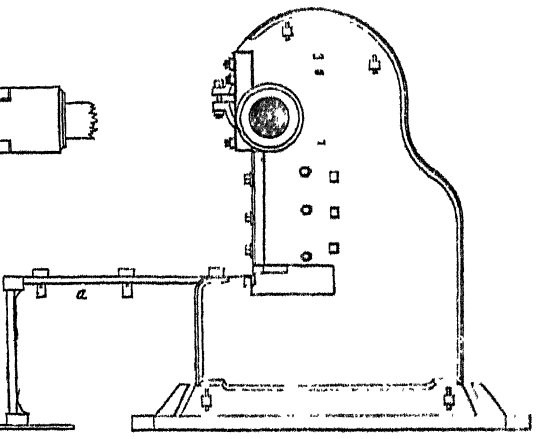


Fig. 33.—Side View.

American machine for cutting boiler-plate.

At the Paris Universal Exhibition of last year (1855), a plate-cutting machine was exhibited, from the United States of America, which appears to effect the same operation as Messrs Thorneycroft and Co.'s. It consists of a strong cast-iron frame, nine or ten feet wide, having inserted along its face a steel plate, on which the iron to be cut rests and is held firmly by a faller, which descends on the upper side of the plate. On the same side of the frame a revolving steel cutter, about nine inches in diameter, traverses the whole length of the frame, and in its passage cuts the plate, by compression, in a perfectly straight line, corresponding with the steel edge below. Cutting and shaving plates by a revolving disc has been long in use, but the traversing motion in this machine is certainly new, and its application very creditable to the ingenuity of the inventor. The travelling cutter, which requires great power when cutting thick plates, is driven by a strap over a pulley at one end of the machine, and looking at the work it has to perform and the complexity of its parts, we should consider it less effective and more liable to derangement than the simple and powerful machine of Messrs Thorneycroft.

General Summary.

Having thus traced the processes for the conversion of crude into malleable iron, and the machinery employed, it only remains to give a general summary of the whole. As regards the arrangement of large iron-works, the general principle should be for the machinery to be classed and fixed in the order of the different processes, so that the products of one machine should pass at once to the next, and, in fact, the crude iron should be received at one end, and having passed through all the processes, delivered at the other in the manufactured state.

The crude iron from the smelting furnace is either refined and puddled, or subjected to the boiling process, to get rid of the combined carbon and render the iron malleable; it is then shingled by the forge hammer, by the "alligator," by Brown's squeezer, or by the other machines which have been invented for this purpose. It is then at once passed through the puddling rolls, where it is reduced to the form of a flat bar, and is then cut into convenient lengths by the shears. These pieces are again piled or faggoted together into convenient heaps and re-heated in the furnace. As soon as a faggot thus prepared has been heated to the welding temperature, it is passed through the roughing rolls to reduce it to the form of a bar, and then through the finish-

The manufacture of iron.

The manufacture of iron.

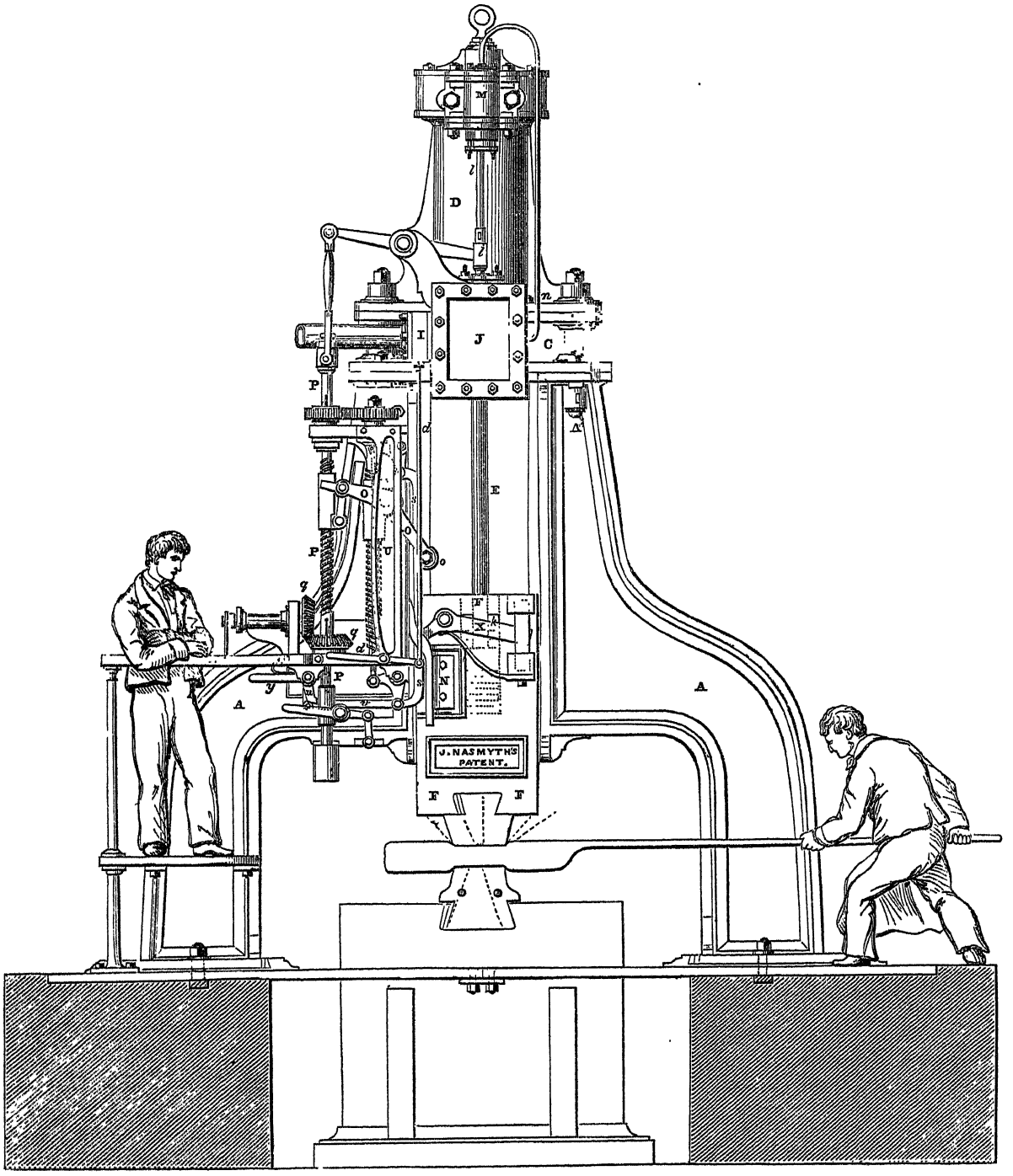


Fig. 34.—Elevation.

ing rolls, where the required form and size is given to it, either round or square bars, &c. These are straightened and cut to the required sizes, and are then ready for delivery. In most large works all these operations are carried on simultaneously with the smelting process, and in some with extensive mining operations for procuring the coal, ore, and limestone required to supply a production of several thousand tons of manufactured iron per month.

THE FORGE.

The forging of iron has entered, of late years, so largely into the constructive arts, that the manufactures, however perfect in the rolling-mill, would be very imperfect indeed without the forge. To the discussion of this part of the subject there are many inducements, and we cannot but wonder at the many devices, and the numerous contrivances which present themselves for the attainment of the operations of the forge. In effecting these objects, Mr Nasmyth's steam-hammer is evidently the most effective, and to that instrument we are indebted for the formation and welding of iron upon a scale previously unknown to the workers in that metal.

Nasmyth's hammer.

Mr Nasmyth took out his patent for this invention

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in 1833; and from that time up to the present, it has maintained its ground against every innovation, and has performed an important duty in almost every well-regulated work in Europe. It consists of an inverted cylinder D, figs. 34 and 35, through which the piston-rod E passes, attached to the hammer-blade F by means of bars and cross-key *k*, which press upon an elastic packing, to soften the blow of the hammer, which in heavy forgings

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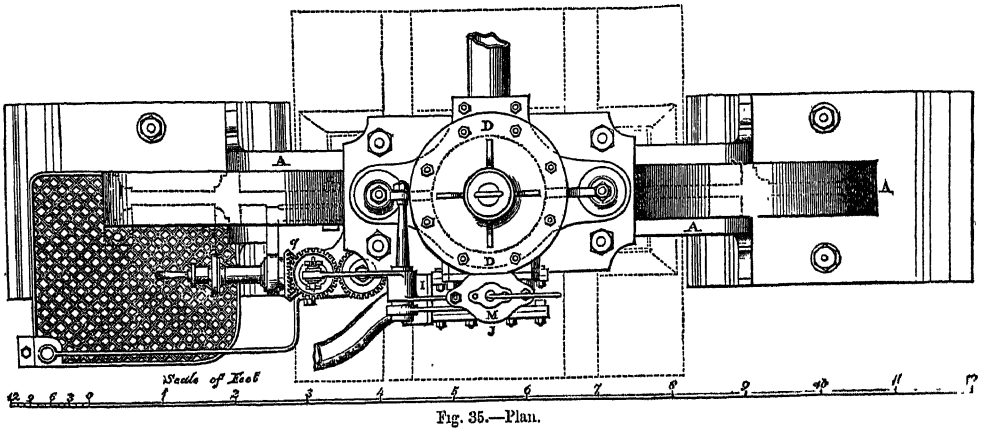


Fig. 35.—Plan.

and heavy blows, operates severely upon the piston-rod. The hammer-block FF is guided in its vertical descent by two planed guides or projections, extending the length of the side-standards AA, between which the hammer-block slides. The attendant gives motion to the hammer by admitting steam from the boiler to act upon the under side of the piston, by moving the regulator I by the handle *d*. The length of stroke is regulated by increasing or diminishing the distance between the cam N and the valve lever O *o*, by turning the screws P and U by the bevil wheels *q q*. The lever O *o* operates by the cam N coming in contact with the roller *o*. As soon as this contact takes place, the further admission of steam is not only arrested, but its escape is at the same time effected, and the hammer, left unsupported, descends by its gravity upon the work on the anvil with an energy due to the height of the fall. From this description, it will be seen that the movement of the roller *o* causes the shoulder of the rod P to get under the point of the trigger catch U; the valve is by these means kept closed till the whole force of the blow is struck. The instant the operation is effected, the concussion of the hammer causes the latch X to knock off the point of the trigger from the shoulder on the valve-rod P, by means of the bent lever *s v*, and the instant this is accomplished, the valve is re-opened to admit the steam below the piston, by the pressure of steam on the upper side of the small piston in the cylinder M, forcing down the valve rod, which, in this respect, is the active agent for opening the valve.

To arrest the motion of the hammer, it is only necessary to shut the steam-valve; during the process of forging, it is, however, desirable to give time between the blows, to enable the workman to turn and shift his work on the anvil; and to effect this reduced motion, the trigger U is held back from the shoulder of the valve-rod P, by the handle *y*, which at the same instant opens the valve in the case J, and thus the action of the steam in the cylinder D retards the downward motion of the hammer. The result of these changes is an easy descent of the hammer, which vibrates up and down without touching the anvil, but ready for blows of any severity the instant the trigger is elevated above the shoulder of the valve lever P. From this description, it will appear evident that Mr Nasmyth's invention is one of the most important that has occurred in the art of forging iron. It has given an impetus to the manufacture, and affords facilities for the welding of large blocks of malleable iron that could not be accomplished by the tilt and helve hammers formerly in use; and we have only to instance the forging of the stern-posts and cutwaters of iron ships; the paddle-wheel and screw-shafts of our ocean steamers, some of them weighing upwards of 20 tons, to appreciate the value, as well as the intensity of action of the steam-hammer.

In addition to the machinery of the forge, the V anvil, the natural offspring of the steam-hammer, came into existence from the same fertile source. It is chiefly employed for forging round bars and shafts, and may be thus described, A being a section of the round bar or shaft to be forged, B the anvil-block, and C the hammer. From this, it is obvious that, in place of the old plan, where the work is forged upon flat surfaces, as shewn in the annexed figure, and where the blows are diverging, the effect of the V anvil is a converging action, thus consolidating the mass, and enabling the forger to retain his work directly under the centre of the hammer. This is the more strikingly apparent, as the blows of the hammer upon a round shaft have the effect of causing the mass to assume the elliptical form, forcing out the sides as at AA in every successive blow, and this again, when turned, produces a spongy, porous centre, as shewn in fig. 38. This process is, however, more clearly exemplified in Ryder's forging machines, where all the anvils are of the V form, for the forging of spindles, round bars, and bolts.

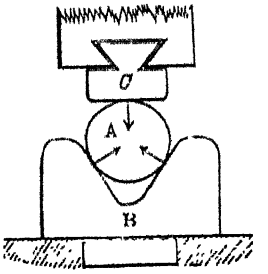


Fig. 36.

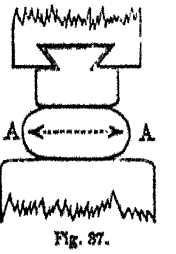


Fig. 37.



Fig. 38.

The next important discovery in the art of forging, is that of Mr Ryder's machine, patented some years since, for forging small articles, which, on account of the rapidity and precision of its operations, demands a notice in passing. It consisted essentially of a series of small anvils about three inches square, supported from below by large screws passing through the frame of the machine. This screw was employed in order that the distance between the hammer and anvil might be accurately adjusted. Between the screw and the anvil, a stuffing of cork was introduced to deaden the effect of the blow. The hammers were arranged over the anvils, and slid up and down in the frame of the machine. The blow was effected by the revolution of an eccentric, acting

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by means of a cradle on the hammer-head, the hammer, however, being lifted again by a strong spiral spring. The hammers made about 700 strokes a-minute. At the side of the machine was a cutter or shears worked by a long lever; with this the articles were cut to the required length as they were finished.

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Figs. 39 and 40 represents this machine as improved by Messrs Platt Brothers of Oldham. A A A A are the

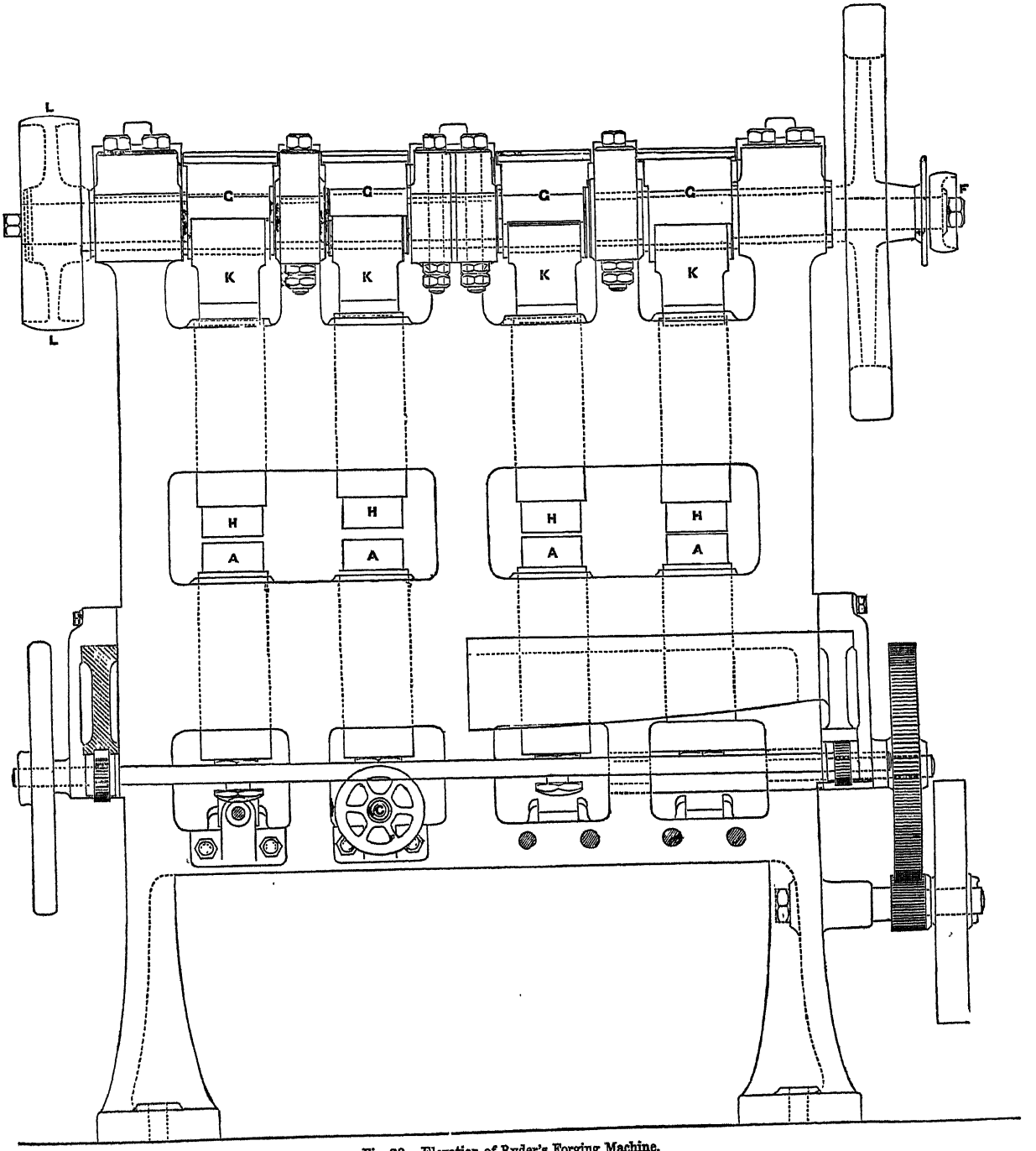


Fig. 39.—Elevation of Ryder's Forging Machine.

anvils supported on a wedge B, instead of the screw, as in Ryder's. This substitution was made because the blows of the hammer tore off the threads of the screw, and the machine soon got out of order. The distance between the hammer and anvil is regulated by forcing forwards the wedge B by the rack and pinion C. The cork was then found insufficient as a stuffing, and an immensely strong spring D was substituted; this spring is formed of a band of steel $1\frac{3}{4}$ inches broad, and $\frac{5}{8}$ thick, coiled in a close spiral 2 inches in diameter, and $6\frac{1}{2}$ long; it answers its purpose admirably. The hammers are shewn at HHHH, supported by springs, one of which is seen in the section at E. The eccentrics GGGG, driven by the shaft FF, in their revolution force down the cradles KKKK, which in their turn act on the tops of the hammers, the springs (E) keep the hammer-head always in contact with the cradles KK. The shaft FF is driven by a strap on the pulley LL. It is evident that, by the revolution of the shaft, the eccentric forces down the hammer, and then allows the spring to lift it again; the rapidity of the strokes is only limited by the power of the spring E to keep the hammer in contact with the cradle; if the eccentric revolves too fast, a violent jerking motion is produced. In Mr Ryder's machine,

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700 strokes a-minute was the maximum; but Messrs Platt Brothers, by increasing the strength of the spring, run as high as 1100. A pair of knife edges, worked by the machine itself, has also been substituted for the hand-

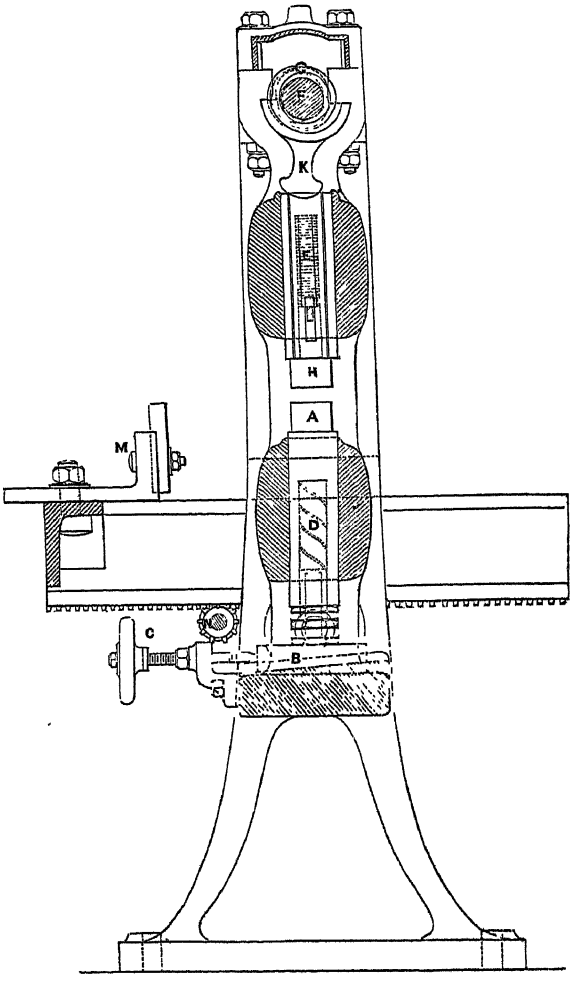


Fig. 40.—End Section.

shears. These perform the work more rapidly and accurately than before, and leave the workman more at liberty. Dies are let into the surfaces of the hammers and anvils, which shape the iron as required.

The rapidity with which this machine executes all kinds of intricate work is truly remarkable; for instance, a bar about $2\frac{3}{4} \times 2\frac{1}{2}$ inches, will be reduced to $1\frac{1}{4} \times 10$ inches, and cut off in a minute. Set screws, bolts, spindles, and all kinds of small work are produced at the same rate. Its precision is very effective; the articles are almost as true as if turned in a lathe, and very accurate as to size and weight. Other machines, called "lifts," have been, and continue to be, used for forging a variety of forms and "*uses;*" but as these partake more or less of the principle employed in Ryder's machine, it will not be necessary to furnish further examples.

In conclusion, we may observe that the facilities afforded by the present age for the forging of malleable iron, are without a parallel in the history of that material. Every known resource has been adopted, and every contrivance and device has been employed to meet the demands of a large and an intricate trade; and looking at the present resources of the country, and the admirable mechanical contrivances for the conversion of crude iron into the malleable state, it assuredly is not unreasonable to look forward to still greater improvements in the manipulations of the forge.

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IV.—THE STRENGTH AND OTHER PROPERTIES OF IRON.

In this section we have to consider the tensile and transverse strengths and powers of resisting compression of cast and malleable iron, as determined by direct experiment upon specimens of the material; and also to examine whether, as has been alleged, the hot-blast process injures the tenacity of the metal.

Cast Iron.—The following tables give the results of experiments undertaken by Mr Hodgkinson and Mr Fairbairn at the request of the British Association, to determine the tensile and transverse strengths of cast-iron derived from the hot and cold blast. The castings for ascertaining the tensile strain were made very strong at the ends, with eyes for the bolts to which the shackles were attached; the middle part, where it was intended that the specimen should break, was cast of a cruciform + transverse section. The four largest castings were broken by the chain-testing machine belonging to the corporation of Liverpool, the others by Mr Fairbairn's lever.

Table I.—*Results of the Experiments on the tensile strength of Cast-Iron.*

Description of Iron.	Number of Experiments.	Mean strength per square inch of section.	
		lbs.	tons. cwts.
Carron iron, No. 2, hot-blast	3	13,505	6 0½
" " cold-blast	2	16,683	7 9
" No. 3, hot-blast	2	17,755	7 18½
" " cold-blast	2	14,200	6 7
Devon (Scotland) iron, No. 3, hot-blast	1	21,907	9 15½
Buffery iron, No. 1, hot-blast	1	13,434	6 0
" cold-blast	1	17,466	7 16
Coed Talon (North Wales) iron, No. 2, hot-blast	2	16,676	7 9
Do. do. cold-blast	2	18,855	8 8

From the same series of experiments we select the following tables, giving the results obtained in regard to the resistance opposed to compression by cast-iron. The specimens employed were cylinders and prisms of various dimensions, and having their faces turned accurately parallel to each other and perpendicular to the axis of the specimen. They were crushed by a lever between parallel steel discs.

Table II.—*Weights required to crush cylinders, &c., of Carron Iron, No. 2, Hot-Blast.*

Diameter of Cylinder in parts of an inch.	Number of Experiments.	Mean Crushing Weight.	Mean Crushing Weight per square inch.	General Mean per square inch.
		lbs.	lbs.	
$\frac{1}{2}$	3	6,426	130,909	121,685 lbs. = 54 tons 6½ cwt.
$\frac{3}{4}$	4	14,542	131,665	
$\frac{7}{8}$	5	22,110	112,805	
$\frac{16}{25} = .64$ . . .	1	35,888	111,560	
Prism base .50 inch square .	3	25,104	100,416	100,788 lbs. = 44 tons 19½ cwt.
Prism base 1·00 × .26 . . .	2	26,276	101,062	

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TABLE III.—*Weights required to crush cylinders, &c., of Carron Iron, No. 2, Cold-Blast.*

Diameter of Cylinder in parts of an inch.	Number of Experiments.	Mean Crushing Weight.	Mean Crushing Weight per square inch.	General Mean per square inch.
		lbs.	lbs.	
1	2	6,088	124,023	125,403 lbs. = 55 tons 19½ cwt.
¾	4	14,190	128,478	
½	7	24,290	123,708	
Equilateral triangle side ·866	2	32,398	99,769	100,631 lbs. = 44 tons 18½ cwt.
Squares—side ½ inch	2	24,538	98,152	
Rectangles base 1·00 × ·243 . .	3	26,237	107,971	
Cylinders ·45 inch diameter and ·75 inch high .	2	15,369	96,634	

TABLE IV.—*Results of Experiments to ascertain the forces necessary to crush short cylinders, &c., of Cast-Iron from various parts of the United Kingdom.*

Description of Iron.	Number of Experiments.	Mean Crushing Weight per square inch.	
		lbs.	tons. cwt.
Devon (Scotch) iron, No. 3, hot-blast	2	145,435	64 18½
Buffery iron, No. 1, hot-blast	4	86,397	38 11¼
,, ,, cold-blast	4	93,385	41 13½
Coed Talon, No. 2, hot-blast	4	82,734	36 18½
,, ,, cold-blast	4	81,770	36 10
Carron iron, No. 2, hot-blast	2	108,540	48 9
,, ,, cold-blast	3	106,375	47 9¾
Carron iron, No, 3, hot-blast	3	133,440	59 11¼
,, ,, cold-blast	4	115,442	51 10¾

The specimens of Carron iron in table IV. were prisms, whose base was $\frac{3}{4} \times \frac{1}{3} = \frac{1}{4}$ inch, and whose height varied from ½ inch to 1 inch. The other specimens were cylinders, whose diameter was about ½ inch, and height varied from ½ inch to 2 inches.

From the above experiments, Mr Hodgkinson concludes that "where the length is not more than about three times the diameter, the strength for a given base is pretty nearly the same." Fracture took place either by wedges sliding off, or by the top and bottom forming pyramids, and forcing out the sides; and the angle of the wedge is nearly constant, a mean of 21 cylinders being 55° 32′.

From the same series of experiments we give the results obtained by Mr Fairbairn, in regard to the effects of time and temperature. The bars employed were cast to be 1 inch square, and 4 feet 6 inches long, and were loaded with permanent weights as under; the deflections being taken at various intervals during a period of fifteen months. Coed-talon hot and cold-blast iron was employed.

TABLE V.—*The Effects of Time on loaded bars of Hot and Cold-blast Iron in their resistance to a transverse strain.*

Permanent load in lbs.	Increase of deflection of cold-blast bars.	Increase of deflection of hot-blast bars.
280	.033	.043
336	.046	.077
392	.140	.088
449	.047	. . .
Mean.	.066	.069

It has been assumed by most writers on the strength of materials, that the elasticity of cast-iron remained perfect to the extent of one-third the weight that would break it. This is, however, a mere assumption, as it has been found that the elasticity of cast-iron is injured with less than one-half that weight, and the question to be solved in the above experiments was, to what extent the material could be loaded without endangering its security; or how long it would continue to support weights, varying from one-half to one-tenth of the load that would produce fracture. These experiments were continued from six to seven years, and the results obtained were, that the bars which were loaded to within $\frac{1}{10}$ of their breaking weight, would have continued to have borne the load, in the absence of any disturbing cause, *ad infinitum;* but the effect of change, either of the same or a lighter load led ultimately to fracture.

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From these facts it is deduced, that so long as the molecules of the material are under strain (however severe that strain may be), they will arrange and accommodate themselves to the pressure, but with the slightest disturbance, whether produced from vibration or the increase or diminution of load, it becomes, under these influences, only a question of time when rupture ensues.

In the following experiments on the relative strengths of coed-talon hot and cold-blast iron to resist transverse strain at different temperatures, the results are reduced to those of bars 2 feet 3 inches between supports, and 1 inch square, as follows:—

TABLE VI.

	Temperature, Fahr.	Specific Gravity.	Modulus of Elasticity.	Breaking weight.	Ultimate deflection.	Power of resisting impact
Cold Blast, No. 2	27°	6.955	12799050	874	.4538	397.7
	32°	6.955	14327450	949 6	.402	382.4
	113°	6.955	14168000	812.9	.336	273.1
Hot Blast, No. 2	20°	6.968	14902900	811 69	.4002	325.0
	32°	6.968	14003350	919.7	.429	395.0
	84°	6.968	14500000	877.5	.421	369.4
Cold Blast, No. 2	192°	...	14398600	743.1	.301	223.7
No. 3	212°	...	...	924.5		
,,	600°	...	...	1033.0		
No. 2	Red by daylight.	...	...	663.3		
,,	Red in dark.	...	...	723.1		
Hot Blast, No. 2	136°	...	13046200	875.7	.389	340.6
,,	187°	...	11012500	688.8	.359	229.3
,,	188°	...	13869500	823.6	.363	298 9
No. 3	212°	...	...	818.4		
,,	600°	...	...	875.8		
No. 3	Red in dark.	...	...	829.7		

From the above it will be seen "that a considerable failure of the strength took place after heating the No. 2 iron from 26° to 190°. At 212°, we have in the No. 3 a much greater weight sustained than by No. 2 at 190°; and at 600° there appears, in both hot and cold-blast, the anomaly of increased strength as the temperature is increased." [1] The above results are, with one exception, in favour of the cold blast, as far as strength is concerned; and in favour of the hot blast, with one exception, as regards power of resisting impact.

The following table gives the results of Mr Fairbairn's experiments on the transverse strength of rectangular cast-iron bars, each bar being reduced to exactly one inch square.

"In the following abstract, the transverse strength, which may be taken as a criterion of the value of each iron, is obtained from the mean of the experiments first on the long bars, 4 feet 6 inches between the supports, and next on those of half the length, or 2 feet 3 inches between supports."

"All the other values are deduced from the 4 feet 6 inches bars."

[1] This probably arises from the greater ductility of the bars at an increased temperature.

TABLE VII.—*General Summary of Results on rectangular bars, as obtained from nearly the whole of the British Iron-Works.—Manchester Memoirs, New Series, Vol. V.*

No. of iron in the scale of strength.	Description of Iron.	No. of Experiments on each.	Specific Gravity.	Modulus of Elasticity in lbs. per square inch, or stiffness.	Breaking weight in lbs. of bars 4 ft. 6 in. between supports.	Breaking weight in lbs. of bars 2 5 in., reduced to 4 ft. 6 in. between supports.	Mean breaking weight in lbs. (S.)	Ultimate deflection of 4 ft 6 in. bars in parts of an inch.	Power of the 4 ft. 6 in. bars to resist impact.	Colour.	Quality.
1	Ponkey, No. 3, cold-blast . .	4	7·122	17,211,000	567	595	581	1·747	992	Whitish grey	Hard
2	Devon, No 3, hot-blast* . .	2	7·251	22,473,650	537	...	537	1·090	589	White	"
3	Oldberry, No. 3, hot-blast : .	5	7·500	22,733,400	543	537	530	1.005	549	"	"
4	Carron, No. 3, hot-blast* . .	2	7·056	17,873,100	520	524	527	1·365	710	Whitish grey	"
5	Eglinton, No. 4, from prepared coke†	6	...	...	515	...	515	1·460	751	Light grey	Rather hard
6	Beaufort, No. 3, hot-blast . .	5	7·069	16,802,000	505	529	517	1·599	807	Dullish grey	Hard
7	Butterley	4	7·038	15,379,500	489	515	502	1·815	889	Dark grey	Soft
8	Bute, No. 1, cold-blast . . .	4	7·066	15,163,000	495	487	491	1·764	872	Bluish grey	"
9	Windmill End, No. 2, cold-blast	4	7·071	16,490,000	483	495	489	1·581	765	Dark grey	Hard
10	Old Park, No. 2, cold-blast .	5	7·049	14,607,000	441	529	485	1·621	718	Grey	Soft
11	Beaufort, No. 2, hot-blast . .	4	7·108	16,301,000	478	470	474	1·512	729	Dull grey	Hard
12	Low Moor, No. 2, cold-blast .	4	7·055	14,569,500	462	483	472	1·852	855	Dark grey	Soft
13	Buffery, No. 1, cold-blast* .	5	7·079	15,381,200	463	...	463	1·550	721	Grey	Rather hard
14	Brimbo, No. 2, cold-blast . .	5	7·017	14,911,666	466	453	459	1·748	815	Light grey	"
15	Apedale, No. 2, hot-blast . .	3	7·017	14,852,000	457	455	456	1·730	791	"	Stiff
16	Oldberry, No. 2, cold-blast . .	4	7·059	14,307,500	453	457	455	1·811	822	Dark grey	Rather soft
17	Pentwyn, No. 2	4	7·038	15,193,000	438	473	455	1·484	650	Bluish grey	Hard
18	Maesteg, No. 2	5	7·038	13,959,500	453	455	454	1·957	886	Dark grey	Rather soft
19	Muirkirk, No. 1, cold-blast* .	4	7·113	14,003,550	443	464	453	1·734	770	Bright grey	Fluid
20	Adelphi, No. 2, cold-blast . .	5	7·080	13,815,500	441	457	449	1·759	777	Light grey	Soft
21	Blania, No. 3, cold-blast . .	5	7·159	14,281,466	433	464	448	1·726	747	Bright grey	Hard
22	Devon, No. 3, cold-blast . .	4	7·285	22,907,700	448	...	448	·790	353	Light grey	"
23	Gartsherrie, No. 3, hot-blast .	5	7·017	13,894,000	427	467	447	1·557	998	"	Soft
24	Eglinton, No. 4, common coke	6	...	...	447	...	447	1·870	798	Dull grey	Rather hard
25	Frood, No. 2, cold-blast . .	5	7·031	13,112,666	460	434	447	1·825	841	Light grey	Open
26	Lane End, No. 2	3	7·028	15,787,666	444	...	444	1·414	629	Dark grey	Soft
27	Carron, No. 3, cold-blast . .	5	7·094	16,246,966	444	443	443	1·336	593	Grey	"
28	Dundyvan, No. 3, cold-blast .	4	7·087	16,534,000	456	430	443	1·469	674	Dull grey	Rather soft
29	Maesteg (marked red) . . .	5	7·038	13,971,500	440	444	442	1·887	830	Bluish grey	Fluid
30	Corbyns Hall, No. 2	5	7·007	13,845,866	430	454	442	1·687	727	Grey	Soft
31	Pontypool, No. 2	5	7·080	13,136,500	439	441	440	1·857	816	Dull blue	Rather soft
32	Walbrook, No. 3	5	6·979	15,394,766	432	449	440	1·443	625	Light grey	Rather hard
33	Milton, No. 3, hot-blast . . .	4	7·051	15,852,500	427	449	438	1·368	585	Grey	"
34	Buffery, No. 1, hot-blast* . .	3	6·998	13,730,500	436	...	436	1·640	721	Dull grey	Soft
35	Level, No. 1, hot-blast . . .	5	7·080	15,452,500	461	403	432	1·516	699	Light grey	"
36	Pant, No. 2	5	6·975	15,280,900	408	455	431	1·251	511	"	Rather hard
37	Level, No. 2, hot-blast . . .	6	7·031	15,241,000	419	439	429	1·358	570	Dull grey	Soft
38	W. S. S., No. 2	5	7·041	14,953,333	413	446	429	1·339	554	Light grey	"
39	Eagle Foundry, No. 2, hot-blast	4	7·038	14,211,000	408	446	427	1·512	618	Bluish grey	"
40	Elsicar, No. 2, cold-blast . .	4	6·928	12,586,500	446	408	427	2·224	992	Grey	"
41	Varteg, No. 2, hot-blast . .	4	7·007	15,012,000	422	430	426	1·450	621	"	Hard
42	Coltham, No. 1, hot-blast . .	5	7·128	15,510,066	464	385	424	1·532	716	Whitish grey	Rather soft
43	Carroll, No. 2, cold-blast . .	4	7·069	17,036,000	430	408	419	1·231	530	Grey	Hard
44	Muirkirk, No. 1, hot-blast* .	4	6·953	13,294,400	417	...	418	1·570	656	Bluish grey	Soft
45	Brierley, No. 2	5	7·185	16,156,133	406	...	418	1·222	494	Dark grey	"
46	Coed-Talon, No. 2, hot-blast* .	4	6·969	14,322,500	409	424	416	1·882	771	Bright grey	"
47	Coed-Talon, No. 2, cold-blast*	5	6·955	14,304,000	403	418	413	1·470	600	Grey	"
48	Monkland, No. 2, hot-blast .	3	6·916	12,259,500	402	404	408	1·762	709	Bluish grey	"
49	Ley's Works, No. 1, hot-blast	3	6·957	11,539,333	392	...	392	1·890	742	"	"
50	Milton, No. 1, hot-blast . .	4	6·976	11,974,500	353	386	369	1·525	532	Grey	Soft and fluid
51	Plas Kynaston, No. 2, hot-blast	5	6·916	13,341,633	378	337	357	1·366	517	Light grey	Rather soft

* The irons with asterisks are taken from the experiments on hot and cold blast iron made by Mr Hodgkinson and Mr Fairbairn for the British Association for the Advancement of Science. See Seventh Report, vol. vi.

The modulus of elasticity was usually taken from the deflection caused by 112 lbs. on the 4 feet 6 inch bars.

To find from the above the breaking weight in rectangular bars generally: calling b and d the breadth in inches, and l the distance between the supports in feet; and putting 4·5 for 4 feet 6 inches, we have $\frac{4{\cdot}5\, b\, d^2\, S}{l}$ = breaking weight in lbs. The value of S being taken from the table above.

For Example:—What weight would be necessary to break a bar of Lowmoor iron, 2 inches broad, 8 inches deep, and 6 feet between the supports? According to the rule given above we have b=2 inches, d=8 inches, l=6 feet, S=472, by the table. Then

$$\frac{4{\cdot}5 \times b\, d^2\, S}{l} = \frac{4{\cdot}5 \times 2 \times 9 \times 472}{6} = 6372 \text{ lbs.}$$

† This iron was melted in the cupola, from coke entirely freed from sulphur, by Mr C. Calvert's process.

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With regard to the comparative strengths of hot and cold-blast iron, the following extracts from Mr Hodgkinson's report, read before the British Association, give the general results of his experiments:—

TABLE VIII.—*Carron Iron*, No. 2.

	Cold-blast.	Hot-blast.	Ratio representing Cold-blast by 1000.	
Tensile strength in lbs. per inch square	16683 (2)	13505 (3)	1000 : 809	
Compressive do. in lbs. per inch, from castings torn asunder	106375 (3)	108540 (2)	1000 : 1020	Mean 997.
Do. from prisms of various forms	100631 (4)	100738 (2)	1000 : 1001	
Do. from cylinders	125403 (13)	121685 (13)	1000 : 970	
Transverse strength from all the experiments	(11)	(13)	1000 : 991	
Power to resist impact	(9)	(9)	1000 : 1005	
Transverse strength of bars 1 in. square in lbs.	476 (3)	463 (3)	1000 : 973	
Ultimate deflection of do. in inches	1·313 (3)	1 337 (3)	1000 : 1018	
Modulus of elasticity in lbs. per square inch	17270500 (2)	16085000 (2)	1000 : 931	
Specific gravity	7066	7046	1000 : 997	

TABLE IX.—*Devon Iron*, No. 3.

	Cold-blast.	Hot-blast.	Ratio representing Cold-blast by 1000.
Tensile strength	...	21907 (1)	
Compressive do	...	145435 (4)	
Transverse do. from the experiments generally	(5)	(5)	1000 : 1417
Power to resist impact	(4)	(4)	1000 : 2786
Transverse strength of bars 1 inch square	448 (2)	537 (2)	1000 : 1199
Ultimate deflection do.	79 (2)	1 09 (2)	1000 : 1380
Modulus of elasticity do.	22907700 (2)	22473650 (2)	1000 : 981
Specific gravity	7.295 (4)	7.229 (2)	1000 : 991

TABLE X.—*Buffery Iron*, No. 1.

Tensile strength	17466 (1)	13434 (1)	1000 : 769
Compressive do.	93366 (4)	86397 (4)	1000 : 925
Transverse do.	(5)	(5)	1000 : 931
Power to resist impact	(2)	(2)	1000 : 963
Transverse strength of bars one inch square	463 (3)	436 (3)	1000 : 942
Ultimate deflection do.	1·55 (3)	1·64 (3)	1000 : 1058
Modulus of elasticity do.	15381200 (2)	13730500 (2)	1000 : 893
Specific gravity	7·079	6·998	1000 : 989

TABLE XI.—*Coed Talon Iron*, No. 2.

Tensile strength	18855 (2)	16676 (2)	1000 : 884
Compressive do.	81770 (4)	82739 (4)	1000 : 1012
Specific gravity	6.955 (4)	6.968 (3)	1000 : 1002

TABLE XII.—*Carron Iron*, No. 3.

Tensile strength	14200 (2)	17755 (2)	1000 : 1250
Compressive do.	115442 (4)	133440 (3)	1000 : 1156
Specific gravity	7.135	7.056 (1)	1000 : 989

"Beginning with No. 1 iron, of which we have a specimen from the Buffery Iron-Works, a few miles from Birmingham, we find the cold-blast iron somewhat surpassing the hot-blast in all the following particulars: direct tensile strength, compressive strength, transverse strength, power to resist impact, modulus of elasticity or stiffness, specific gravity; whilst the only numerical advantage possessed by the hot-blast iron is, that it bends a little more than the cold-blast before it breaks.

"In the irons of the quality No. 2, the case seems in some degree different; in these the advantages of the rival kinds seem to be more nearly balanced. They are still, however, rather in favour of the cold-blast. The manufacture of iron.

"So far as my experiments have proceeded, the irons of No. 1 have been deteriorated by the hot-blast; those of No. 2 appear also to have been slightly injured by it, while the irons of No. 3 seem to have benefited by its mollifying powers. The Carron iron No. 3 hot-blast, resists both tension and compression with considerably more energy than that made with the cold-blast; and the No. 3 hot-blast iron from the Devon works, in Scotland, is one of the strongest cast irons I have seen, whilst that made by the cold-blast is comparatively weak, though its specific gravity is very high, and higher than in the hot. The extreme hardness of the cold-blast Devon iron above prevented many experiments that would otherwise have been made upon it, no tools being hard enough to form the specimens. The difference of strength in the Devon irons is peculiarly striking.

"From the evidence here brought forward, it is rendered exceedingly probable that the introduction of a heated blast in the manufacture of cast iron has injured the softer irons, whilst it has frequently mollified and improved those of a harder nature, and, considering the small deterioration that the irons of quality No. 2 have sustained, and the apparent benefit to those of No. 3, together with the great saving effected by the heated blast, there seems good reason for the process becoming as general as it has done."

The following table gives a general summary of the results of Mr Fairbairn's experiments on the strength of iron after successive meltings. The iron used was Eglinton No. 3 hot-blast, and was melted eighteen times, three bars being cast at each melting. These bars, which were about 1 inch square and 5 feet long, were placed upon supports 4 feet 6 apart, and broken by a transverse strain. Cubes, from the same irons, exactly 1 inch square, were then crushed between parallel steel bars, by a large wrought-iron lever.

In the following Table XIII., the results on transverse strain are reduced to those on bars exactly 1 inch square and 4 feet 6 inches between supports.

No. of melting	Specific gravity.	Mean breaking weight in lbs.	Mean ultimate deflection in inches.	Power to resist impact.	Mean crushing weight of inch cubes in tons.
1	6.969	490.0	1.440	705.6	
2	6.970	441.9	1.446	630.9	
3	6.886	401.6	1.486	596.7	
4	6.938	413.4	1.260	520.8	
5	6.842	431.6	1.503	648.6	41.9
6	6.771	438.7	1.320	579.0	
7	6.879	449.1	1.440	646.7	
8	7.025	491.3	1.753	861.2	
9	7.102	546.5	1.620	885.3	
10	7.108	566.9	1.626	921.7	
11	7.113	651.9	1.636	1066.5	64.3
12	7.160	692.1	1.666	1153.0	
13	7.134	634.8	1.646	1044.9	
14	7.530	603.4	1.513	912.9	
15	7.248	371.1	0.643	238.6	
16	7.330	351.3	0.566	198.5	82.8
17	lost.				
18	7.385	312.7	0.476	148.8	

In the above results it will be observed that the maximum of strength, elasticity, &c., is only arrived at after the metal has undergone twelve successive meltings. It is probable that other metals and their alloys may follow the same law, but that is a question that has yet to be solved, probably by a series of experiments

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requiring a considerable amount of time and labour to accomplish, but which we may venture to hope will be shortly forthcoming from the same author.

In the resistance of the different meltings from the same iron, to a force tending to crush them, we have the following results.

TABLE XIV.

Number of meltings.	Resistance to compression per square inch, in tons.	Remarks.
1	44.0	
2	43.6	
3	41.1	
4	40.7	
5	41.1	
6	41.1	
7	40.9	
8	41.1	
9	55.1	
10	57.7	
11 } 11 }	Mean 69.8	
12	73.1	In this experiment the cube did not bed properly on the steel plates, otherwise it would have resisted a much greater force.
13	66 0	
14	95.9	
15	76.7	
16	70.5	
18	88.0	

Nearly the whole of the specimens were fractured by wedges which split or slid off diagonally at an angle of from 52° to 58°.

MALLEABLE IRON.—The greatly extended application of wrought iron to every variety of construction renders an investigation of its properties peculiarly interesting. It is now employed more extensively than cast iron; and, on account of its ductility and strength, nearly two thirds of the weight of material may in many cases be saved by its employment, while great lightness and durability are secured. Its superiority is especially evident in constructions where great stiffness is not required, but on the other hand any degree of rigidity may be obtained by the employment of a tubular or cellular structure, and this may be seen in the construction of wrought iron tubular bridges, beams, and iron shops. The material of malleable iron which is making such vast changes in the forms of construction, cannot but be interesting and important, and considering that the present is far from the limit of its application, we shall endeavour to give it that degree of attention which the importance of the subject demands.

From the forge and the rolling mill we derive two distinct qualities of iron, known as "*red short*" and "*cold short.*" The former is the most ductile, and is a tough fibrous material which exhibits considerable strength when cold; the latter is more brittle, and has a highly crystalline fracture almost like cast-iron; but the fact is probably not generally known, that the brittle works as well and is as ductile under the hammer as the other when at a high temperature.

Mr Charles Hood, in a paper read some time ago before the Institute of Civil Engineers, went into the subject of the change in the internal structure of iron, independently of and subsequently to the processes of its manufacture. After adducing several instances of tough fibrous malleable iron becoming crystalline and brittle during their employment, he attributes these changes to the influence of percussion, heat, and magnetism, but questions whether either will produce the effect *per se*. Mr Hood continues, "The most common exemplification of the effect of heat in crystallizing fibrous iron is, by breaking a wrought-iron furnace bar, which, whatever quality it was of in the first instance, will in a short time invariably be converted into crystallized iron, and by heating and rapidly cooling, by quenching with water a few times any piece of wrought iron, the same effect may be far more speedily produced. In these cases we have at least two of the above causes in operation—heat and magnetism. In every instance of heating iron to a very high temperature, it undergoes a change in its electric or magnetic condition; for at very high temperatures iron loses its magnetic powers, which return as it gradually cools to a lower temperature. In the case of quenching the iron with water, we have a still more decisive assistance from the electric and magnetic forces; for Sir Humphrey Davy long since pointed out that all cases of vaporization produced negative electricity in the bodies in contact with the vapour; a fact which has lately excited a good deal of attention in consequence of the discovery of large quantities of negative electricity in effluent steam." Mr Hood then proceeds to the subject of percussion. "In the manufacture of some descriptions of hammered iron, the bar is first rolled into shape, and then one-half the length of the bar is heated in a furnace, and immediately taken to the tilt hammer and hammered, and the other end of the bar is then heated and hammered in the same manner. In order to avoid any unevenness in the bar, or any difference in its colour where the two distinct operations have terminated, the workman frequently gives the bar a few blows with the hammer upon that part which he first operated upon. That part of the bar immediately becomes crystallized, and so extremely brittle that it will break to pieces by merely throwing it on the ground, though all the rest of the bar will exhibit the best and toughest quality imaginable. This change, therefore, has been produced by percussion (as the primary agent) when the bar is at a lower temperature than the welding heat. Here it must be observed that it is not the excess of hammering which produces the effect, but the absence of a sufficient degree of heat, at the time that the hammering takes place; and the evil may probably be all produced by four or five blows of the hammer if the bar happens to be of a small size. In this case we witness the combined effects of percussion, heat, and magnetism. When the bar is hammered at the proper temperature, no such crystallization takes place, because the bar is insensible to magnetism; but as soon as the bar becomes of that lower degree of temperature at which it can be affected by magnetism, the effect of the blows it receives is to produce magnetic induction, and that magnetic induction and consequent polarity of its particles, when assisted by further vibrations from additional percussion, produces a crystallized texture."

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The crystallization of perfectly fibrous and ductile wrought-iron has long been a subject of dispute, and although we agree with most of Mr Hood's views, we are not altogether prepared to admit that the causes assigned are the only ones concerned in producing the change, or that more than one is *necessary*. On the occasion of the accident on the Versailles Railway some years since, the whole array of science and practice were brought to bear upon the elucidation of the cause. Undoubtedly the broken axle presented a crystalline fracture, but it has never been ascertained how far heat and magnetism were in operation as in the case of an axle, and more especially a crank-axle, the constant vibration caused by irregularities in the way and the weight of the engine appears to be quite sufficient to occasion the breakage without aid from the other forces. Undoubtedly in almost all cases of the sudden fracture of axles or

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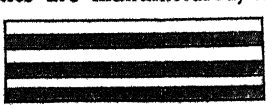
wrought-iron bars, during employment, the fracture presents a crystalline structure, but we believe that any molecular disturbance, such as impact, can effect this, the only question being, how long will the material sustain the action before it breaks. This question has been attempted to be decided by direct experiment under the direction of the Commission on Railway Structures. It was found that with cast-iron bars subjected to long continued impacts, "when the blow was powerful enough to bend the bars through one-half of their ultimate deflection (that is to say, the deflection which corresponds to their fracture by dead pressure), no bar was able to stand 4000 of such blows in succession. But all the bars (when sound) resisted the effects of 4000 blows, each bending them through one-third of their ultimate deflection. These results were confirmed by experiments with a revolving cam which deflected the bars.

"In wrought-iron bars no very perceptible effect was produced by 10,000 successive deflections by means of a revolving cam, each deflection being due to half the weight which, when applied statically, produced a large permanent flexure." These results agree with those obtained by Mr Fairbairn in regard to the effects of time on loaded bars of cast-iron, already given.

Arago and Wollaston have paid considerable attention to this subject, the latter having been the first to point out that native iron is disposed to break in octohedra and tetrahedra, or combinations of these forms. The law which leads to fracture in wrought-iron from changes in the molecular structure operates with more or less intensity in other bodies; repeated disturbances, in turn destroying the cohesive force of the material by which they are held together. A French writer of eminence, Arago, appears to consider the crystallization of wrought-iron to be due to the joint action of time and vibration, but we think with Mr Hood that time and its duration depends entirely upon the intensity of the disturbing forces, and, moreover, that the time of fracture is retarded or accelerated in a given ratio to the intensity with which these forces are applied.

From the above statements we may safely deduce the fact, that it is essential to the use of this material to consider the purposes to which it is applied, the forms to which it may be subjected, and the conditions under which it may be placed, in order to arrive at just conclusions as to the proportions, in order to afford to the structure (whatever that may be), ample security in its powers of resistance to strain.

On the subject of the strength of wrought-iron, we have before us the researches of Mr Fairbairn, in a paper entitled, "An Inquiry into the Strength of wrought-iron plates and their rivetted joints, as applied to Shipbuilding and Vessels exposed to severe strains."[1] In that communication it is shewn, from direct experiments, that in plates of rolled iron there is no material difference between those torn asunder in the direction of the fibre, and those torn asunder across the fibre. This uniformity of resistance arises probably from the way in which the plates are manufactured, which is generally out of flat bars, cut and piled upon each other, as at A, one-half transversely and the other half longitudinal in the line of the pile. From this it will be seen that in preparing the bloom or shingle for the rollers, the fibre is equally divided, and the only superiority that can possibly be attained is in the rolling which draws the shingle rather more in the direction of the length of the plate than its breadth.



In the following table we have the results of the experiments.

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Quality of Plates.	Mean breaking weight in the direction of the fibre, in tons per square inch.	Mean breaking weight across the fibre, in tons per square inch.
Yorkshire plates . . .	25.770	27 490
Yorkshire plates . . .	22.760	26.037
Derbyshire plates . . .	21.680	18.650
Shropshire plates . . .	22.826	22.000
Staffordshire plates . . .	19.563	21.010
Mean . . .	22.519	23.037

Or as 22.5, 23.0, equal to about $\frac{1}{45}$ in favour of those torn across the fibre.

From the above it is satisfactory to know, so far as regards uniformity in the strength of plates, that the liability to rupture is as great when drawn in one direction as in the other; and it is not improbable, that the same properties would be exhibited, and the same resistance maintained, if the plates were drawn in any particular direction obliquely across the fibrous or laminated structure.

From the same author we select the results of a series of experiments on the tensile strength of S C bars of different lengths, and about $1\frac{3}{8}$ in diameter. The following tables gives the strains required for each of four successive breakages of the same pieces of iron. These experiments are highly interesting, as they not only confirm those made upon plates, but they indicate a progressive increase of strength, notwithstanding the elongation and the reduced sectional area of the bars. These facts are of considerable value, as they distinctly shew that a severe tensile strain is not seriously injurious to the bearing powers of wrought-iron, even when carried to the extent of or increased four times repeated, as was done in these experiments. In practice it may not be prudent to test bars and chains to their utmost limit of resistance; it is nevertheless satisfactory to know that in cases of emergency those limits may be approached without incurring serious risk of injury to the ultimate strength of the material.

The following abstract gives the results of the experiments:—

Length between the nippers.	Breaking Strain in tons.	Mean Elongation in inches.
Inches.		
120	32·21	26·0
42	32·125	9·8
36	32·35	8·8
24	32·00	6·2
10	32·29	4·2

"As all these experiments were made upon the same description of iron, it may be fairly inferred that the length of a bar does not in any way affect its strength."

Reduction of the above Table.

Length of bar.	Elongation.	Elongation per unit of length.
Inches.		
120	26·0	·216
42	9·8	·233
36	8·8	·244
24	6·2	·258
10	4·2	·420

[1] Philosophical Transactions, part ii., 1850, p. 677.

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"Here it appears that the rate of elongation of bars of wrought-iron increases with the decrease of their length; thus while a bar of 120 inches had an elongation of ·216 inch per unit of its length, a bar of ten inches has an elongation of ·42 inch per unit of its length, or nearly double what it is in the former case. The relation between the length of and its maximum elongation per unit, may be approximately expressed by the following formula, viz.—

$$l = \cdot 18 + \frac{2 \cdot 5}{L}$$

where L represents the length of the bar, and l the elongation per unit of the length of the bar."

The above results are not without value, as they exhibit the ductility of wrought-iron at a low temperature, as also the greatly increased strength it exhibits with a reduced sectional area under severe strain.

On the transverse strength of wrought-iron it will not be necessary to enlarge, as we have numerous examples before us in the experiments undertaken to determine the strength and form of the Britannia and Conway Tubular Bridges.[1] In these experiments will be found an entirely new description of form and construction, which have emanated from them, and which have led to a new era in the history of bridges, and the application of wrought iron to other purposes besides those in connection with buildings, and its greatly extended application to the useful arts. For further information on this subject we refer the reader to Mr Fairbairn's [2] and Professor Hodgkinson's works, in both of which will be found data sufficient to establish the great superiority of malleable over cast iron, or any other material, either as regards strength or economy in its application.

On the resistance of wrought-iron plates to a force tending to burst them, Rondelet has shewn that it requires a force of 70,000 lbs. per square inch to produce fracture, and Mr Fairbairn's experiments proved that a wrought-iron plate of one-quarter of an inch thick resisted a pressure from a ball 3 inches in diameter, equal to that required to rupture a 3 inch oak plank.

At the request of the British Association, Dr. Thomson of Glasgow examined the chemical constitution of hot-blast iron, and he gives the following as the result of his inquiry:—

"(1.) The specific gravity of hot-blast iron is greater than that of cold-blast.

"The following are the specific gravities of eight specimens of cold-blast iron:

1st. Muirkirk	6·410	5th. Ditto	6·775
2d. Ditto	6·435	6th. From pyrites	6·9444
3d. Ditto	6·493	7th. From Carron	6·9888
4th. Ditto	6·579	8th. Clyde Iron-Works	7·0028

"The specific gravity of the Muirkirk iron is considerably less than of that smelted at Carron and the Clyde Iron-Works; the mean of the eight specimens is 6·7034.

"It has been hitherto supposed that the difference between cast-iron and malleable iron consists in the presence of carbon in the former, and its absence from the latter; in other words, that cast-iron is a carburet of iron. But in all the specimens of cast-iron which we analysed we constantly found several other ingredients besides iron and carbon. Manganese is pretty generally present in minute quantity, though in one specimen it amounted to no less a quantity than 7 per cent.; its average amount is 2 per cent. *Silicon* is never wanting, though its amount is exceedingly variable, the average quantity is about 1½ per cent.; some specimens contained 3½ per cent. of it, while others contain less than a half per cent. Aluminum is very rarely altogether absent, though its amount is more variable than that of silicon. Its average amount is 2 per cent.; sometimes it exceeds 4½ per cent., and sometimes it is not quite 1-5000th part of the weight of the iron.

"Calcium and magnesium are sometimes present, but very rarely, and the quantity does not much exceed 1-5th per cent. In a specimen of cast-iron which I got from Mr Neilson, and which he had smelted from pyrites, there was a trace of copper, showing that the pyrites employed was not quite free from copper; and in a specimen from the Clyde Iron-Works there was a trace of sulphur. The following table exhibits the composition of six different specimens of cast-iron, No. 1, analyzed in my laboratory, either by myself or by Mr. John Tennent.

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	Muir-kirk.	Muir-kirk.	Muir-kirk.	Pyrites.	Carron.	Clyde.	Mean.
Iron, ...	90·98	90·29	91·38	89·442	94·010	90·824	91·154
Copper, ...	...	...	...	0·288	...	...	
Manganese,	...	7·14	2·00	...	0·626	2·458	2·037
Sulphur, ...	...	...	...	...	...	0·045	
Carbon, ...	7·40	1·706	4·88	3·600	3·086	2·458	3·855
Silica, ...	0·46	0·830	1·10	3·220	1·006	0·450	1.177
Aluminum,	0·48	0·016	...	3·776	1·032	4·602	1·651
Calcium, ..	...	0·018	0 20	...	...	...	
Magnesium,	...	...	...	...	...	0·340	

"The constant constituents of cold-blast cast-iron, No. 1, are iron, manganese, carbon, silicon, and aluminum. The occasional constituents are copper, sulphur, calcium, and magnesium. These occur so rarely, and in such minute quantity, that we may overlook them altogether.

"The constant constituents occur in the following mean atomic proportions:

22 atoms iron	= 77·00
½ atom manganese	= 1·75
4·36 atoms carbon	= 3·27
1 atom silicon	= 1·00
1½ aluminum	= 1·40—84·42

"(2). I examined only one specimen of cast-iron, No. 2. It was an old specimen, said to have come from Sweden, but I have no evidence of the correctness of this statement. Its specific gravity was 7·1633 higher than any specimens of cold-blast iron, No. 1. Its constituents were,

Iron	93·594
Manganese	0·708
Carbon	3·080
Silicon	1·262
Aluminum	0·732
Sulphur	0·038—99·414

"The presence of sulphur in this specimen leads to the suspicion that it is not a Swedish specimen; for as the Swedish ore is magnetic iron, and the fuel charcoal, the presence of sulphur in the iron is very unlikely.[3]

"In this specimen, the atoms of iron and manganese are to those of carbon, silicon, and aluminum, in the proportion of 4½ to one, instead of 3½ to one, as in cast-iron No. 1.

"The atoms of carbon, silicon, and aluminum, approach the proportions of 7, 2, and 1, so that in cast-iron, No. 2, judging from one specimen, there is a greater proportion of carbon, compared with the silicon and aluminum, than in cast-iron, No 1.

"Mr. Tennent analysed a specimen of hot-blast iron, No. 2, from Gartsherry. Its specific gravity was 6·9156, and its constituents,

		Atoms.	
Iron	90·542	25·86	3·72
Manganese	2·764	0·78	
Carbon	3·094	4·05	
Silicon	0·680	0·68	1·
Aluminum	2·894	2·31	
Sulphur	0·023	0·011	
	99.997		

So that it resembles cast-iron, No. 1, in the proportion of its constituents. The carbon is almost the same as in cold-blast iron, No. 2, but the proportion of aluminum is four times as great, while the silicon is little more than half as much. The atomic ratios are, carbon, 4·; silicon, 0·67; aluminum, 2·28.

"3. Five specimens of hot-blast cast-iron, No. 1, were analysed. Two of these were from Carron, and three from the Clyde Iron-Works, where the hot-blast originally began; and where, of course, it has been longest in use. The specific gravity of these specimens was found to be as follows:

[1] See Mr Fairbairn's and Mr Edwin Clark's works on the Conway and Britannia Tubular Bridges.
[2] "On the application of cast and wrought iron to building purposes," and "Useful Information for Engineers."
[3] I have been told by Mr Mushet that the Swedes add sulphur to their iron No. 2.

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1st. From Clyde Works	7·0028
2d. From Carron	7·0721
3d. From Carron	7·0721
4th. From Clyde Works	7·1022
Mean	7·0623

"It appears from this, that the hot-blast increases the specific gravity of cast-iron by about 1-22d part. It approaches nearer the specific gravity of cast-iron, No. 2, smelted by cold air, than to that of No. 1.

The following table exhibits the constituents of these four specimens:—

	Clyde.	Carron.	Carron.	Clyde.	Clyde.
Iron	97·096	95·422	96·09	94·966	94·345
Manganese	0·332	0·336	0·41	0·160	3·120
Carbon	2·460	2·400	2·48	1·560	1·416
Silicon	0·280	1·820	1·49	1·322	0·520
Aluminum	0·385	0·488	0·26	1·374	0·599
Magnesium	...	...	...	0·792	...
	100·55	100·466	100·73	100·174	100·

The mean of these analyses gives us,

		Atoms.	
Iron	95·584	or 27 31	6·5
Manganese	0·871	or 0·249	
Carbon	2·099	or 2·79	1·
Silicon	1·086	or 1·086	
Aluminum	0·422	or 0·337	
	101·285		

Or, in the proportion of 6½ atoms of iron and manganese to 1 atom of carbon, silicon, and aluminum. In the cold-blast cast-iron we have,

	Iron.	Carbon, &c.
In No. 1	3½ atoms	1 atom.
In No. 2	4½	1 —
In hot-blast	6½	1 —

"Thus it appears, that when iron is smelted by the hot-blast its specific gravity is increased, and it contains a greater proportion of iron, and a smaller proportion of carbon, silicon, and aluminum, than when smelted by the cold-blast.

V. THE STATISTICS OF THE IRON TRADE.

This article has already extended so much beyond the limits of our inquiry, that we must confine ourselves to an exceedingly brief notice of the statistics of this important manufacture. In 1740 the iron trade suffered a sudden check from a falling off in the supply of charcoal, coal or coke not having been employed at that time for smelting. The annual production seems to have decreased from 180,000 to about 17,350 tons per annum. This comparatively small quantity was smelted in the following counties, viz.—

	Furnaces.	Tons.		Furnaces.	Tons.
Brecon	2	600	Nottingham	1	200
Glamorgan	2	400	Salop	6	2,000
Carmarthen	1	100	Stafford	2	1,000
Cheshire	3	1,700	Worcester	2	700
Denbigh	2	550	Sussex	10	1,400
Gloucester	6	2,850	Warwick	2	700
Hereford	3	1,350	York	6	1,400
Hampshire	1	200	Derby	4	800
Kent	4	400			
Monmouth	2	900		59	17,350

	Tons.	cwt.	qrs.
Annual average for each furnace	294	1	1
Weekly do. do.	5	13	0

Soon afterwards the difficulties in the way of using coal were overcome, and the manufacture extended rapidly. The number of charcoal furnaces decreased, but the quantity produced by each was considerably increased. The following table shews the state of the trade in 1788:—

The manufacture of iron.

	Charcoal.			Coke.		
	Furnaces.	Tons each.	Total.	Furnaces.	Tons each.	Total.
Gloucester	4	650	2600			
Monmouth	3	700	2100			
Glamorgan	3	600	1800	6	1100	6,600
Carmarthen	1	400	400			
Merioneth	1	400	400			
Shropshire	3	600	1800	21	1100	23,100
Derby	1	300	300	7	600	4,200
York	1	600	600	6	750	4,500
Westmorland	1	400	400			
Cumberland	1	300	300	1	700	700
Lancashire	3	700	2100			
Sussex	2	150	300			
Stafford	...	...	...	6	750	4,500
Cheshire	...	...	...	1	600	600
Brecon	...	...	...	2	800	1,600
Stafford (about to blow)	...	...	...	3	800	2,400
	24	...	13,100	53	...	48,200

	Charcoal. Tons.	cwt.	qrs.	*Coke.* Tons.	cwt.	qrs.
Annual average from each furnace	545	16	2	907	0	0
Weekly do. do.	10	9	3	17	9	0

In the same year were erected and blowing in Scotland the following furnaces:—

	Charcoal.			Coke.		
	Furnaces.	Tons each.	Total.	Furnaces.	Tons each.	Total.
Goatfield	1	700	700			
Bunawe	1	700	700			
Carron	...	...	...	4	1000	4000
Wilsontown	...	...	...	2	800	1600
	2	...	1400	6	...	5600

Total quantity of charcoal iron, in Britain, in 1788	14,500
Do. coke do. do.	53,800
Total quantity of iron, in Britain, in 1788	68,300
Do. do. 1740	17,350
Increased produce of pig iron	50,950

About the year 1796 it was contemplated by Mr Pitt to add to the revenue by a tax on coal. This met with a powerful opposition on the part of the manufacturers and consumers, especially those in the iron trade. A committee was appointed, witnesses were examined, and the measure abandoned as unwise and impracticable. The following table exhibits an abstract of the facts collected, and shews the rapid progress of the iron trade in the eight preceding years:—

Counties.	No. of Furnaces.	Excise Return of Iron made.	Supposed quantity by the Trade.	Actual Return.
Chester	2	4,710	2,200	1,958½
Cumberland	4	5,144	3,000	2,034
Derby	3	2,138	2,138	2,107
Gloucester	2	380	380	380
Hereford	5	2,850	2,850	2,529
York	22	21,984	21,987	17,947
Shropshire	23	68,129	43,360	32,969
Wales	28	45,994	42,606	35,485
Stafford	14	15,820	15,256	13,210½
Sussex	1	172¾	173	173
	104	167,321¾	133,950	108,793

The manufacture of iron.

	Tons.
The return from Scotland exhibited a list of 17 furnaces, and an exact return of pig iron, manufactured, of	16,086
Making an annual total of	124,879
Annual average produce from each furnace, including charcoal furnaces	1,032
Increase of annual average since 1788	232

The following table shews the comparative make of pig iron in 1820 and 1827:—

	1820. Tons.	Furnaces.	1827. Tons.
North Wales	150,000	12	24,000
South Wales		90	272,000
Shropshire	180,000	31	78,000
Staffordshire		95	216,000
Yorkshire	50,000	24	43,000
Derbyshire		14	20,500
Scotland	20,000	18	36,000
	400,000	284	690,500

From that time to the present the manufacture has steadily increased. The following table gives the state of the trade in 1854; the particulars are extracted from the Mining Records, published under the direction of Mr R. Hunt, in connection with the Museum of Practical Geology, London. The importance which Scotland has assumed in reference to the iron manufacture is especially worthy of notice.

Counties.	No. of Works.	No. of Furnaces erected.	No. of Furnaces in blast.	Total produce in tons.
ENGLAND:—				
Northumberland, Durham, and Yorkshire	37	106	80	348,444
Derbyshire	13	33	25	127,500
Lancashire and Cumberland	2	5	3	20,000
Staffordshire	72	203	166	847,600
Shropshire	13	34	28	124,800
Gloucestershire	4	7	5	21,990
WALES:—				
Flintshire, Denbighshire	7	11	9	32,900
Glamorganshire, Anthracite district	14	35	21	750,000
Glamorganshire and Monmouthshire, Bituminous district	34	134	100	
SCOTLAND:—				
Ayrshire	9	41	30	249,600
Lanarkshire	13	88	72	468,000
Other Counties	10	27	16	79,040
	228	724	555	3,069,874

In connection with the above, we insert the following table from Mr Kenyon Blackwell's paper on the Iron Industry of Great Britain, read before the Society of Arts. It gives the estimated production of crude iron in the various countries.

	Tons.		Tons.
Great Britain	3,000,000	Sweden	150,000
France	750,000	Various German States	100,000
United States	750,000	Other Countries	300,000
Prussia	300,000		
Austria	250,000		6,000,000
Belgium	200,000		
Russia	200,000		

In referring to the above, it will be seen that Great Britain produces as much crude iron as all other countries put together; and a great portion of that iron being converted into bars and plates, indicates a large and important article of production. An article of immense value to the country—of great demand at home and abroad—and justly entitled not only to improvements and economy in its manufacture, but to the generous support of a liberal and an enlightened Government.

The manufacture of iron.

(W. F.)

ADDENDA.

(A) *Mr Cort's inventions.*—It would be a difficult task to enumerate all the services rendered by Mr Cort to the iron industry of this country, or sufficiently to express our sympathies with the descendants and relatives of a man to whose mechanical inventions we owe so much of our national greatness. It is, perhaps, not generally known that Mr Henry Cort expended a fortune of upwards of £20,000 in perfecting his inventions for puddling iron, and rolling it into bars and plates; that he was robbed of the fruit of his discoveries by the villany of officials in a high department of the Government, and that he was ultimately left to starve by the apathy and selfishness of an ungrateful country. When these facts are known, and it has been ascertained that Mr Henry Cort's inventions have conferred an amount of wealth upon the country equivalent to *six hundred millions sterling*, and have given maintenance and employment to *six hundred thousand* of the working population of our land for the last three or four generations, we are surely justified in referring to services of such vast importance, and in advocating the principle that substantial proofs of the nations gratitude should be afforded to rescue from penury and want the descendants of such a benefactor

(B) *The Ores of Belgium.*—A species of bog ore is also used, which is said to be found near the surface, and is washed to free it from impurities.

(C) *The Calcination of the Ores.*—We are informed that the black and clay bands are all calcined in Scotland, even for the hot-blast process, the coaly matter in the black bands being sufficient to effect the calcination without other fuel. The carbonaceous ores lose as much as 40 to 50 per cent. of their weight in the process.

(D) *The blast.*—The Scotch iron smelters allege that the diffusive power of the blast is increased rather than diminished by increasing the number of blowpipe nozzles, and give as a reason for the use of so many that they can be so much more easily repaired, the stoppage of one not materially affecting the working of the furnace.

(E) *Mr Bessemer's process.*—Such is the discovery which Mr Bessemer has communicated to the world, but having reason to believe that the products of this new process of conversion have not been sufficiently tested, we deem it essential to reserve our opinion on this important question until further experiments have proved the efficiency of the process. We are the more convinced of the propriety of exercising precaution from the fact that experiments have been made by competent authorities, in which it has been ascertained that the ingots derived from Mr Bessemer's process are not *malleable*, but highly *refined* metal, deprived of its carbon, but still requiring to be puddled to fit it for the hammer or the rolls. Should this be the case, the saving effected will not be so great as at first anticipated, and, moreover, it has been asserted by practical men that the heat produced is so intense, as not only to deprive the metal of its carbon, but to injure the tenacity of the iron. Should these statements be correct, it will seriously detract from the merits of a discovery, which at first sight promised the commencement of a new era in the manufacture of iron. It is, however, due to Mr Bessemer to wait for further developments, which may lead to important results before coming to any conclusion as to the merits of his invention. We trust, however, that the practical difficulties which appear to surround the process will ultimately be overcome by a series of well conducted experiments, calculated to determine the full value of the invention.

(F) We are informed that the circular saw for cutting railway bars is frequently driven by the Eolipile or Hero's engine, by which a speed of 2000 revolutions a minute may be attained.

(W. F.)

IRON BRIDGES.

Iron Bridges. THE exclusive use of iron in the construction of bridges is of modern date, though no other material is so peculiarly adapted to such a purpose; it was not, however, from any want of appreciation of these advantages, so much as from the great cost, and even impossibility, of obtaining iron in large masses, that its use was so long delayed. It is now most extensively employed in bridge construction, and though, in elegance or durability, iron cannot compete with stone, where the span is moderate, yet there are numberless cases where its adoption has been the means of solving many of the great problems of modern engineering, and its use has more especially become an absolute necessity in Railway Bridge construction, where headway is so frequently of paramount importance,—and where rapidity of execution is often a more necessary consideration than even economy or durability,—while the defective foundations that have so often to be contended with, render the lightness, the independent strength, and pliable character of iron for such structures of the utmost value. Iron Bridges.

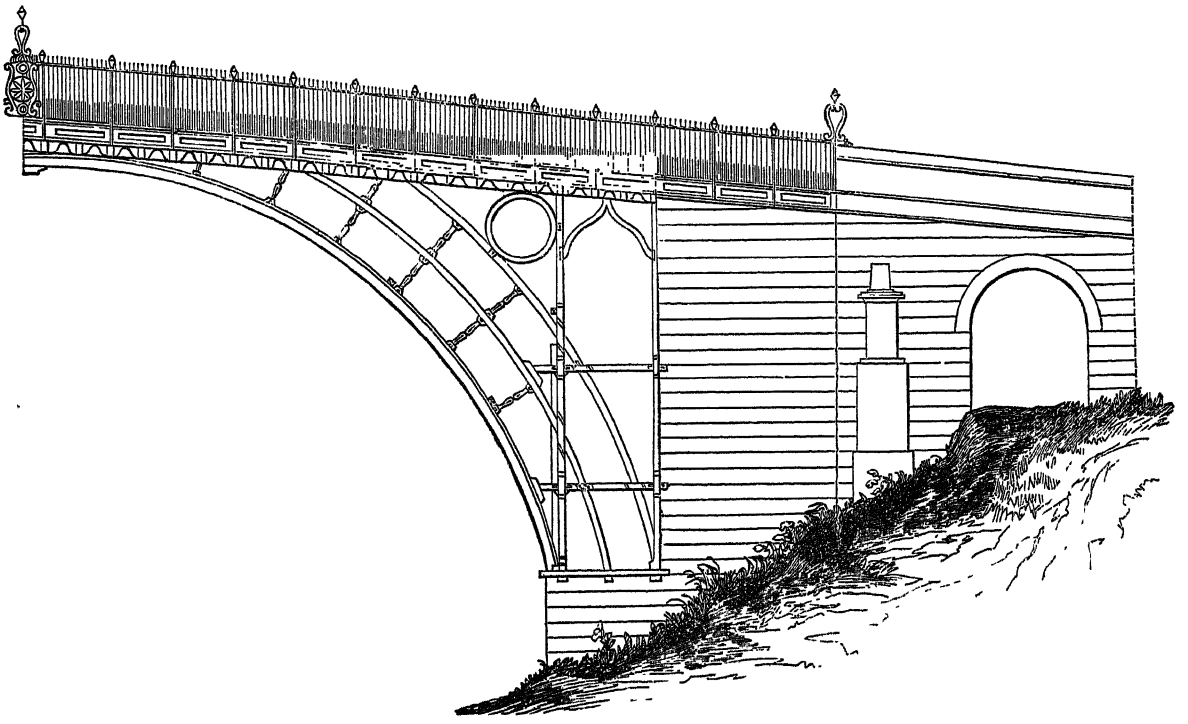
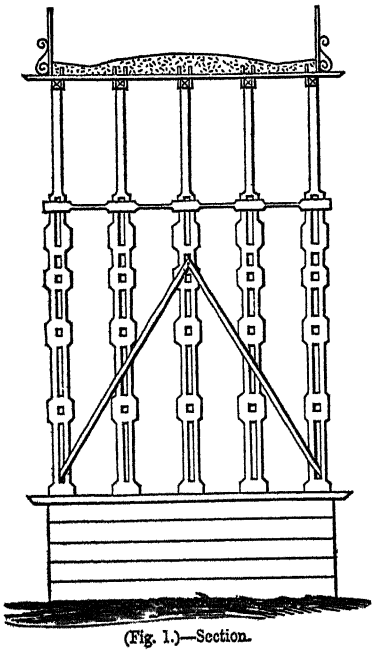
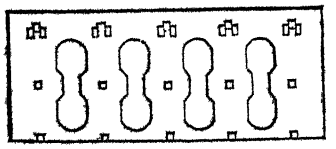


Fig. 1.—Coalbrookdale Bridge.



(Fig. 1.)—Section.



Bed-plate (fig. 1).

We shall confine our remarks in this article to ri id structures. It is not, therefore, our intention to treat of the Suspension Bridge, which is, moreover, not of such modern date, nor have any important modifications been made in its construction since the first magnificent specimen of its class was erected by Telford over the Menai Straits in 1820. It will, however, come within our scope to describe the attempts that have been lately made to render the suspension bridge sufficiently rigid for railway traffic, and to point out the difficulties of such a problem.

Previous, however, to any description of the various forms of iron bridges now in use, we shall give a brief history of their introduction.

According to Gauthey,[1] the history of iron bridges

[1] "Traité de la Construction des Ponts," par M. Gauthey.

Iron Bridges.

commences in the sixteenth century, when such structures were first proposed in some Italian works. In 1719 the subject was again revived by Desaguliers, but nothing like an attempt at construction appears to have been made till 1755, when an iron bridge was proposed at Lyons, which was to consist of three arches of eighty-two feet span; one of these arches was actually put together in the builder's workyard, but this project was subsequently abandoned from motives of economy, and a timber bridge was substituted.

Iron Bridges.

The first iron bridge actually erected was the semicircular cast-iron arch across the Severn, near the village of Brosely, at Coalbrookdale, in Shropshire, which was commenced in 1777, and completed in 1779. It must

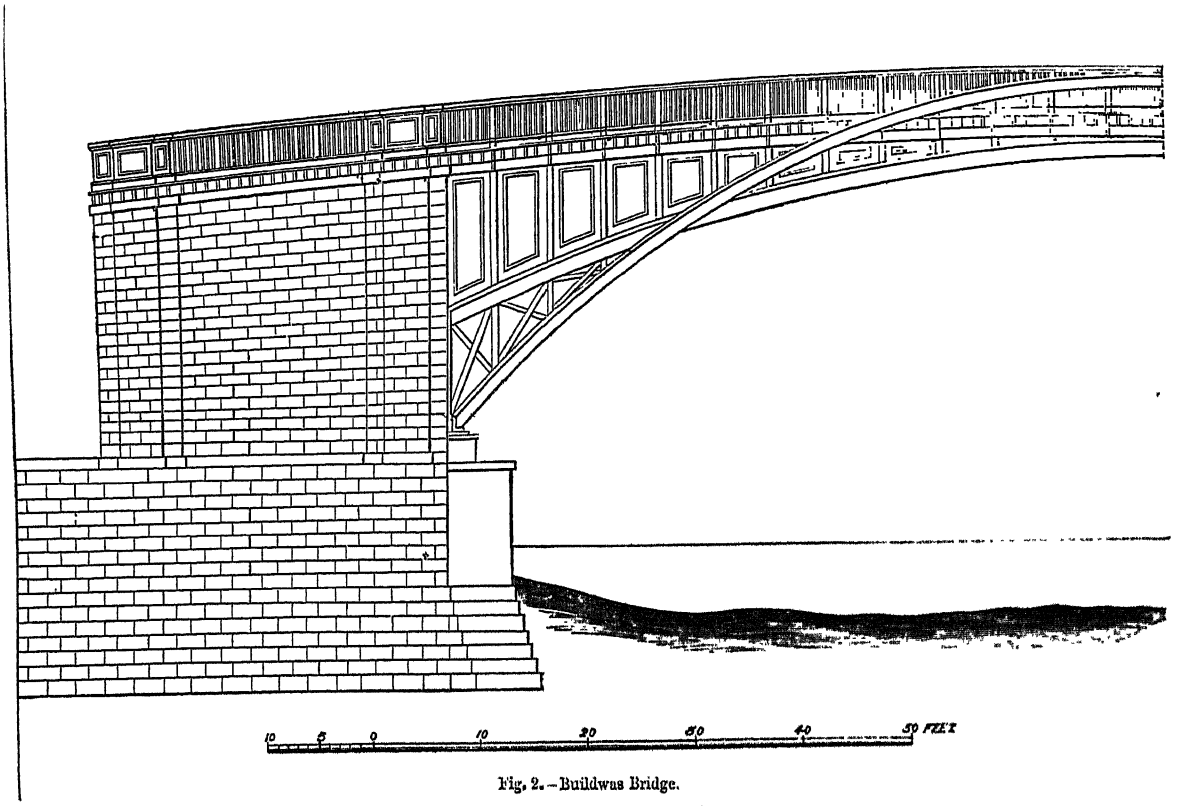
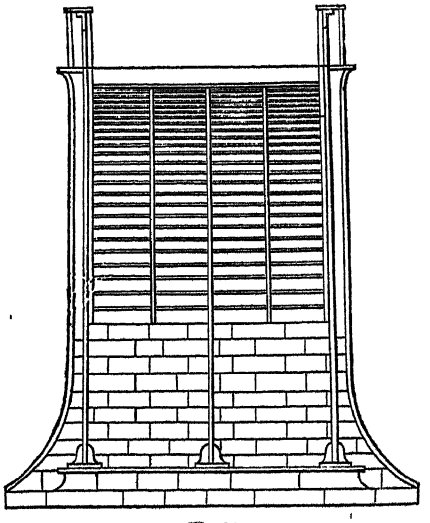
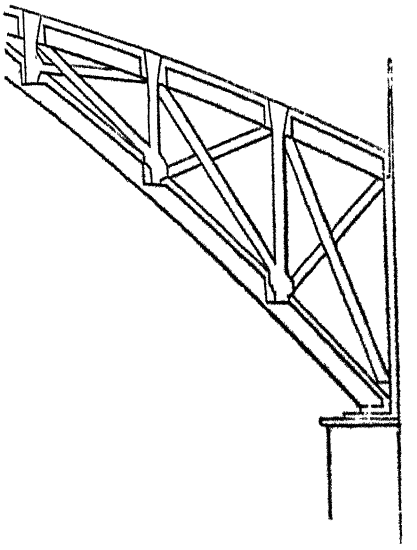


Fig. 2.—Buildwas Bridge.



(Fig. 2.)



(Fig. 3.)

be remarked that some few years prior to this date, the smelting of iron with coke was first successfully accomplished by Mr Abraham Darby of Coalbrookdale, when the use of cast-iron began at once to supersede that of timber in numerous details of construction. This bridge was designed by a Mr Thomas Farnolls Pritchard, an architect of Shrewsbury, and was erected by Mr Abraham Darby, and his partner Mr Reynolds, the proprietors of the Coalbrookdale Iron Works; the expense of its construction being defrayed by a joint-stock company. This arch is nearly semicircular, the span being 100 feet 6 inches, and is composed of five ribs, placed 4 feet 10 inches apart; the ribs (see fig. 1) are formed of three concentric arcs of cast-iron, of which the lower one only is entire, and made in two castings united at the crown, the other two being deficient at their summits, in consequence of the superstructure resting on the crown of the lower and entire arc; the outer arcs are 5½ inches

Iron Bridges.

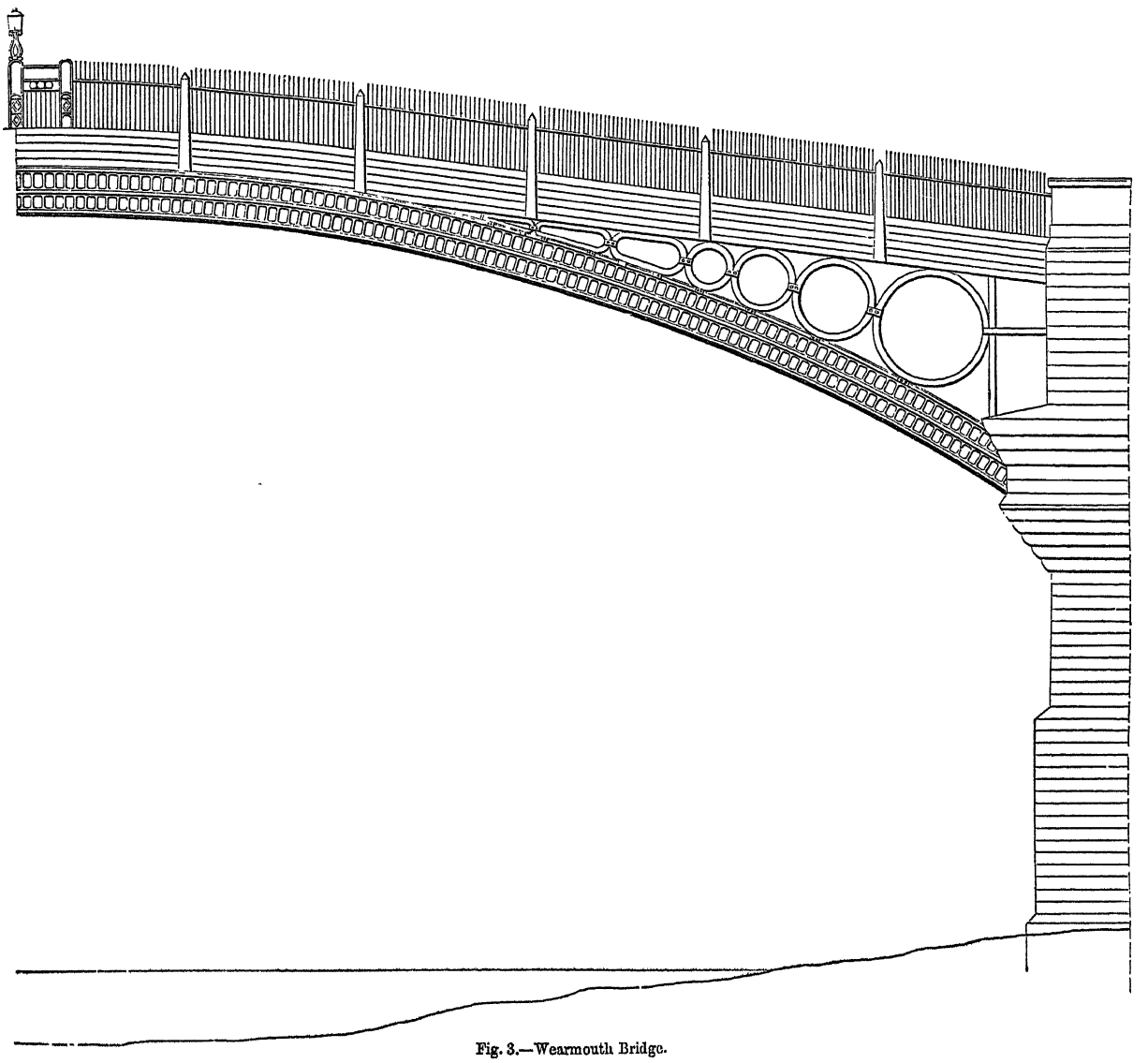


Fig. 3.—Wearmouth Bridge.

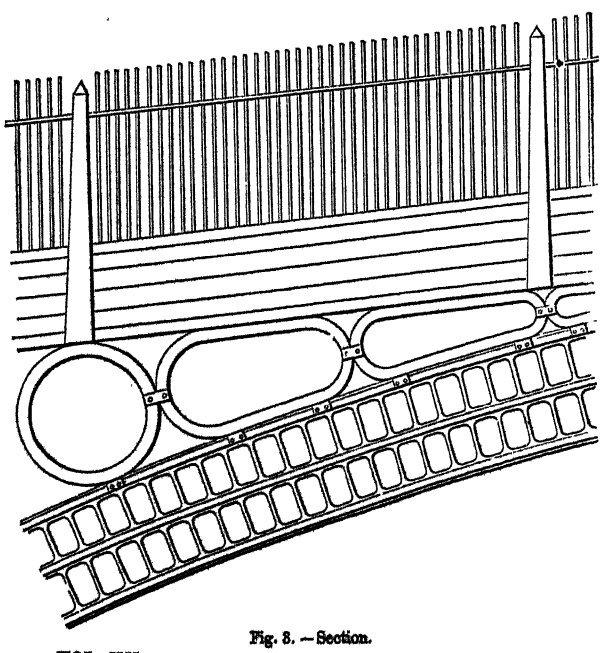


Fig. 3.—Section.

square, and the lower arc is 8¼ inches deep, by 5¼ inches thick; they are connected by means of radial bars fastened with bolts and nuts; and, at their springings, they are supported upon cast-iron plates 4 inches thick, bedded upon masonry. The roadway is supported on open cast-iron spandrils, and is formed of a bed of clay mixed with foundry slag laid upon cast-iron plates. The total weight of iron-work is 378½ tons.

If we consider that the manipulation of cast-iron was then completely in its infancy, a bridge of such dimensions was doubtless a bold, as well as an original undertaking, and the efficiency of the details is worthy of the boldness of the conception. It is to be regretted that, from a defect in the abutments, and the error committed in treating the arch as one of equilibrium, the abutments were thrust inwards at the approaches, and the ribs partially fractured.

Shortly after the completion of this arch, some bold propositions for an extension of the principle originated with some French engineers. M. Callipe, in 1779, made a design for a wrought-iron arch of 656 feet span; proposing to form the ribs of plate-iron placed edgewise, the thrust being resisted by wrought-iron tie-bars, connected with the ribs by vertical and inclined bars; and M. Montepetit, in 1782, presented a plan for an arch of

Iron Bridges.

213½ feet span over the Seine at Paris, of which the ribs were to consist of two concentric arcs 5 feet 4 inches apart, composed of double plates of wrought-iron, 12½ inches deep by ⅝ inch thick; the segments were shewn with return ends, fixed together by bolts and nuts. An engraving of this bridge was given in the *Encyclopédie Methodique*. M. Guyton published, in 1782, some observations upon these designs, proposing to form the ribs of three plates, breaking joint with each other, and united by a species of stirrup at each joint, with distant-pieces between the arcs, and bolts passing through all. M. Guyton, moreover, was of opinion that no difficulty would be found in constructing such arches of double the span of the largest existing stone arches.

In 1783, M. Racle gave a design for an iron bridge of three arches of 84 feet span, to be erected at Lyons on the site of the Pont de la Mulatiere. In this bridge, as well as in other designs by that gentleman, the arcs consisted of panel work, or of cast-iron hollow voussoirs. M. Aubry also proposed a bridge at Cordon, of six wrought-iron arches of 75 feet span each. The ribs were to be formed of two arcs of different radii united by bars, the roadway being suspended from the arches. He also gave a design, in 1786, for the construction of a wrought-iron arch of 318¼ feet span,[1] the ribs being formed of two tiers of arcs, united by radial bars, and the spaces between them filled with diagonal bracing. Though our neighbours were thus so prolific in design, not one of these various bridges was constructed; a circumstance to be accounted for partly from want of enterprise, and partly from the fact that, with the exception of M. Racle's cast-iron voussoir bridge, they were all formed of wrought-iron, a material which, though more employed in France than cast iron, was not obtainable in plates or bars of sufficient dimensions for these bold projects; accordingly, after a lapse of some years, the next actual construction of iron bridges took place in England.

In 1795, the old stone bridge which crosses the Severn at Buildwas, about ten miles below Shrewsbury, was washed away by a flood, and Mr. Telford being engineer to the county, was called upon to replace it, which he did, in 1796, by a single arch of 130 feet span (see fig. 2). The arch, which is very flat, is formed of five cast-iron ribs, having a rise of only 14 feet; there are also two outer ribs with a rise of 30 feet, their springings being lower than those of the inner ribs, and their summits reaching to the top of the iron railing of the superstructure. The platform is 18 feet wide, and formed of cast-iron plates, with deep flanges, which, in themselves, serve as an additional stiffness to the system. The expansion and contraction of the outer arcs being different from that of the remainder, to which they were dovetailed, was, as might be expected, found rather to derange their action than to add any strength to the structure. The total weight of iron in the above bridge is about 174 tons, and it was constructed by the Coalbrookdale iron-masters at a cost of £6,034.

We now come to a description of probably one of the boldest examples of arch construction in existence—the bridge over the Wear at Wearmouth, which was completed also in 1796. About the year 1790, Thomas Payne, the well-known political author, proposed to construct cast-iron arches of framed open panels, in the form of voussoirs, and with characteristic energy, he put his views to the test by constructing an experimental arch of 88 feet 6 inches span, which was made by Messrs. Walker of Rotherham, and exhibited in a bowling-green at Paddington; this experiment was completely successful. It was intended to have shipped this arch to America, but Payne not being able to defray the expenses, the manufacturers took it back, and the malleable iron was afterwards worked up in the construction of the Wearmouth Bridge.[2] It was in the same year that a committee was appointed for investigating the inconvenient and dangerous state of the ancient ferry in the middle of the harbour at Wearmouth; and it being decided that a bridge should be substituted, arrangements were made for erecting one of stone, although this intention was subsequently abandoned, and at the instigation of Mr. Burdon, the Member for the county, who had gone into the subject with the Messrs. Walker of Rotherham, it was determined to construct a cast-iron arch. Mr. Thomas Wilson was accordingly entrusted with the design, and the ideas of Payne with regard to open voussoirs of cast-iron were adopted.

Iron Bridges.

The history of this extraordinary structure is thus as remarkable as its execution. If we are to consider Payne as its author, his daring in engineering certainly does full justice to the fervour of his political career; for successful as the result has undoubtedly proved, want of experience, and consequent ignorance of the risk, could have alone induced so bold an experiment; and we are led rather to wonder at, than to admire, a structure which, as regards its proportions and the small quantity of material employed in its construction, will probably remain unrivalled.[3] This bridge (see fig. 3) consists of a single circular arch of 236 feet span, with a rise of 34 feet; the springings commence at 95 feet above the bed of the river, and the whole height above low water is about 100 feet, admitting vessels of from two to three hundred tons burthen to pass under it without striking their masts. The ribs, which are six in number, are placed 6 feet apart, and they are composed of cast-iron panels acting as voussoirs. In elevation these panels form three concentric arcs, distanced by radial bars, each arc being 6 inches broad by 3½ inches thick, and the radial bars 1 foot 9 inches long by 2 inches broad. Each separate panel contains two radial bars, and a series of 105 of these panels or voussoirs form a rib, and they are connected by wrought-iron arcs fitting in grooves on their faces, to which they are finally secured by screws. The ribs were united with each other by transverse horizontal struts 5 feet 11 inches long, formed of cast-iron pipes, which are placed at every joint of the voussoirs, with flanges at their extremities, by which they are attached to them. The spandrils are filled in with cast-iron circles, following the contour of the roadway, and thus diminishing in diameter from the springing to the crown of the rib. The superstructure is a strong frame-work of timber planking, which was first coated with a mixture of tar and chalk, to preserve it from rot, and then covered with a rod of marl, limestone, and gravel. The whole width of the bridge is 32 feet. The abutments, which are almost of solid masonry, are 24 feet thick, 42 feet broad at their base, and 37 feet at top. The south abutment has a foundation upon a solid rock, and rises from about 22 feet above the bed of the river. On the north side, the ground not being so favourable, it was necessary to carry the foundations 10 feet below the bed.

[1] "*Mémoires* par M. Aubry, 1re partie."

[2] See Ree's *Cyclopædia*, art. "Bridge," sec. Iron Bridges.

[3] In March 21st, 1859, Mr. G. H. Phipps, assistant to the late R. Stephenson, Esq., addressed a letter to R. Burdon, Esq., regarding the part which must be assigned to his father, the late Rowland Burdon, in the design and construction of the Wearmouth Bridge. That letter concluded as follows: "we should probably make a fair division of the honour connected with the unique bridge at Sunderland [the bridge in question] by conceding to Burdon all that belongs to a careful elaboration and improvement upon the designs of another."

The total weight of iron is 260 tons, 46 tons of which are wrought-iron, and 214 cast.

The mode of putting together the ribs was so simple and expeditious, that it was accomplished, and the whole bridge thrown over the river, in ten days; the scaffolding, which was very light, was immediately removed, and the bridge was opened for general use on the 9th of August 1796, the total cost being £27,000.

The construction of the bridge, however, occupied altogether a period of three years, and to complete its singular history, it was sold for £30,000 in a lottery, in October 1816.

Independent of the want of material, the most remarkable deficiencies in this bridge are the want of diagonal bracing, and the bad construction of the spandrils which are filled in with light cast-iron circles.

Soon after the centres were removed, the arch, indeed, was found to have deflected laterally eastward to the extent of 12 or 18 inches, but by means of wedges, tie-bars, and braces, it was partially restored to its original form, and the light cross-bracing, as it at present exists, was inserted. The stability of the bridge has been at all times, however, extremely precarious, and ordinary prudence cannot much longer delay its entire removal.

We must here mention that, in 1794, a small bridge was erected at Laason, in Lower Silesia, by M. le Comte Burghauss, consisting of a cast-iron arch, 43 feet span and 20 feet wide, composed of five ribs, formed of several arcs of different radii united by radial bars; the platform was of cast-iron plates. A similar bridge of 20 feet span was constructed at Berlin, upon the Kupfergraben.

In 1797, Mr John Nash took out a patent for some improvements in cast-iron arches, the ribs being formed of plates. Two bridges upon his system were erected over one of the canals in St. Petersburgh. Nash also proposed to form an arch of a series of cast-iron boxes, bolted together, and filled with earth or cement.

About the same period M. Gaston Rosnay obtained a *brevet d'invention* for some improvements in iron bridges; and suggested the employment of the railing itself, in conjunction with arcs of double or triple wrought-iron plates, for ensuring rigidity. The platform was also made instrumental in strengthening the bridge, and consisted of a double layer of cross planks, which formed an arch resting against the ribs, which were tied together by cross tie-bars.

In the same year, M. Gauthey proposed for the Pont de la Cité at Paris, two outer arches of cast-iron, somewhat similar to the Wearmouth Bridge arches, although not put together in the same manner, the platform being supported between the ribs. Although the Council of Ponts et Chausées had approved of this design, it was not carried out, two wooden ribs being substituted for the iron ones, which ultimately failed.

In chronological order, we next come to the remarkable design by Messrs Telford and Douglas, in 1801, for replacing London Bridge by a single cast-iron arch of 600 feet span, with a clear headway of 65 feet above high water. The ribs were to be of cast-iron, in segments as large as possible, and they were to be connected by diagonal cross-bracing, disposed in such a manner that any part of the ribs or braces could be taken out and replaced without injuring the stability of the whole, or stopping the traffic. On plan the superstructure was arranged to spread in width from the centre of the arch to the approaches. The scheme was investigated by a select committee of the House of Commons, the works were put in hand, and the river was contracted to the necessary width. But this design was at length abandoned, owing more immediately to the difficulties, with such a headway, of constructing the approaches, which would have involved the formation of extensive inclined planes from the adjoining streets.

Iron bridges now began to be generally adopted. Mr Wilson constructed a cast-iron arch of a span of 180 feet, at Staines-upon-Thames, in 1802 (see fig. 4). Its radius was 260 feet, its rise being 16 feet. It was in many respects similar to the bridge of Wearmouth, being formed of cast panelled voussoirs 4 feet 10 inches long; the concentric arcs were 6 inches deep by 4½ thick. The ribs were connected by cast-iron rectangular bracing-frames,

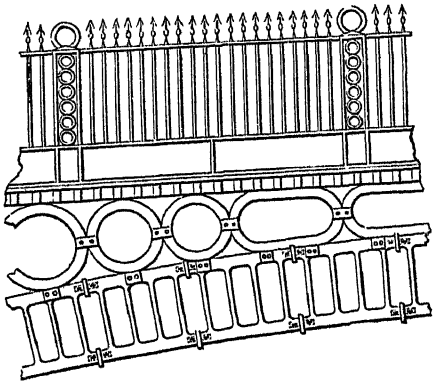


Fig. 4.—Section.

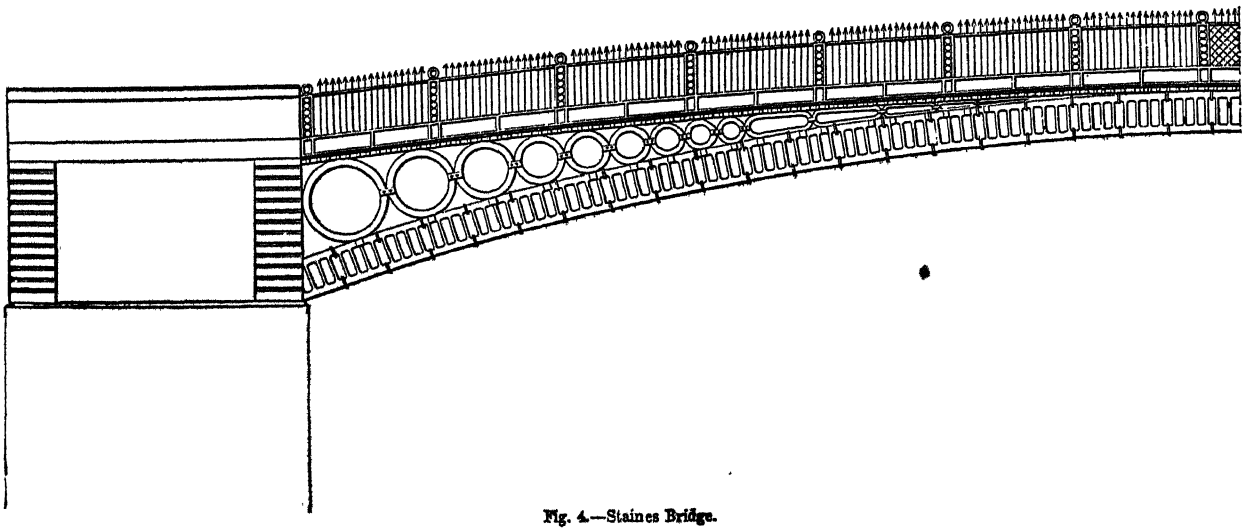


Fig. 4.—Staines Bridge.

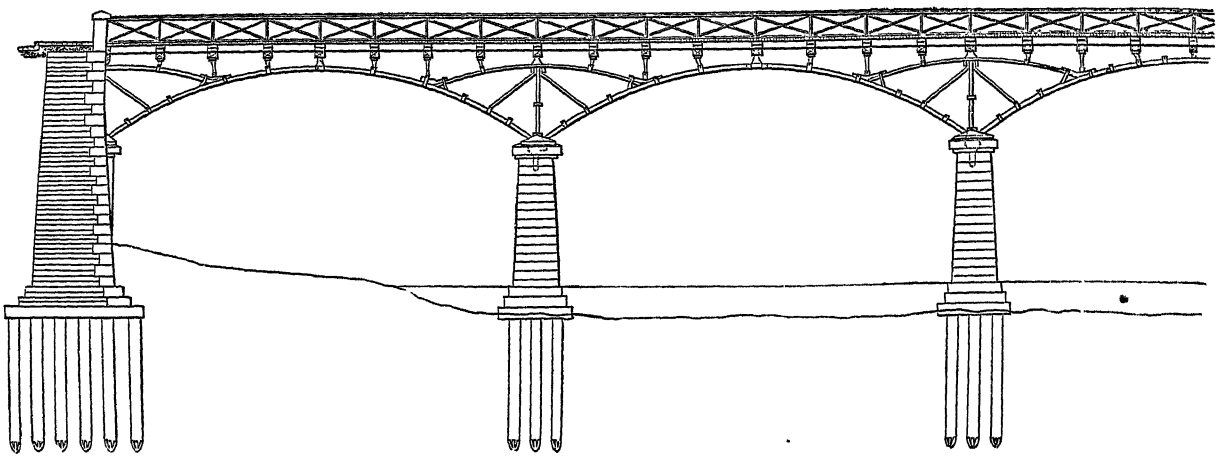


Fig. 5.—Pont du Louvre.

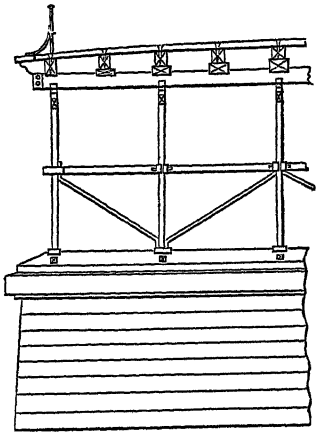


Fig. 5.

and the voussoirs were united by dowels; the wrought-iron arcs, such as were used to coneect the voussoirs of Wearmouth Bridge, being dispensed with. The spandrils are filled with cast-iron circles, and the platform is formed of cast-iron plates stiffened by curved webs, so arranged as to cover two and three ribs alternately. The abutments of this bridge were insufficient to resist the thrust of the arch, and one of them actually moved horizontally on its base without disturbing its joints.

The first iron bridge constructed in France was the Pont du Louvre at Paris, in the year 1803. The plans were prepared by M. Cessart, and modified by M. Dillon, who had charge of its erection. The castings were made near Touronde, at the iron-works of MM. Baudry and Mercia.

The arches of this bridge, which are nine in number (see fig. 5), and 57 feet span, are composed of five cast-iron ribs placed 8 feet apart. Each rib or arc is 6½ inches deep by 3 inches thick, and is made in two parts connected at the crown.[1]

The springings rest on cast-iron plates let into the masonry of the piers, which at top are 6 feet 4 inches thick. The rise of the arcs is 10 feet 8 inches. Other arcs of lesser dimensions, striding over the piers, and resting on each pair of large arcs, are employed to fill in the depth of the spandrils or haunches. This bridge was intended for foot passengers;—its total length between the abutments is 516 feet, and its width between the railings 30 feet. The total weight of iron in the nine arches is about 263 tons. The stone piers, which are eight in number, rest on pile foundations. An interesting experiment was made on one of the ribs by M. Dillon; it was placed upon a substantial timber platform, and weighted with several boxes suspended from the same points of the rib from which the platform itself was to be ultimately suspended, the boxes were gradually loaded until the weight they contained amounted to double that which the rib could possibly have to sustain, the rib was found to be depressed at the summit, and raised at the haunches; but on the removal of the weights the arch

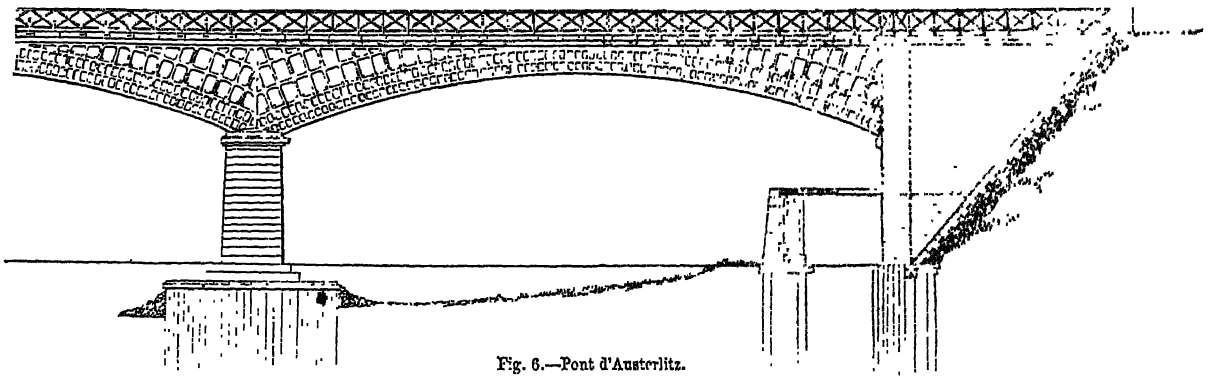


Fig. 6.—Pont d'Austerlitz.

[1] The original design for this bridge consisted of eleven arches of 51½ feet span, and the ribs were somewhat similar in external appearance to those of the modified design by M. Dillon, although differently put together. M. Cessart, who was eighty-two years old when he made this design, had the satisfaction of obtaining the approval of the Council of Ponts et Chaussées; and to shew the gratification he experienced by that honour, it may be as well to quote his own words:—"Si le Pont des Artes (now the Pont du Louvre) n'a pas été entièrement exécuté comme je l'ai proposé dès le principe, je m'en tiens pas moins à l'honneur d'avoir conçu la première idée de cet ouvrage et d'en avoir ainsi préparé le succès, à l'âge de quatre-vingt-deux ans, et sous les auspices du Conseil générale des Ponts et Chaussées."—*Description des Travaux Hydrauliques, de Louis Alexandre de Cessart*, tom. i.

Iron Bridges.

regained its original figure, which circumstance was strictly in accordance with the theoretical views upon the subject.

We now come to the Pont d'Austerlitz, erected at Paris by M. Lemandé. This light and elegant structure consists of five equal arches (see fig. 6), which are segments of circles 138 feet radius, the span being 106 feet, and the rise 10 feet 8 inches. Each arch is composed of seven ribs placed 6 feet 8 inches apart, each consisting of three concentric arcs, which form panels by their intersection with radial bars. The arcs are $5\frac{3}{8}$ inches deep by $2\frac{5}{8}$ inches thick, and the radial bars are $2\frac{3}{8}$ inches broad; the spandrils are filled up by arcs and radial bars, forming panels similar to those of the voussoirs. The ribs are united by cast-iron cross-frames, formed of bars $2\frac{5}{8}$ inches square by 6 feet 5 inches long, with a double return at their extremities, by which they are attached to the voussoirs; the depth of the entire arc is 5 feet 3 inches. The platform is of timber,

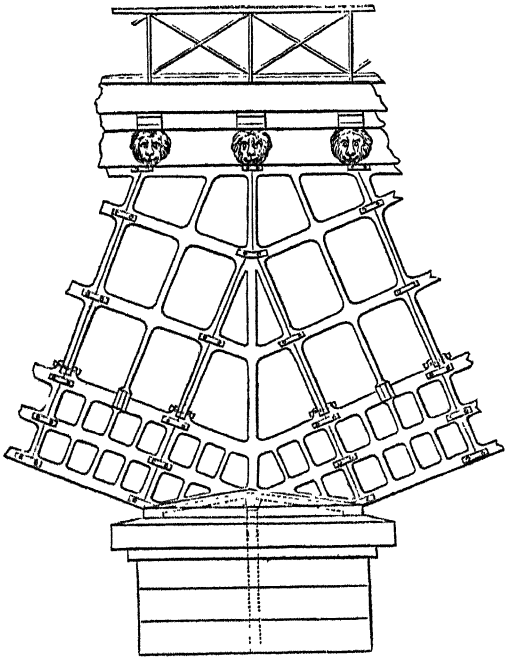


Fig. 6.—Section.

covered with a thick bed of loamy earth and gravel. The joints of the voussoirs were run in with spelter, and an excess of rise was given to the summit of the arches

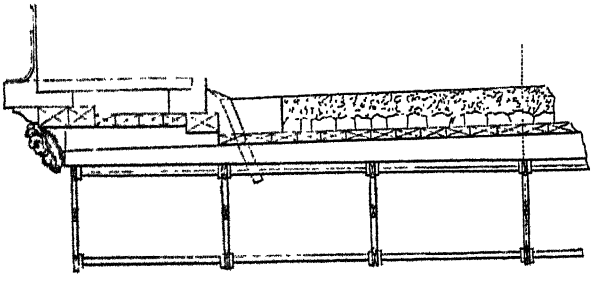


Fig. 7.—Section.

of $2\frac{1}{8}$ inches. The settlement which took place on the striking of the centres varied in different arches from $\frac{1}{4}$ inch to $\frac{7}{16}$ inch—but it ultimately increased to $2\frac{1}{8}$ inches and $2\frac{7}{8}$ inches. The deflection was partly caused by the fracture of some of the radial bars, particularly those near the abutments, caused by the bridge having been overloaded immediately after its completion. The arcs themselves remained, however, uninjured, and the radial bars having been repaired by bands of wrought-iron placed over the broken parts, the arcs were rendered secure from further distortion.

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This bridge was commenced in 1800, and finished in 1806.

In January 1805, some discussion took place as to the best method of widening the waterway of the Pont de l'Archevêché at Lyons, and it was proposed to replace

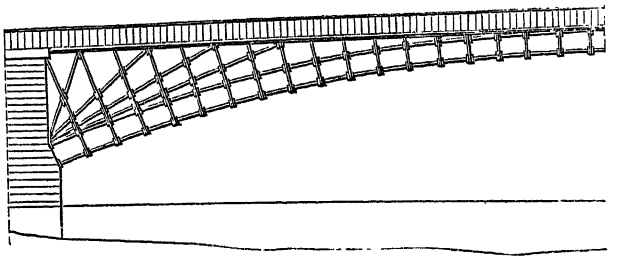


Fig 7.—Pont l'Archevêché.

the five stone arches of that edifice by three cast-iron arches, of which the centre one would have had a span of $239\frac{1}{2}$ feet. (See fig 7.) The proposed construction was novel; the arcs being formed of cast-iron pipes, two tiers of which were proposed for each rib, connected by radial bars, having their ends flattened and bolted between the flanges of the pipes. A similar arrangement was proposed for the bracing-frames between the ribs. The haunches of the arches were also composed of pipes.

The proposed advantages in the use of pipes arose from the consideration that the same quantity of metal in a hollow section was much more advantageously disposed of than in a solid section, and this first application of that principle to bridge structure is deserving of notice.

Some novelty in construction next occurs in a small wrought-iron arch, constructed in 1808, by William

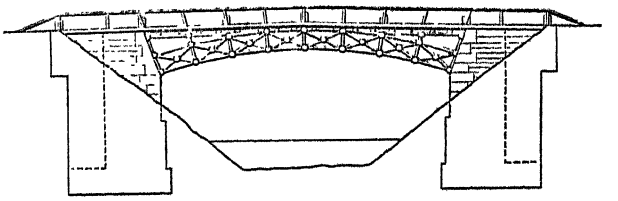


Fig. 8.—Pont St. Denis.

Bruyère[1] near St. Denis; the span is only 37 feet 5 inches, with a rise of 3 feet 3 inches, and the ribs are composed

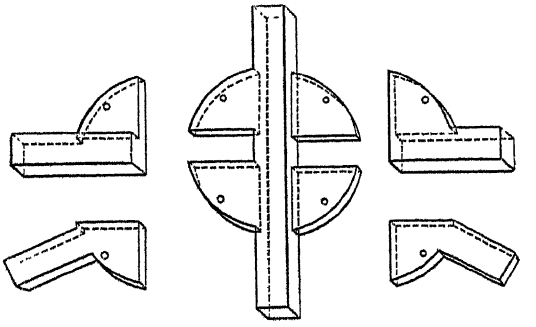
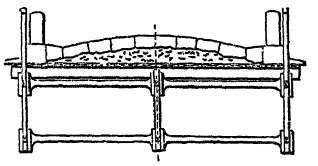


Fig. 8.—Section.

of panel voussoirs, but the angles of each panel are con-

[1] M. Bruyère had applied this arrangement with advantage to the construction of wrought-iron sluice gates.

nected in a peculiar manner (see fig. 8); the ends of each radial bar have four quadrant plates forged to them, and the arcs and the diagonal cross-bars, which all meet in the same point, have similar quadrant plates, that halve in thickness with those of the radial bars, and circular plates are made to cover the whole, which are fastened together by four bolts and nuts.



(Fig. 8.)—Cross-section.

Such a method of construction is extremely costly, and evidently inapplicable to large structures.

A similar bridge was, however, proposed in 1810, by M. Bruyèr for the prolongation of the centre portion of the Hotel des Invalides, at Paris; it was to be a single arch of 426½ feet span, the ribs being divided into voussoirs similar to that just described, and tied together by cross-bars and diagonal tie-bars at every interval of the voussoirs. The execution of this structure, which was only meant for foot passengers, had been decided upon, but was afterwards suspended.

Another bridge for the same site was proposed by M. Lamandé, in 1811. This design presented some additional peculiarities, inasmuch as it consisted of a combination of wrought and cast-iron; the bridge was to consist of three arches, but the centre one only was to have been of iron, with a span of 262½ feet. In this instance there was to have been a carriage-way. The arcs of the voussoirs were to be of cast-iron, but the radial bars and the diagonal braces, and in fact, all those pieces which were exposed to tensile strains, were to have been of wrought-iron. Each upright served to connect two adjoining voussoirs, and carried, at its extremities, ears or lugs, forming a kind of fork which clasped the voussoirs; the cast-iron arcs of the voussoirs were further bound together by wrought-iron arcs.

Improvements in the manufacture of iron kept pace with the rapid increase of its application to construction, while the ingenuity of inventors in this, as in all other developement of new principles, far outstripped the requirements of practice. Mr Pope proposed to construct bridges of 1000 feet span, on a new principle, named by him the "Flying Lever Pendant Bridge." However impracticable the construction may have been, the idea is worthy of notice, inasmuch as it involved new and important applications of action and reaction. These bridges were to consist of a combination of struts and ties acting with various leverages—and so arranged that the entire half-bridge was one huge cantilever, with the abutments sufficiently massive to bear all the overhanging weight and strain of the half-arch. By this means, there was no dependent pressure at the crown or meeting of the two half-arches—each of which was to be built progressively from the abutments to the centre, without the aid of centering or scaffolding; with this arrangement, any portion of the middle could be removed without disturbing the rest.

These bridges were to be constructed of iron or timber.[1]

M. Wilbeking, Director-General of Ponts et Chaussees, in Bavaria, published, in 1812, a treatise upon Iron Bridges, in which he proposed to construct arches of iron pipes, fastened together by means of sockets attached to the extremities of the cross-bars into which the ends of the pipes entered; the cross-bars themselves were also formed of cast-iron pipes. M. Wilbeking gave a design for two bridges upon this principle, one of 111½ feet span, by 11 feet 2 inches rise, and the other of 292 feet span by 29 feet rise. The pipes were to be about 8½ inches diameter, by 1½ inch thick, those forming the cross-bars being something less. Each of these bridges was composed of three parallel ribs, with two diagonal or bracing ribs. The spandrils were filled in with radial supports, stiffened by diagonal bars, or by wrought-iron rings. The possibility of keeping such a system in form is extremely problematical.

Messrs Jessup erected two iron bridges of great simplicity at Bristol, the spans being 100 feet, and the rise 15 feet. The arch is composed of six ribs made of two castings united at the crown, and each rib is provided with seven uprights, which sustain the platform of the roadway: the ribs are held together by nine wrought iron cross-bars or ties. Each of these bridges contains 150 tons of grey iron, and was constructed at a cost of £4000.

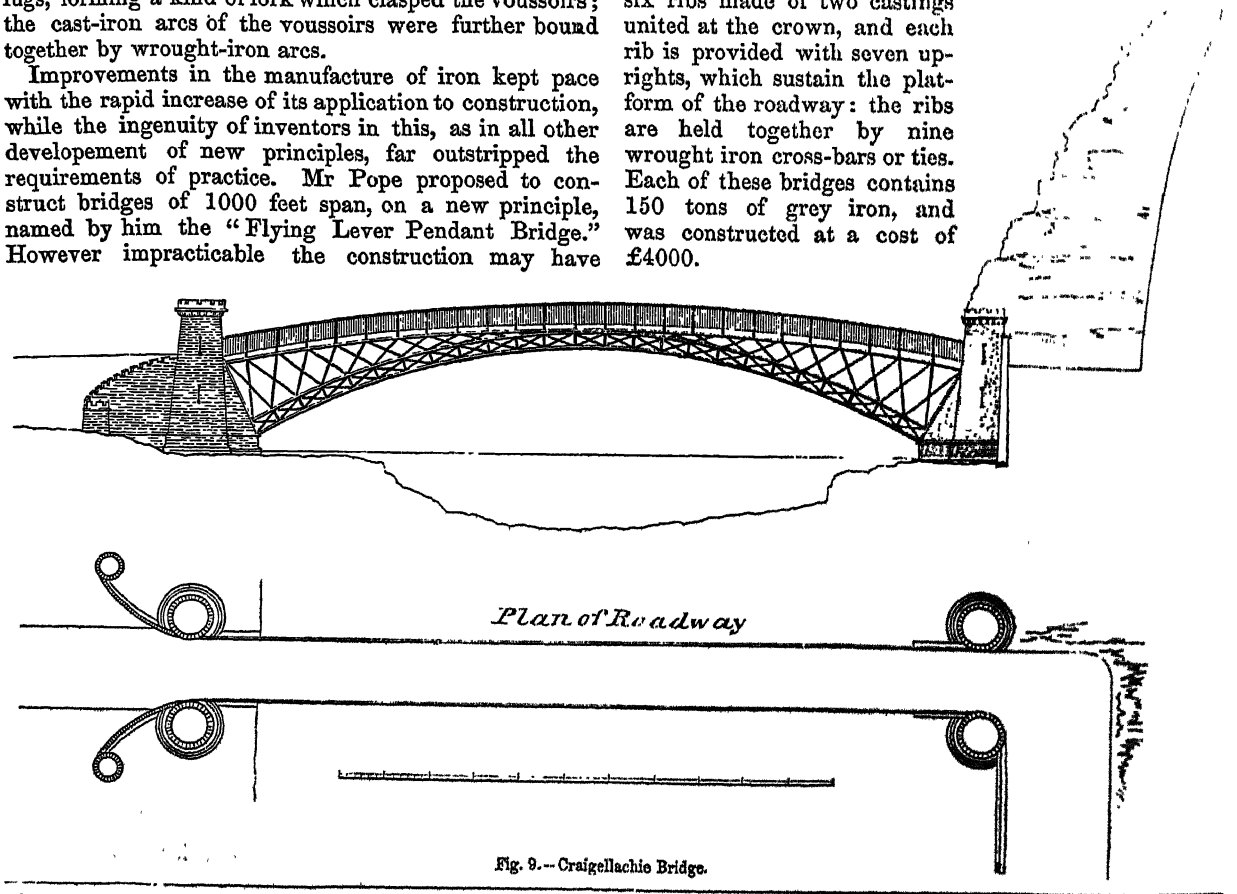


Fig. 9.—Craigellachie Bridge.

[1] Mr Pope, in his work upon Bridges, expresses his indignation in strong terms against many scientific gentlemen of that day for their seeming little faith in his design

Iron Bridges.

For examples in iron bridges, we are much indebted to Mr Telford. A very fine iron bridge (see fig. 9), by that gentleman, spans a natural channel formed by the Spey in the Craigellachie rock. The span is 150 feet, and the arch is composed of four ribs, the rise being 20 feet. Each rib consists of two concentric arcs, forming panels, which are filled in with diagonal bars. The roadway is only 15 feet wide, and is formed of another arc of greater radius, to which is attached the iron railing; the spandrils are filled by diagonal ties, forming coarse trellis-work. The bridge rests upon stone abutments, with circular castellated towers and curved wing walls at each approach. This bridge is undoubtedly open to the objection, that it consists of two very dissimilar arches, which, owing to the variations of temperature, must be subject to very variable strains. The total cost of this bridge, including the blasting of rock on the west side of the river, was £8200.

Another bridge very similar, and of the same span, was erected by Telford over Dornoch Frith, called Bonar Bridge.

Several iron bridges, about the same date, were erected by Mr Rennie—one at Boston, over the Witham, has a span of 86 feet, with a rise of only 5 feet. Owing to the unequal cooling of the ribs in the foundry, or from some other cause, they were fractured in several places when loaded, but notwithstanding these fractures, the arch generally preserved its form.

We now come to the description of the two iron bridges erected over the Thames, in London, viz., Vauxhall Bridge and Southwark Bridge, the latter being in every respect a most remarkable structure, whether as regards its bold proportions or architectural effect.

The bridge at Vauxhall was designed originally by Mr James Walker; but in consequence of some disputes in regard to its construction, four engineers were ultimately engaged in its erection, namely, Mr Ralph Dodd, Sir James Bartham, Mr Rennie, and Mr James Walker. It consists of nine arches, the span being only 78 feet, and the rise 29 feet, the piers are 12 feet thick; the roadway is 36 feet wide between the railings, including the footpaths of 6 feet each. Each arch is composed of ten cast-iron ribs 18½ inches deep, with a double flange 6 inches wide, the thickness of the middle web is 1 inch, and that of the flanges 2 inches. Each rib, with its spandrils, consist of three castings; there are, consequently, only two joints which divide the arc in three equal segments; the spandrils consist of light vertical panel work, the verticals in section forming a cross. The upper line of the ribs is straight, forming two inclines to suit the slope of the road; the ribs are united by diagonal strutting-frames, of which there are five rows in each arch. The ribs abut upon cast-iron plates, which are embedded in the pilaster of the piers and abutments. The roadway plates are of cast-iron, with flanges on the upper side, by which they are bolted together. Over each of the four faces of the middle piers, there is a cast-iron alcove; the railing is 4 feet 6 inches high, and composed of cast-iron verticle bars. The outline of the superstructure is a curve between the middle piers, with two straight inclines, tangents to it. The total length of the bridge is 809 feet. The first stone was laid on the 9th of May, 1811, and the bridge was opened to the public in July 1816. The iron-work was cast at Butterly, in Derbyshire, and the cost was £300,000 for the whole of the work included in the structure.

The Southwark Bridge (see fig. 10), designed by Mr Rennie, crosses the Thames between London and Blackfriars' bridges, and as an example of arch construction, stands confessedly unrivalled as regards its colossal proportions, its architectural effect, or the general simplicity and massive character of its details. The depth of the river being from 30 to 36 feet at high water, Mr Rennie decided on crossing it with three arches; the centre one having a span of no less than 240 feet, and the external arches 210 feet each; the rise of the centre arch is 24 feet, and of the external arches 21 feet. The piers and abutments are built of Scotch granite, and rest on platforms upon timber piles, protected by timber sheeting. The length of each pier, including the cutwater, is 78 feet, and the width 24 feet; the height from the cornice of the centre arch, to the surface of the water at high spring tide, is 42 feet; the total length of the bridge, with the abutments, is 800 feet, and the width of the roadway between the railing is 42 feet, which includes two footways of 7 feet each. Each arch consists of eight ribs, each rib being formed of thirteen vertical cast-iron segments or voussoirs; they do not abut immediately upon each other, but upon an intervening transverse plate, extending across the eight ribs at the junction of every voussoir, a most efficient bond being thus obtained between the individual ribs: there are fourteen such trans-

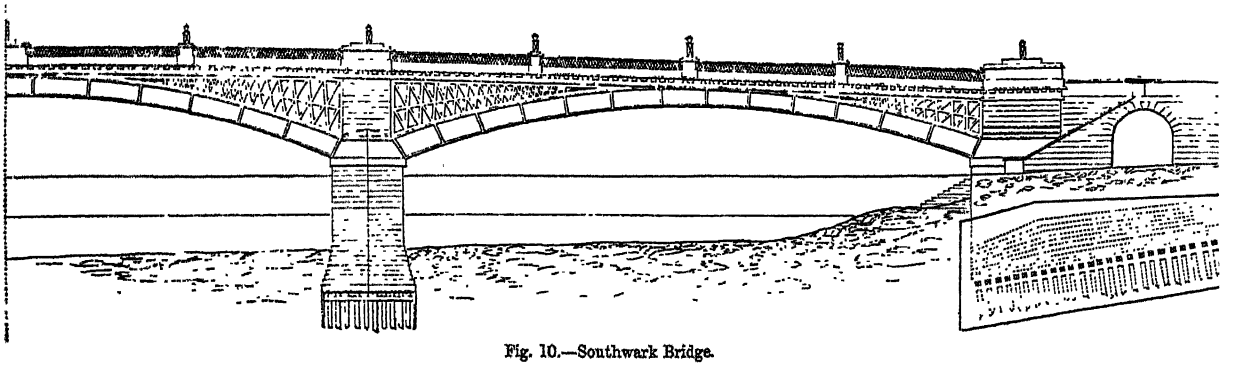


Fig. 10.—Southwark Bridge.

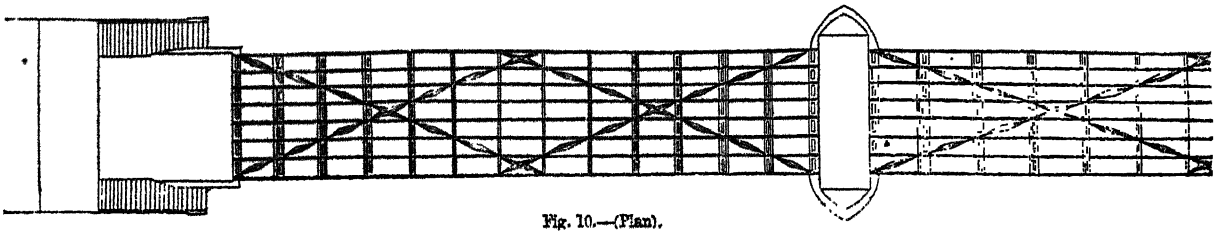


Fig. 10.—(Plan).

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verse plates on each arch, including the two at the abutments. The voussoirs are 20 feet long, and 6 feet deep at the crown, and gradually increase to 8 feet deep at the abutments; they are 3½ inches thick, and have double

Iron Bridges.

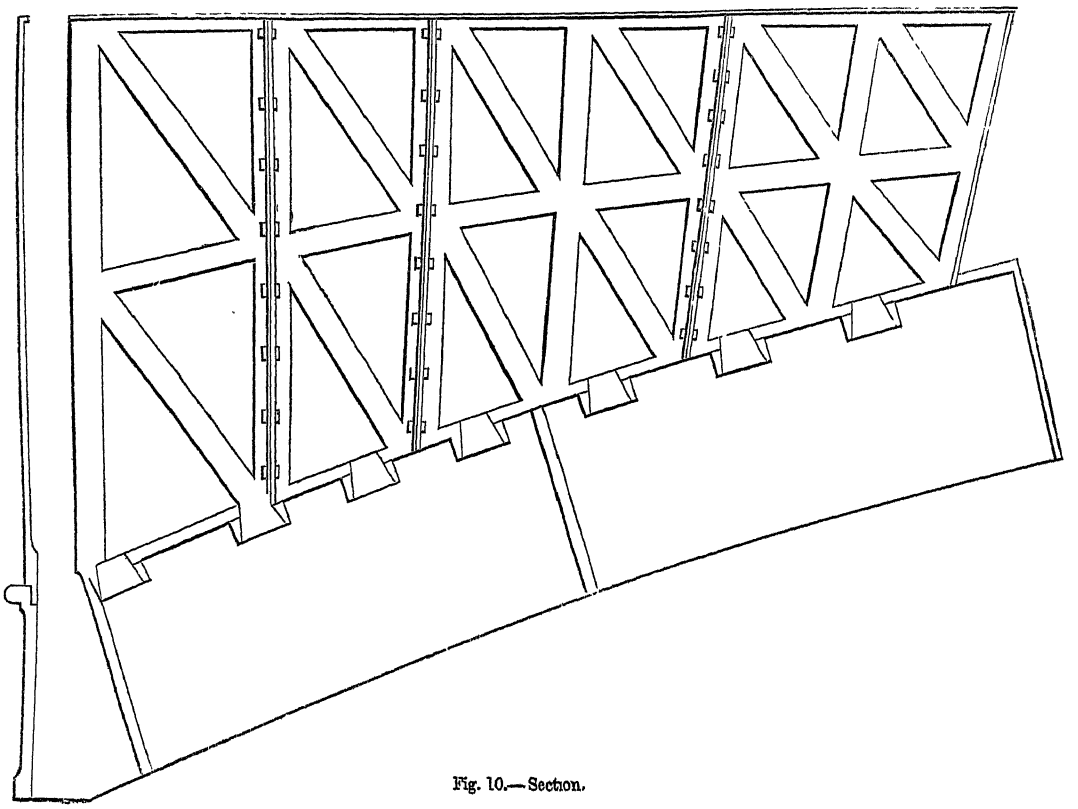


Fig. 10.—Section.

returns, 4 inches wide at their abutting edges, by which they are bolted to the transverse plate; fillets are cast upon this plate for the introduction of wedges to insure perfect contact throughout the whole depth of the voussoirs. The spandrils are cast independent of the voussoirs, and attached to them by means of a number of dental projections fitting into corresponding recesses in the voussoirs, both of which are dovetailed; their form is exceedingly simple and efficient; they consist of lozenge-shaped panels, formed by diagonal lines, and intersected at about the middle of the depth by a curved line much flatter than that of the arc of the voussoir. Diagonal bracing-frames are introduced between each consecutive spandril, and the whole system is farther secured from lateral motion by means of four diagonal lines of bracing-bars intersecting each other and extending across every arch. The roadway is formed of cast-iron plates 4 feet wide, and alternately 22 and 11 feet long. These plates are strengthened by ribs, and are bolted together by flanges at their edges, they break joint with each other and rest alternately on six and four ribs, and thus contribute materially to the lateral strength of the structure. The parapets and cornice, as well as the balustrade, which is 4 feet 8 inches high, are all of cast-iron.

The iron-work was cast by Messrs Walker & Co., of Rotherham, and the total weight was about 5780 tons; each rib was carefully fitted together at the works before it was shipped for London. The total cost, including the approaches, connecting-avenues, &c., &c., amounted to about £800,000. The work was commenced on the 23d of September 1814, and the bridge was opened in April 1819.

No provision having been made for expansion and contraction, considerable inconvenience arose from its effects, the paving stones of the footpaths having been broken and disturbed in adapting themselves to the change of form of the arches. The enormous weight of this structure contrasts rather disadvantageously with that of others we have described, but the importance of unusual durability in such circumstances was doubtless duly considered.

A short time after the completion of Southwark Bridge, two cast-iron arches were erected by Telford, viz., an elegant arch across the Severn at Tewkesbury (see fig. 11), of 170 feet span, with a rise of 17 feet only, consisting of six ribs about 3 feet 3 inches deep, the spandrils being filled in with light diagonal work; and an arch, of a span of 180 feet, over the Gloucester and Birmingham Canal at Galton, with a rise of 18 feet; in this case, the ribs consist of diagonal panel work.

It will be observed that all the iron bridges we have described have been arches, and the material used cast-iron. Wrought-iron has been but partially introduced, although its use had been suggested for such structures at an early period; it had, however, been used in the construction of suspension bridges, of which the Menai Bridge, by Telford, was one of the earliest and finest examples. It is evident that in many, if not in all of these structures, the arch has been treated as an arch of equilibrium, and that the two principles on which such construction should be based, were but imperfectly understood. The stability of an arch of masonry depends on its own weight, and the equilibrium of its individual parts, for maintaining its form; such also is the case to a great extent with cast-iron arches of colossal dimensions, such as the Southwark Bridge, where the weight of the rolling load bears only a small proportion to the weight of the structure itself; but the theory of equilibrium, as applied to arches of masonry, is evidently inapplicable when the rolling load bears so large a proportion to the weight of the structure, as is the case in most arches constructed of iron. Another important difference

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arises from the fact, that arches of masonry owe much of their stability to the friction and adhesion of the large bearing surfaces of the stones which form the voussoirs, whereas, the bearing surfaces of the segments of cast-iron arches are necessarily limited in dimension, and being in all cases attached by bolts, the arch is rigidly restrained from assuming a position of equilibrium and rest. In the Southwark Bridge, this difficulty was partly met by the introduction of the wedges we have described; and on the Pont d'Austerlitz, by ultimately closing the joints with spelter run in between the voussoirs. It is evident, on these grounds, that a cast-iron arch cannot be considered as a mere system of voussoirs assuming a position of equilibrium, but rather as a rigid structure, consisting of two inclined struts or beams, abutting against each other horizontally at the summit of the arch, and upon this assumption, we can arrive at the true direction and amount of strain, each semi-arch being treated as a

Iron Bridges.

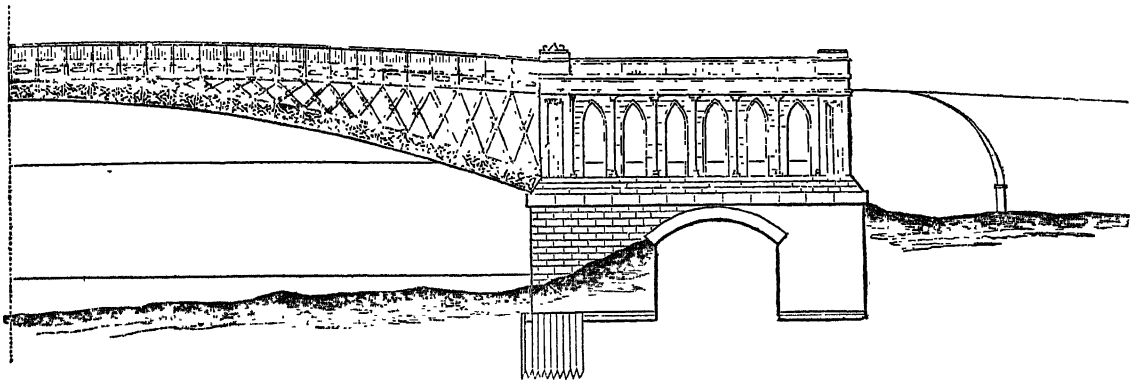


Fig. 11.—Tewkesbury Bridge.

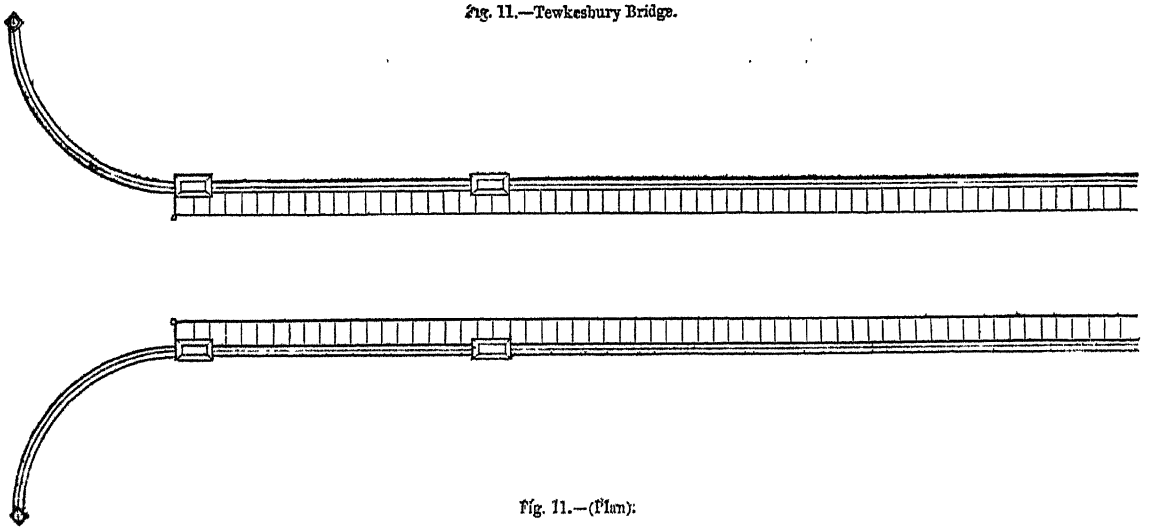


Fig. 11.—(Plan).

rigid beam. Such considerations render the calculations of the strains in an iron arch extremely simple.

It will be observed, that in all the arches hitherto described, the thrust is resisted directly by the abutments, as in arches of masonry, and not by the tie-rods, as in the ordinary "bowstring girder," they are all therefore true arches, their claim to originality arising from the introduction of iron in lieu of masonry, and from the ingenious and skilful arrangement of detail displayed by the engineers.

We have now arrived at an epoch in civil engineering, which at once enlarged tenfold its sphere of action, and rendered impossible all reference to experience or precedent; and the arch and the beam, as well as every other established principle of construction, underwent, with miraculous rapidity, entire modification, and their application became wonderfully extended.

We allude, of course, to the introduction of railways, in which the application of iron takes an entirely new direction. The success that had attended the use of tramways in some collieries, led, in 1823, to the construction of the Stockton and Darlington line. The Liverpool and Manchester line, however, which was immediately afterwards commenced, and where the locomotive engine was first successfully applied, ranks as the true prototype of our present system.

Hitherto, bridges had been applied generally to high roads where inclined approaches were of small importance, and in determining the rise of his arch, the engineer selected any headway he thought proper, while every other consideration was similarly made subsidiary to the problem of constructing the bridge itself, and the completion of a single large bridge was an epoch in engineering history. On the introduction of railways, hundreds of roads, rivers, and valleys had at once to be spanned with level roads. Time was as important an element as economy or durability in the erection of these structures, while every conceivable difficulty arose from their limited headway, their bad foundations, their oblique directions, or their gigantic dimensions. Navigable waters, as well as crowded thoroughfares, had now to be crossed without interference with existing traffic, and the ponderous locomotive dashed over these new and hastily constructed works, instead of the quiet team. The arch was evidently at once inapplicable to the bulk of such requirements; new principles of construction became imperative, and the beam, with all its numerous modifications, at once

Iron Bridges.

superseded the iron arch as completely as the locomotive did the stage coach. The earliest simple iron beams of which we possess any account, are those used by Mr Telford in building a cotton-mill in Salford, in the year 1800 as recorded in "Tredgold's Essay on Cast Iron," by Hodgkinson, part ii. But the application of simple cast-iron beams to the construction of bridges originated with the late George Stephenson, who employed them on the Liverpool and Manchester Railway.

It will now be more convenient to discontinue our chronological history, and to avoid repetition, we shall, in the next chapter, give a classification of the various forms of girders now in use on railways, describe their general principles of construction, and proceed with our descriptions of some of the most remarkable examples. Under their respective heads, we here give, in a tabular form, some of the dimensions and other characteristics of the works hitherto described.

Iron Bridges.

Tabular List of the Bridges constructed as described in the First Chapter.

Name of Bridge.	No. of Openings.	Span.	Rise.	Total weight of Iron-work.	Cost.	Date of Completion.
		Ft. Ins.	Ft. Ins.	Tons.		
Coalbrookdale	1	100 : 6	50 : 0	378½	...	1779
Buildwas	1	130 : 0	30 : 0 / 14 : 0	174	L.6,034	1796
Sunderland Bridge	1	236 : 0	34 : 0	260	27,000	1796
Laason Bridge	1	43 : 0	...	...	...	1794
Staines Bridge	1	180 : 0	16 : 0	...	...	1802
Pont du Louvre	9	57 : 0	10 : 8	263	...	1803
Pont d'Austerlitz	5	106 : 0	10 : 8	...	...	1806
St Denis	1	39 : 5	3 : 3	...	...	1808
Bristol Bridge	1	100 : 0	15 : 0	150	4,000	...
Craigellachie Bridge	1	150 : 0	20 : 0	...	8,200	...
Witham Bridge	1	86 : 0	5 : 0	...	. .	...
Vauxhall Bridge	9	78 : 0	29 : 0	...	300,000	1816
Southwark Bridge	3 { 1 / 2	240 : 0 / 210 : 0	24 : 0 / 21 : 0	5780	800,000	1819
Tewkesbury Bridge	1	170 : 0	17 : 0	...	...	...
Galton Bridge	1	180 : 0	18 : 0	...	...	...

CHAPTER II.

We have, in the last chapter, traced the history of iron bridges of rigid form down to the re-introduction of the primitive straight beam or girder—apparently no doubt a retrograde step, when compared with the elaborate and elegant structures we have been considering, and on which so much scientific investigation and mechanical skill had been bestowed. We shall find, however, that the beam rapidly outgrew its original simple form and dimensions, and it is now scarcely to be recognised as the parent of those magnificent structures (far exceeding in dimensions the largest arches), which have become our most prominent monuments of engineering enterprise and skill. We cannot fail to be struck with the reverse order of progress which obtains in architectural history, where we find the beam or lintel characteristic of all the early temples, the arch and abutment characterising the progress of scientific construction.

The word beam, or girder, has thus entirely changed its original signification, and some notice of its present extended meaning is requisite. If we consider the various means employed for crossing space, we find, first, that the weight of the structure and its load is transferred to the bearing points on each side of the space to be crossed, always exerting there a vertical force or pressure corresponding with the weight; and secondly, that these vertical forces or pressures are invariably resolved at the centre of the span into direct horizontal forces.

Now, in order that vertical forces may be transformed into horizontal strains, and equilibrium maintained, some fulcra or resistances must be interposed, and equivalent horizontal forces of an opposite character be exerted; and these fulcra and forces may either exist within the structure itself, where they are termed the "strains on a beam subjected to transverse pressure," or may be external, in the form of corresponding horizontal pressure upon the points of support, in which case the pressure is called "the thrust of the arch;" the oblique direction of the thrust of the arch is thus the resultant of the direct vertical weight of the mass itself, and the direct horizontal reaction of the thrust at the centre.

We have thus two distinct classes of bridges,—First, those in which the horizontal strains are counterbalanced by corresponding horizontal resistances at the abutments, the strain on them being consequently oblique, tending either to draw them together, or thrust them asunder. Suspension bridges and arches are evidently of this class, the simplest type of which would be two abutting struts as in the figure—

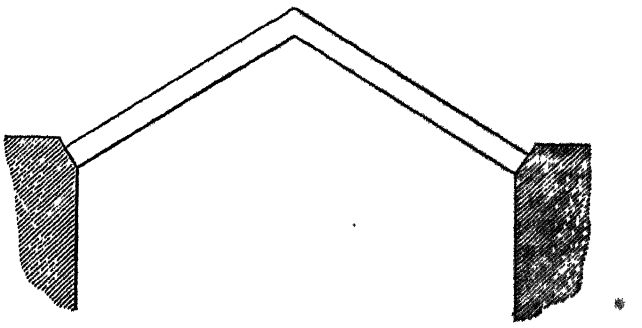


Fig. 12.

Secondly, those bridges in which the pressure upon the abutments is purely vertical, the horizontal strains being met by corresponding horizontal strains within the structure itself, the simplest type of such structures would

Iron Bridges.

be two abutting struts with a connecting tie-chain, as in the figure—

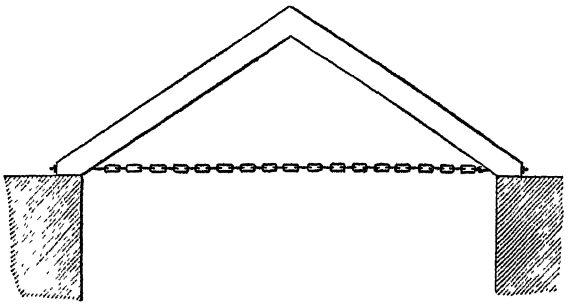


Fig. 13.

It is to every construction of this latter class that we propose to apply the term beam or girder.

All bridge structures will be thus included under these two types. The various forms of beam or girder now in use may, however, be again farther subdivided, and we shall adopt the following classification:—

First Type.	1*st.*	Arches.
	2*d.*	Suspension bridges.
Second Type.	3*d.*	Simple beams, including flanged girders, whether with plain or trellis work sides.
	4*th.*	Trussed girders.
	5*th.*	Bowstring girders.
	6*th.*	Tubular or hollow girders.

(1.) *Iron Arches.*

It would be tedious to devote much more space to a description of those structures, after the numerous examples cited, more especially as, in their application to railway practice, no important novelties were introduced.

The true theory of iron arches has been partially alluded to, and it has been shewn that all such structures should be considered as consisting of two inclined struts—it is evident, however, that these struts being curved in the form of the arch, the load will not have an uniform effect upon them—but this adds little difficulty to the problem. The horizontal forces we have shewn to be equal at the springing and centre of the arch; and the vertical pressure which is at each springing equal to half the weight of the centre structure, is, at any other point, equal to half the weight included between that point and a corresponding one on the other side of the centre.

The laws which govern the horizontal and vertical forces being thus known, it is only necessary to calculate their amount and their resultants to shew the magnitude of the force in the direction of the curve at any point. The joints at each point should naturally be at right angles to the direction of these resultants, and the depths of the voussoirs should correspond with the amount of pressures.

The horizontal force, which is everywhere constant, may be found upon very simple considerations. It depends, first, upon the depth of the arch, or rise, as it is termed. Secondly, upon the horizontal distance of the centre of gravity of the half-loaded arch from its springing; and thirdly, upon the amount of load.

In considering the strains caused by the weight of the arch itself, exclusive of the load, it may be well to observe that, supposing the arch to be uniform in section, its weight per unit of horizontal dimension will not be uniform; and therefore, the horizontal distance of the centre of gravity of the half-arch from the abutment must be the element of length in the calculation, and this horizontal distance will vary, of course, according to the figure of the arch. Similar reasoning must be observed with regard to spandril arches, or those with a horizontal top chord. From the preceding remarks, it is evident that when the weight of the arch itself is considerable as compared with the load, it will be necessary, as we at first observed, to take the horizontal distance of the centre of gravity of the loaded half-arch, which will be at a point between that of the arch itself and that of the load, which, if uniform, will be at the quarter span.

Iron Bridges.

The following simple proportion will therefore give at once the horizontal thrust:—

As the depth of the arch *is to* the horizontal distance of the centre of gravity of one half of it from the springing, *so is* the weight of half the arch *to the* horizontal thrust throughout its length.

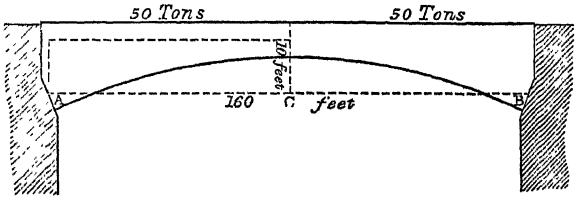


Fig. 14.

Let A B be such an arch, the points A and B being taken at the centre of the springing. Let the rise at the centre, measured from A B to the centre of the middle voussoir, be 10 feet, and let the whole weight of the structure and its load be 100 tons; the girder itself forming but an insignificant portion of that weight, the centre of gravity may be taken at the quarter span, or 40 feet horizontally from the point A.

Then as 10 : 40 = Tons. 50 : Tons. 200 { The horizontal strain and the centre and abutments.

The same reasoning applies to all the description of beam that we have tabulated. In the "Bowstring," the horizontal thrust of the arch or bow is resisted by the tensile strength of the tie-rod or chain; and in the plain girder, by the tensile resistance of the bottom web. To determine the horizontal strains in all these various forms of beams a very simple rule is given in "Britannia and Conway Bridges," page 195, which is—

$$S = \frac{WL}{8d}$$

where S is the horizontal strain in the middle of the top or bottom member of the beam, W the total uniform load including that of the beam L the span, and *d* the depth (or in an arch the rise). Applying this rule to the example just given, we shall have—

$$200 = \frac{100 + 160}{8 + 10}$$

which agrees with the method before used.

We will call attention to another most useful and practical formula, explained also at page 196 of "Britannia and Conway Bridges," and which is of extremely general application, namely,—that in all arches, suspension bridges, tubes, flanged girders, or bowstring girders, and, in fact, every similar structure with top and bottom members, whenever the depth is $\frac{1}{8}$th of the span, and the load, including the weight of the structure, is equally distributed, the horizontal strain in the middle of both top and bottom members of the system is exactly equal to twice the weight of the system with its distributed load.

Iron Bridges.

Again referring to the example which is given in the proportions mentioned:—

Tons. Tons.
$2 \times 100 = 200$ as before.

It must be remarked that, in solid beams, trellis beams, or any of those which have their top and bottom webs attached by intervening struts or continuous plates, the horizontal strains in such top and bottom webs are not, as in the tie of the "bowstring," everywhere equal; but they diminish as they approach the bearings, where they become zero. The rules we have given, when applied to these beams, only determine the horizontal strains in the middle.

Towards the end of this chapter, when describing beams of this class, we shall treat more fully of the theory of the various strains to which they are subjected. As regards the arch, from what we have shown, the reader will meet with no difficulty in finding the horizontal thrust, with the centre of gravity of the semi-arch, in any position; and, as we propose to confine ourselves to the principles of our subject, we shall leave to the reader all mathematical application, merely observing that a simple practical way of discussing the arch will be found to be its imaginary transformation into a beam, and the application of similar reasoning to its investigation.

The requirements of railway practice have by no means been favourable for the introduction of the iron arch the height required, from the circumstance that the roadway must be over the top, the practical difficulty of meeting the thrust, and the necessity of a perfect stability in its foundations, have all been drawbacks to its use, although some of our most elegant and efficient railway bridges are cast-iron arches.

The earliest examples we have of such an application of cast-iron arches are in a series of three bridges for crossing the London and Birmingham Railway over the Grand Junction Canal at Blisworth, Boxmoor, and Nash-mill.

That at Blisworth is of 50 feet clear span, and consists of six cast-iron arched ribs, having a rise of 8 feet; the four inner ones are arranged in two pairs, one under each line of rails; the two ribs composing each pair being 4 feet 11 inches from centre to centre, and a 6-feet space between each pair; the two single outer ribs are again 6 feet from those in pairs; making a total width from centre to centre of the outer ribs of 27 feet 10 inches. The depth of the ribs is 2 feet 3 inches at the springing, diminishing to 2 feet at the crown; their thickness is 2 inches, with a projecting flange 6 inches wide at the top and bottom; making a total sectional area of 51 square inches in each rib at the crown. They rest on cast-iron skew back plates, and these again on blocks of stone let into the brick piers. The ribs are each made in three equal segments bolted together, and are connected by a system of trussing which we shall hereafter describe. The haunches are filled in with three separate castings, one over each spandril, and one as a saddle over the crown. The pattern consists of bars of a cruciform section, crossing each other diagonally, and forming diamond-shaped panels, decreasing in size towards the crown, whose upper apices are connected together by a rib or top table, and their lower ones connected to the main rib by being keyed in between projections upon it. Upon the top tables just mentioned, and firmly bolted to them, are placed strong cast-iron plates 3 feet wide, $\frac{3}{4}$th of an inch thick, with flanges $4\frac{3}{4}$ inches deep all round, and diagonal flanges from corner to corner. These answer the double purpose of steadying and bracing together the spandrils, and also of carrying the ballast, which, however, is not used for bedding sleepers, the rails being carried in chairs resting on longitudinal balks of timber, and bolted down through them to the top table of the spandrils.

The peculiar feature of the bridge is in the system of trussing employed to connect the main ribs. At equal distances along the curved rib there are cast-iron struts furnished with skew ends, with bevelled edges, for the purpose of keying them in between projections cast on the main ribs; these struts are 12 inches deep, 2 inches thick, and all radiate towards a line joining the centres of curvature of all the arched ribs. The skew end of one strut is placed opposite that of the strut on the other side of the rib, so that they form a zig-zag line, the general direction of which is parallel to the abutments; between these struts are placed distance pieces of a cruciform section, with broad ends with bevelled edges, and keyed in between projections on the struts, in the same manner as the latter are fixed to the main ribs. The skew-back plates before mentioned extend the whole length of the abutment, and are of an irregular shape, so as both to fit the springing of the arch, and also to radiate in the same manner as the struts above mentioned, forming, indeed, the last of these struts on each side.

Iron Bridges.

It will be observed that the whole of the bearing portion of this bridge is put together without any bolts (with the exception of those at the junctions in the main ribs, and those fastening the platform plates to the top tables of the spandrils), every junction being made with keys in the manner just described, so as to render motion in the joints almost impossible, and to assimilate the system, as it were, to one entire piece.

The bridge, indeed, though not perhaps remarkable for its great span, is one that justly deserves notice for the extreme care bestowed by the designer on the minutiæ of all its parts, and the great rigidity given to it by the system of trussing so well adapted to the purpose.

The bridge over the canal at Boxmoor is of much the same description; the arrangement of the ribs is precisely the same as of those at Blisworth, but the span and rise are greater; the former is 66 feet, and the latter 11 feet 9 inches, the depth being 2 feet 9 inches at the springing, diminishing to 2 feet at the crown; the spandrils are similar to those at Blisworth, and also the top plates, except that they are lozenge-shaped instead of square. The trussing of the main ribs is different, the system of keying not being so entirely adhered to. It consists of cast-iron struts of a cruciform section keyed in between the main ribs in lines perpendicular to the abutments, and of cast-iron pipe struts, through the entire length of which wrought-iron tie-rods pass, and which extend from side to side of the bridge parallel to the abutments. These also are keyed in between the main ribs, but are not in any way connected with the struts described as being placed at right angles to the abutments.

The bridge at Nash-mill is precisely similar to the one at Boxmoor.

The outer ribs of these bridges are surmounted by light cast-iron railing which extends some distance each way past the arch to the top of the slopes on either side, and gives the bridge a neat and pleasing appearance.

There is also an elegant bridge on this principle, erected on the Midland Counties Railway over the River Trent, at its confluence with the Soar, near Sawley. (See fig. 15.) It consists of three segmental arches of 100 feet span, the radius being 130 feet. They are similar in principle to the arches of Vauxhall Bridge, but possess considerable architectural beauty, the spandrils of the ribs being formed with vertical panels in the Tudor style. Each arch consists of six ribs, strutted and tied by bracing-panels and rods; the ribs are double-flanged, and the rise is $\frac{1}{13}$th of the span; the depth of the rib is 3 feet at the springing, and 2 feet 6 inches at the crown; they are each in three castings, and the work is admirably executed. The platform is of timber; the width between the balustrades being 27 feet. This bridge was completed by the Butterly Company in 1839; its situation amidst fine scenery adds much to its successful artistic effect.

Numerous other examples might be given on all our

railways, while the advantages which such structures possess, as regards durability and beauty, would warrant their much more frequent use, where circumstances would allow of their adoption.

Iron Bridges.

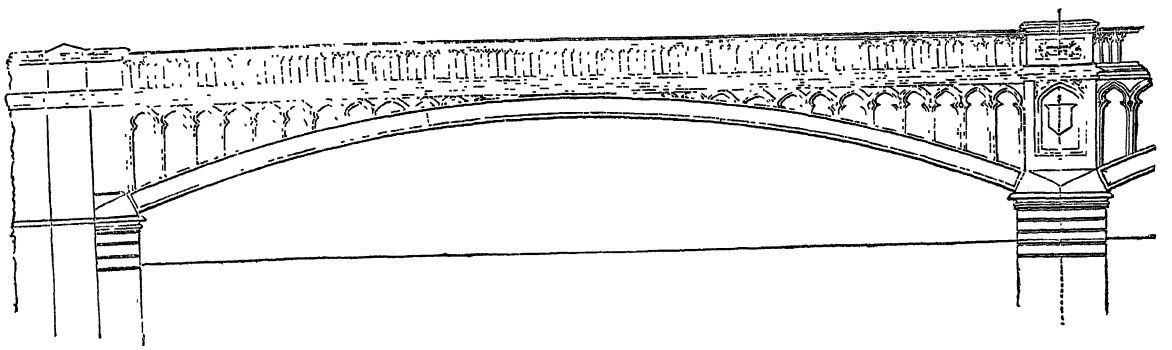


Fig. 15.—Trent Bridge.

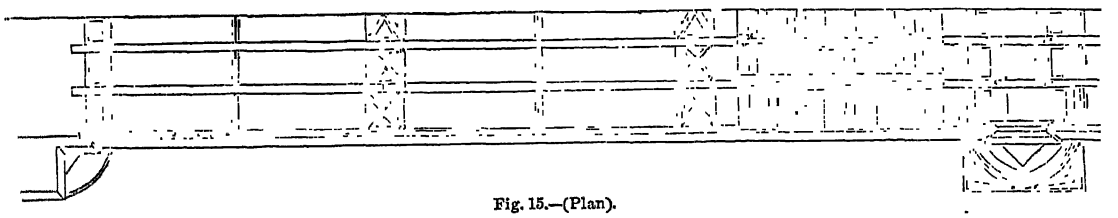


Fig. 15.—(Plan).

Among the boldest structures of this class which have been contemplated, the arches designed to cross the Menai Straits, on the site of the present tubular bridge, are perhaps the most remarkable. These arches, two in number, were of great architectural beauty, the span being 350 feet, with a rise of 50 feet. They are engraved and described in *Britannia and Conway Bridges*, page 17, and plate 32. The process proposed for their erection was equally remarkable. It was necessary to dispense with all centering, which was to be effected by resisting the horizontal thrust of each successive voussoir by tie-rods passing over the pier, and attached to a corresponding voussoir on the opposite side. Each semi-arch would thus form a bracket tied back by an opposite semi-arch, and the horizontal thrust being thus entirely destroyed, the semi-arches would exert no pressure on each other when they met over the centre of the span, while the whole of the rods employed would only equal in their combined section the sectional area of a chain of sufficient strength to resist the horizontal thrust of the complete arch; the consideration of the strain on these individual rods affords an instructive illustration of the actual strains on the voussoirs of an arch.

Before leaving this part of the subject, we may allude to the introduction of deep iron arches in the construction of roofs, of which an interesting example exists at the Great Western Railway Station at Paddington, and in the roof of the transept of the Crystal Palace. The investigation of the strains in the arch in such cases is extremely difficult. The unequal distribution of the lead, the great degree of curvature, and consequent great vertical depth from the springing, together with the attachment of the arch to its supports—all complicate the problem.

These curved ribs, however, are not true arches, since they may be considered as nearly free from thrust.

(2.) *Suspension Bridges.*

Under this head, we only intend, as before explained, to notice the attempts that have been made to render such structures sufficiently rigid for railway travelling. We may, however, observe, that similar reasoning to that which we have applied to the arch may be applied to suspension-bridges,—*i.e.*, we may consider them as girders, by imagining the existence of a horizontal strut to resist the tension of the chains.

In comparing a suspension-bridge, or an arch with a girder of the same span, depth, and strength, it is evident that while the suspension-bridge will correspond with the lower member of the girder, the arch will correspond with the upper member, therefore there must be a theoretical advantage possessed by the suspension-bridge and arch in weight over the girder; but the arch is a structure which requires so many additions to preserve it from change of shape, that it cannot practically be taken as merely suffering compression. With the suspension-bridge the case is entirely different; the chain being in a state of equilibrium preserves its form, independent of all extraneous assistance, possessing unaided all the qualifications for resisting the strains of a horizontal load. The suspension-bridge is thus, undoubtedly, the lightest of bridge structures; and the only drawback to its application to railway purposes is its flexibility, which renders it unfit for the support of a rigid roadway. To overcome this difficulty, and combine the rigidity of the girder with the advantages of the chain, has been a problem which has naturally occupied the attention of engineers.

The construction of a suspension-chain for the erection of the tubes intended for the Britannia Bridge, for a long time occupied attention; but this was finally abandoned, owing to the difficulty arising from the expansion and contraction of the chain, which it was proved in a span of 460 feet, with versed sine of 40 feet, would amount to 4 inches. Such a degree of extension would increase the versed sine, and lower the centre portion of the tube as much as 9½ inches. Unless, therefore, the roadway be pliable enough to follow this descent and rise of the chain, it is evident that the chain would be at times either sustaining the whole weight or none at all. The trussing on any rigid roadway suspended from a chain must, therefore, be sufficiently pliable to yield to this motion of the chain, and to be uninjured by its constant action, consequently it must be subject to considerable deflection on the passage of a heavy load. The requisite bracing for securing even this partial rigidity would add, moreover, great weight and cost to the structure, so that, in fact, the economy of the chain would disappear; and, where circumstances will permit, it is far preferable to

Iron Bridges.

convert the chain into the lower member of a rigid beam, as in the Chepstow and Saltash bridges by Mr Brunel, which will be described under the head of Trussed Girders.

In the crossing of the River Niagara over the Niagara Falls, where scaffolding or the floating of any kind of structure to its place were equally impracticable, a suspension bridge was the only possible expedient; and the skilful and successful manner in which the difficulties of such a problem have been met deservedly characterize this work as one of the most remarkable that claims our attention.

The Niagara bridge which has been lately completed by Mr Roebling is indeed the only successful railway suspension bridge of large span. It crosses the Niagara River at a height of 245 feet above the water by a single span of 821 feet 4 inches, and forms the connecting link between the American States and Canada.

The superstructure may be best described as a hollow rectangular box, 18 feet deep and 24 feet wide, on the top of which the railway is laid, while the bottom, which is 25 feet wide, forms the roadway for public traffic—both these floors are constructed of timber beams; and each connecting side consists of a row of double posts or uprights of timber, each pair being 5 feet apart; between them wrought-iron diagonal bars are made to pass, extending each way to the fourth pair of posts at an angle of 45 degrees. The upper or railway floor is suspended from two wire cables at intervals of 5 feet, and the lower floor is suspended at similar intervals from two other wire cables which have a deflection of 10 feet more than the upper ones; these cables, four in number, are each 10 inches in diameter, and composed of seven strands, each containing 520 wires, making a total of 3640 wires. One strand forms the axis round which the other six are twisted; a section of the cable is shown in the accompanying figure. Sixty wires are equal to 1 square inch of solid section; therefore the total area of each cable is 60·4 square inches, or the total sectional area of iron supporting the structure is 241·6 square inches.

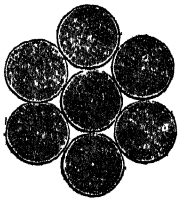


Fig. 16.

Each cable rests upon a separate saddle, there being two on the top of each of the four towers. The saddles are placed on ten cast-iron rollers, 5 inches diameter and 25½ inches long, which bear upon cast-iron plates 8 feet square and 2½ inches thick, strengthened by three parallel flanges which form two compartments for the reception of the saddles.

The ends of the cables are attached to cast-iron shoes, in each of which is inserted a wrought-iron pin which forms the connection with the anchor chains. These anchor chains are each imbedded in a solid shaft of masonry 7 feet by 3 feet, enlarged at the bottom to form a chamber 8 feet square cut in the rock. The shafts are sunk to a depth of 25 feet on the New York side, and 35 feet on the Canada side.

Each anchor chain is composed of nine links, the eight lower links being 7 feet long, and the ninth or uppermost 10 feet long. The lowest link consists of seven wrought-iron bars, 7 inches by 1·4 inches each, and amounting collectively to an area of 69 square inches. They are secured to a cast-iron anchor plate, by a pin 3½ inches diameter. From the fourth link the chain curves, and the section is gradually increased to an area of 93 square inches. There are two towers at each end of the bridge, based upon a mass of masonry 60 feet by 20 feet, which is pierced by an arch 19 feet wide, forming the entrance to the lower roadway. The towers are 60 feet high, 15 feet square at the base, and 8 feet square at the top.

Above the floors are 64 diagonal stays, extending from the saddles to the suspenders, amongst which they are equally distributed; they are formed of wire-rope 1⅜th inches diameter. There are also 56 stays attached at their upper extremities to the soffit of the bridge, and at their other ends well anchored to the rocks below. The superstructure is thus tied down as well as suspended, and all undulations directly resisted.

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The weight of the bridge is estimated as follows:—

Timber	910·130 lbs.
Wrought-iron	113·120 „
Castings	44·332 „
Rails	66·740 „
Cables between towers	534·400 „
The total weight being	1668·722 lbs. = 745 tons.

The bridge was commenced in September 1852, and opened for traffic in March 1855. The total cost was L.80,000.

It may scarcely be necessary to observe, that were a span of this magnitude required to cross a navigable channel, it would be impossible to adopt the system of stays we have described, and which are so essential in rendering the bridge sufficiently rigid *for railway traffic*. The engineer has here most successfully and judiciously availed himself of this and every other advantage which the peculiar site afforded, though, under ordinary circumstances, suspension-bridges are not applicable to such traffic. Even in the bridge we are describing, it is found necessary to limit the speed of the trains to three miles an hour.

(3.) *Simple Beams.*

Under this head we shall include not only rectangular prismatic beams, which are but little used in bridge construction, but more especially that particular form of beam with top and bottom flanges, to which the term flanged girder is generally applied, the vertical web of such girders consisting either of open work or solid plate.

The investigation of the strength of a prismatic beam to resist the effect of a horizontal load, has engaged the attention of mathematicians from the time of Galileo, who considered that a beam loaded horizontally was only subjected to one strain, and consequently only exerted one resistance, viz., that of tension, or, in other words, a beam under pressure would turn on a fulcrum close to that pressure; but by the able experiments and investigations of our more modern philosophers this theory was shown to be fallacious, and we are greatly indebted to the mathematical treatment of the subject by Marriotte, Coulomb, Young, Barlow, Tredgold, and others, without which, and the more recent investigations by Mr Eaton Hodgkinson, we should never have had those magnificent triumphs of art and science which span the widest rivers, and which form the subject of our article. Yet the problem is by no means completely solved, even at the present day, for there still exists a great discrepancy with respect to the calculated and actual strength of a beam.

When, supported at each end, a beam is loaded horizontally, it is found by experiment that its upper surface suffers compression, and its lower surface suffers extension; such compression and extension evidently originating from the vertical support of the beam at each end. Each half of the beam may, therefore, be regarded as a lever in inducing these forces. Now, the beam is imagined to consist of a succession of indefinitely thin horizontal layers, and the compression and extension of these layers is found to be greatest near the upper and lower surfaces of the beam, and to diminish in some ratio towards the centre; it is, therefore, presumed that some layer must exist within the beam in which neither compression nor extension takes place. The position of this layer is called the neutral axis. Now, presuming such to be the case, the extension or com

pression of a layer must be as its distance from the neutral axis, and the force will be as the extension, if we admit the truth of Hook's principle, *Ut tensio sic vis;* also the force of a layer must be as its area, consequently the power of any layer to resist a horizontal load is as its force, its area, and the square of its distance from the neutral axis, and by summing up the moments of the indefinitely thin layers, we arrive at the well-known formula—

$$W = \frac{f b d^2 C}{6l},$$

which also applies to a solid prismatic beam loaded as in the figure:—

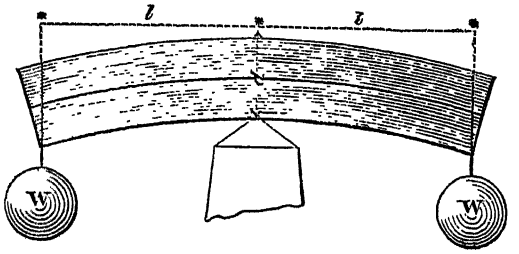


Fig. 17.

where W is the load, l is the horizontal length from the fulcrum, d is the depth of the beam, b its breadth, and C is the constant derived from experiment. In the figure, however, the top is in tension and the bottom is suffering compression; in fact, the support in the middle may be considered as a weight acting upwards while the weights WW have the same effect as supports acting downwards.

It is remarkable that the importance of depth in an ordinary beam should so long have escaped notice. We find the floors of old houses invariably supported on massive square beams, with no regard to economy of material, or its proper disposal to resist strain. The use, however, of a more expensive material, such as cast iron, called attention to this important subject, and the solid beam merged slowly into the flanged girder; for it was an easy step, when the effect of depth in a beam was carefully considered, to perceive the value of the addition of a top and bottom flange, thus introducing the material where it was evidently acting to the greatest advantage.

The earliest flanged girders used in bridge construction were formed with their flanges of equal strength, and their vertical ribs were much more massive than requisite for the office which they had to perform, namely, that of simply uniting the flanges. The strength of such beams was calculated by peculiar formulæ highly mathematical and complicated, inasmuch as due account was taken of the strength of the middle web to resist horizontal strains. The mode of calculation generally adopted was to consider the section as a rectangle of the entire depth into the width of the flanges, and then to deduct the value of the side portions, the remainder being the strength of the flanged beam.

The rule deduced from the above reasoning was as follows:—

$$W = \frac{\left(bd^2 - \frac{b_1 d_1^3}{d}\right) C}{l},$$

in which W is the load to be sustained, b the entire breadth, d the entire depth, b_1 the breadth, exclusive of the thickness of the web, d_1 the depth between the flanges, l the length, and C the constant quantity, as before.

Upon the preceding mode of reasoning, it is assumed that when the outer layer is strained beyond its ultimate strength, the fracture of the entire section must ensue.

*It seems reasonable to suppose that, with the above data, it would be only necessary to obtain by experiment the ultimate force of a unit of section to resist a direct strain (represented by C in the foregoing rules), to enable us to calculate the strength of a prismatic beam. Yet, as we have before observed, such a calculation gives a result widely different to that of practice, the actual strength of the beam being invariably much greater than is determined by the calculation. Some assumption that has been made must therefore be erroneous, and the difficulty of the problem is in accounting for this anomaly. By some it has been assumed that the position of the neutral axis is not situated in the centre of gravity of the section of a beam, but is much nearer the compressed side. This, to a certain extent, is going back to the exploded Galilean theory, yet it is a singular fact that experiments agreed very nearly with this view. (See *Experimental Researches on Cast Iron*, by Mr Eaton Hodgkinson.) Subsequently, in a paper by Mr W. H. Barlow, read before the Royal Society, on a New Element of Strength in Beams subjected to transverse pressure, and called the *Resistance of Flexure*, an account of some valuable and interesting experiments was given, which were conducted with the greatest nicety, and which seem to prove that the axis of motion is in the centre of a uniform section; therefore the discrepancy before named has yet to be accounted for, and it seems evident that a great error is committed in considering the existence of a neutral axis as it is called, which suffers neither extension nor compression, the fact being that if it is inactive it is only in a horizontal direction, for there is no part of a beam sustaining a load that is not strained in some direction; and wherever a particle of which it is composed can be shown to be free from strain in one direction, in another direction that particle bears its full share of strain. It appears evident that the vertical reaction of the supports is not entirely met by the simple horizontal resistances of an indefinite number of independent layers. The layers should not be considered as independent like the leaves of a book, since they form altogether a solid mass; and we cannot imagine a top layer to be compressed say $\frac{1}{100}$ of its length, and the next below it $\frac{999}{1000}$ without the top layer receiving considerable assistance from its less strained neighbour to which it is so intimately united, and which, in its turn, receives successively similar assistance from every other layer between itself and the neutral axis. The external layer is not therefore subject to the strain which is assumed on account of this assistance which it receives from subsequent layers, and fracture does not take place so soon as such a theory foretells.

The mode alluded to of dealing with the forces brought into action on a beam, when subject to transverse strain, must therefore lead to a misapprehension regarding the true directions of these forces; for instance, the neutral axis is supposed to be a point situated between the portion of the beam undergoing compression and that undergoing extension, and consequently neither subject to extension nor compression, it being regarded as absolutely inactive. Now, this would only be true if the forces called into play were truly horizontal, which in fact is what the present theory of beams assumes.

If, however, we consider the relative motions which take place amongst the particles comprising the upper portions of a beam when undergoing compression, and those undergoing extension in the lower portion, it will at once be perceived that an infinite number of diagonal lines, passing through the region near what is called the neutral axis, may be drawn exhibiting the direction of a variety of forces, both compressive and tensile, and which are not represented by the horizontal lines alone taken into account by the above theory. It is conceived that this mode of looking at the subject shows more clearly than any other that no actual neutral axis can exist; that is, no portion of a beam under

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strain can be in a quiescent or passive state. To illustrate this more clearly, let us refer to the figure which represents the centre portion of a beam, the vertical line *bd* being in fact the centre line.

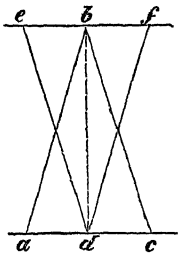


Fig. 18.

Let us suppose the beam to be loaded at the top point *b*, then when deflection takes place, the points *a* and *c* will recede from each other, and at equal distances from the point *d*, but the other extremities of these diagonal lines will be fixed in the point *b* by equal forces, consequently there will be a direct strain down these lines of tension. Again, the diagonals *de* and *df* suffer compression, being shortened by the approach of the points *e* and *f*.

Innumerable other diagonal lines in all possible angles might be drawn from these points *b* and *d*, in which the forces of extension and compression might be traced crossing each other in all directions; therefore, as we have before observed, when a beam is subjected to such a strain as is caused by a horizontal load, and by which pressure naturally takes place, there is no part of such a beam in a quiescent state. Now, respecting the neutral axis referred even to horizontal strains, it is assumed to be free from such strains by the following geometrical reasoning,—viz., if a rectangular parallelogram be bent into a curve, the outer line being extended and the inner line shortened, there must be some line between the two which will neither be extended nor shortened; but it does not follow from this geometrical fact that the line is free from strain because it is unaltered in length. A beam is curved by the effect of strain throughout, and every line in it, excepting the vertical lines, is curved, including, of course, that called the neutral axis; and the fact of that line being curved shows evidently a molecular disturbance which is certainly produced by force, and therefore it is strained.

The other assumption in the above theory, which renders it dependent upon the kind of material of which the beam is composed,—viz., that the reaction of a compressed or extended fibre is proportionate to the amount of compression or extension,—has within moderate limits been proved to be correct as regards wrought iron and cast iron, the amount of the extension or compression caused by 1 ton in a bar 1 inch square, being respectively $\frac{1}{6000}$th of its length, and $\frac{1}{10,000}$th of its length, or twice as great for the former as for the latter; similarly, if the pressure or tension is twice or three times as great, the alteration in length will also become twice or three times as great, but as we approach the ultimate strength of the iron this law entirely ceases, the compression or extension then increasing in a much higher ratio than the force applied. The assumption, *ut tensio sic vis*, on which this theory of a beam is founded, only therefore holds good within moderate limits; and this variation, combined with the erroneous assumption of the action of the fibres as being independent layers, before alluded to, gives rise to the anomalies which exist between theory and experiment, and renders the solution of the problem extremely difficult.

To Mr Eaton Hodgkinson the credit is more especially due of pointing out the proper relative proportions of the top and bottom flanges; but the section which these proportions rendered it necessary to adopt, caused the true valuation of the entire section to be so tedious, and even difficult, in the summation of the moments on each side of the neutral axis,—which in this case was not in the mid section,—that that gentleman thought it far better to consider the vertical rib as useless to resist horizontal strains, giving it only sufficient strength to resist lateral strains, to connect the top and bottom flanges, and transmit the strains between them. Therefore, without any complexity of formulæ, the strength of the beam was considered to exist in its flanges, and to vary simply as their distance apart, or as the depth of the beam.

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The investigations made by Mr Hodgkinson led directly or indirectly to a great part of the information we possess respecting the properties of wrought and cast iron. He found the ultimate resistance of cast iron to be as follows, viz., the extension 6·5 tons per square inch, and in compression 40 tons per square inch. He determined, moreover, the variation in length within certain limits of a cast-iron bar 1 inch square subjected to strain to be about $\frac{1}{10,000}$th of its length per ton. Similarly with ordinary wrought iron, the ultimate resistance was determined to be 18·6 tons per square inch in extension, and 16 tons in compression, and the elongation of an inch bar $\frac{1}{10000}$th of its length per ton. He applied these practical results in determining the flexure and strength of girders and pillars, and corroborated the accuracy of his deductions by numberless experiments rivalling in practical value his earlier investigations.

If we neglect the vertical rib of a girder, a very simple view may be taken of its action in resisting a horizontal load, and the result will agree exactly with what we have given with respect to arched beams. In fact, the rule becomes universally applicable to beams generally, and may be briefly explained as follows:—

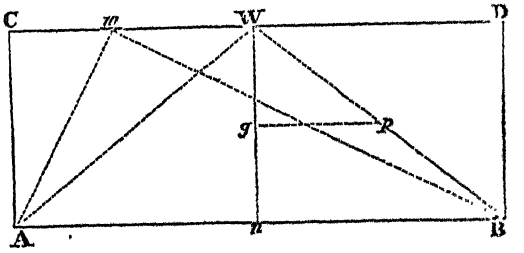


Fig. 19.

Let ABCD be a girder, loaded at W, and supported on the points A and B. The forces are transmitted along the diagonal lines AW and BW. If we now construct the parallelogram of forces on the diagonals, we shall have W*g* representing the vertical force, or half the weight transmitted to the bearings A and B, and *pg* will represent the horizontal strain at the centre of the beam, or, taking the whole depth, W*n* = *d*, and A*n* = half the length, we shall have—

$$d : \frac{l}{2} :: \frac{W}{2} : gp = \frac{Wl}{4d},$$

which is the horizontal strain at the point W. Again, suppose we consider W to act as a fulcrum with the weight acting at A or B = $\frac{W}{2}$; the moment of this force will be $\frac{W}{2} \times \frac{l}{2} = \frac{Wl}{4}$, and the horizontal strain acting with the leverage *d* will be S × *d*; and by equating these $Sd = \frac{Wl}{4}$, or $S = \frac{Wl}{4d}$, as before.

By a similar method of reasoning, the horizontal strain at any other point caused by a load in the middle can be determined.

Referring once more to the figure, we will endeavour to determine the strain at the point *w*.

Still considering the point W to act as a fulcrum, and the weight $\frac{W}{2}$ to act upwards at each of the points A and B,

each half beam will act as a cantilever or as a beam fixed at one end and loaded at the other.

The weight $\frac{W}{2}$ will act with a leverage r = distance wC with an effect $\frac{W}{2} \times r$, and the horizontal strain at w acts with a leverage d, its moment being $S \times d$; therefore

$$Sd = \frac{rW}{2} \text{ and } S = \frac{rW}{2d},$$

which becomes, when $r = \frac{l}{2}$, $S = \frac{Wl}{4d}$, as before.

The requisite strength of the top and bottom flanges of a girder to support any weight at the centre is thus at once determined.

If the weight, instead of being placed on the centre of the girder, be equally distributed over its length, it is evident we still have a load equal to $\frac{W}{2}$ at each end of the girder as before, but the horizontal strain at the centre W is now only half what it was in the former case; it is, in fact, the same as though one-half of the entire distributed weight were accumulated at the centre, and this will be easily understood if we reflect, that although the weight at each end is still $\frac{W}{2}$, each half of the beam no longer tends to fold itself around the point W, at the centre of the beam as before, but around a series of points equally distributed along the beam as shown in the figure.

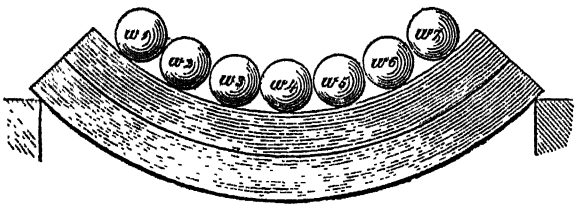


Fig. 20.

The weights w_1, w_2, w_3, w_4, &c., may be considered as acting at their centre of gravity, half way between the points of bearing, and one-half only of their pressure acts directly at the centre in a vertical direction.

We may suppose the whole weight to exist in the form of two solid bars AC, CB, laid upon the beam, one-half of the weight of which is evidently supported at A and B, pro-

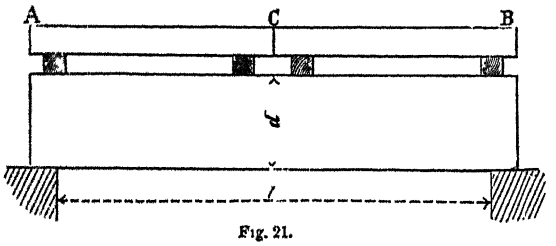


Fig. 21.

ducing no transverse strain on the beam, while the other half alone acts directly at C.

The beam at the centre therefore suffers from an equally distributed weight only half as much as though the same weight were accumulated at the centre, therefore we have for the horizontal strain in the centre, caused by a uniform load,

$$S = \frac{lW}{8d}.$$

And to find the strain at any other point caused by a uniform load, we have the following proportion:—As the square of the half span is to the strain at the centre, so is the rectangle of the segments into which the given point

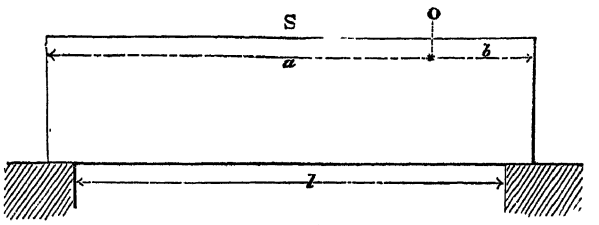


Fig. 22.

divides the beam to the strain at that point. Or referring to the figure, we have, expressed algebraically,

$$\left(\frac{l}{2}\right)^2 : S :: ab : \frac{4abS}{l^2} =$$

the strain at the point O.

For all these beams or girders a general rule appertains, which is

$$W = \frac{adC}{l},$$

in which W = the load, a the area of the section strained, l the length, and C the constant as before. With respect to this rule, however, it will be necessary to observe that the constant C will vary according to circumstances—that is, it will be different for beams loaded and placed in different positions.

The above rule equally applies to a solid section where $a = bd$, and $bd^2 = ad$; and to show the analogy between the preceding rules for the horizontal strains and the above, we shall have for a beam loaded in the middle

$$S = \frac{Wl}{4d}, \text{ and } W = \frac{adC}{l};$$

and therefore, in this instance $C = \frac{4S}{a}$; but if the load be uniform $C = \frac{8S}{a}$; this constant will, therefore, be different for all the various applications of the load and position of the beam.

We shall now consider those simple girders which have open work sides, including the trellis and Warren girders.

If the top and bottom flanges of an equally loaded girder are united by vertical bars, the elements of a beam are wanting in such a system, and flexure takes place, as in

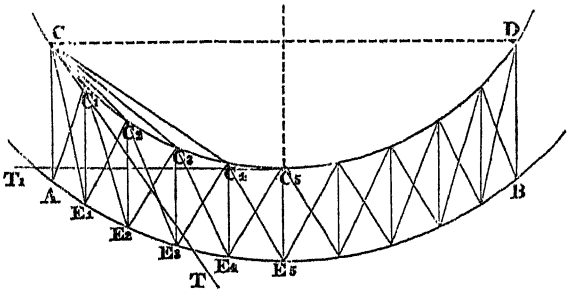


Fig. 23.

the figure. The diagonals CE_1, C_1E_2, C_2E_3, &c., become elongated, while the diagonals AC_1, E_1C_2, E_2C_3, &c., become shortened, this distortion being greatest at the ends of the beam, and nothing at the centre panel C_4E_5.

Assuming the curve to be a circle, the number of the panels to be n, and T and T_1 to be tangents at C and C_5; it is evident, that since the chords are equal, the angles TCC_1, C_1CC_2, &c., are all equal, and the angle DCT, which measures the distortion of the first rectangle, is n times as great as the angle TC_5C_4, which measures the distortion of the rectangle at the centre; consequently when n becomes infinite, as in a girder with plain sides, the angle

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in the centre = 0, or the strain on the centre diagonals is nothing, increasing regularly towards each extremity. This result must be considered rather as an illustration than a demonstration; but to illustrate this important subject more fully, let us first consider all the verticals and diagonals perfectly inelastic, confining our attention to one panel C_4E_5. It is evident that from the compression on the top flange, the two points C_4, C_5 must have approached each other, and the two points E_4, E_5 must become further removed from each other: and this change of form of the top and bottom flange is greatest at the centre of the beam and nothing at the ends; the ends of the beam CADB do not therefore remain parallel, but approach each other at the top, and recede at the bottom. Now it is of extreme importance to remark, that this distortion of the rectangle C_4E_5 from the compression and extension of its top and bottom lines does not necessarily involve any change in the length of the verticals or diagonals, or, in other words, it may take place without producing any strain in them.

If ABCD is the original rectangle, A_1, B_1, C_1, D_1, will represent the distorted rectangle, the side CD being compressed to C_1D_1, the side AB elongated to A_1B_1, the remaining sides $A_1C_1B_1D_1$ and the diagonals $A_1D_1B_1C_1$ remaining precisely of the same length as in the original rectangle, but the line of junction of the diagonals is raised from O to O_1, and the whole depth of the beam is diminished.

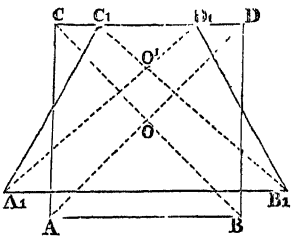
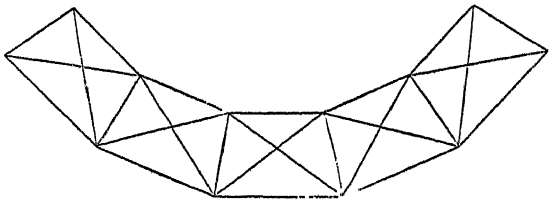


Fig. 24.

The girder may therefore, from mere change in its top and bottom flanges, assume the following form, even if the verticals and diagonals were perfectly inelastic.


Fig. 25.

If, however, these rectangles are filled in with solid plates, it is evident that these plates must be stretched and compressed, and consequently distorted through every atom of their composition, before the rectangle ABCD can be changed into the figure $A_1B_1C_1D_1$. Hence the remarkable stiffness and rigidity of girders with solid plates in their sides, and the small amount of deflection in such girders, as compared with those whose sides are formed of open or trellis-work; the difference resolving itself into this—that in the trellis girder deflection is only resisted by the elasticity of the top and bottom flanges, and in the girder with solid sides it is resisted, in addition to the above, by the elasticity of every particle of material of which the sides are composed.

Again, if we suppose the top and bottom flanges perfectly inelastic, and the verticals and diagonals alone capable of extension and compression, flexure takes place solely by the elongation of the diagonals CE_1 C_1E_2, &c., and by simultaneous compression of the diagonals A_1C, E_1C_2, &c., as in fig. 24.

In this case the distortion of the rectangles is greatest at the extremities of the girder, and nothing at the centre; the ends would now remain vertical, and, if plates were substituted for the diagonals, the change of figure of these plates would again involve compression, extension, and distortion of every atom of which they are composed.

We have then this important deduction, that as regards that portion of the entire flexure of a girder which arises from extension or compression of the flanges, the trellis-work, whatever may be its strength, does nothing towards its diminution, while the plate, on the contrary, does resist this flexure; and as the distortion is greatest at the centre of the girder, the centre panel in a trellis girder might be omitted; but it is by no means useless to insert a plate on the centre panel of a solid-sided girder, though such has generally been assumed to be the case.

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Again, as regards that portion of the whole flexure of a girder which arises from elongation or compression of the verticals or diagonals, it is evident that such change of form is greatest at the extremities, and whether plates or trellis-work be used, the strength of the vertical rib should at those points be greatest, while at the centre it may be reduced to zero.

Now, in practice, the deflection of the girder arises from both the above-named causes combined, viz., from the elasticity of the flanges and that of the vertical rib; and to secure the least deflection possible, it is evidently necessary to strengthen the flanges at the centre, to avoid that which arises from their change of form; also to strengthen the vertical rib at the extremities, so as to avoid the deflection caused by its distortion. We therefore perceive that trellis-work can only be substituted for plates at a sacrifice of stiffness, and that plates are efficient in insuring stiffness, even in the centre panel of the beam.

If we consider the origin of the strain in a girder, we arrive also at the same result. Let A, B, C, D be the flanges of a girder with vertical bars between them. Half the

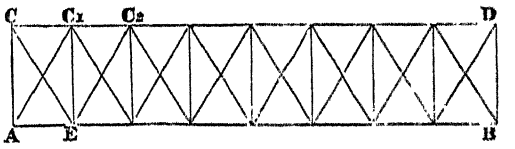


Fig. 26.

weight of the girder $\frac{W}{2}$ is supported by the vertical prop AC. Then the strain on AC_1 is to the vertical pressure at A, as the diagonal AC_1 is to the vertical AC; the strain on AC_1 varies therefore as the cosecant of the angle of inclination C_1AC.

Although in a girder with plain sides, the horizontal strain vanishes at the extremities, this is not the case with the trellis sides; for the strain on AE is evidently to the pressure at A, as AE is to EC_1, or varies as the tangent of the angle of inclination C_1AE. If this angle be 45°, then the tension on AE is exactly equal to the pressure at A.

The strut AC_2 may be replaced by the tension-rod CE, and with the exception that the strain will now be a tensile one, it will in every other respect be similar to the strain on A.

If the strut and tension-rod are both used, each may be assumed as resisting one-half of the strain that would come upon either singly.

If a thin plate is inserted, it may be considered as of no effect in resisting compression, but as replacing the tension-

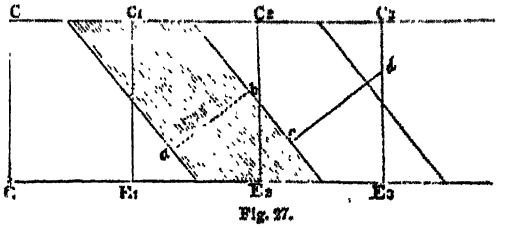


Fig. 27.

rod CE; and with respect to its requisite strength we may arrive at a very useful practical approximation as follows:—

If C_1, E_1 and C_2, E_2 are the verticals as before, the portion of shaded plate, C_1E_2 takes the place of the tension-rod between C_1 and E_2, and being subjected to the same strain, requires the same sectional area across the lines *ab* and *cd*. Each fibre in the direction of the shading being also of the same length as the diagonal which they replace, it is evident that the quantity of material required per panel is approximately the same whether the diagonal or the plate be employed. We have alluded to the advantage on the side of the plate with respect to flexure. It is also evident, from the figure we have given of the distortion of the plate, that this tensile strain is not the only efficient resistance it offers to the fracture of the beam, so that the strength arrived at above is certainly on the safe side.

Having determined the requisite strength of the diagonals and verticals of the extreme panel, and of the centre panel, which, in fact, need only be of sufficient strength to act as an independent beam in supporting the rolling load which comes upon it, the strain on the intermediate panels will be as their distance from the extremity. This may be illustrated as follows:—

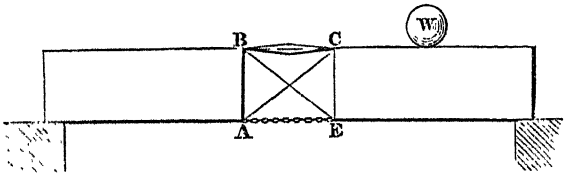


Fig. 28.

If an equally loaded girder be cut in two at the centre, it will be perfectly restored by the insertion of a strut at C and a chain at E. The tendency of either half to descend at E is precisely counterbalanced by the similar tendency of the other half, and no diagonal is necessary to maintain equilibrium. If a weight W be placed at the centre of one half, this equilibrium is destroyed, the point E now has a tendency to descend vertically, with a pressure equivalent to $\frac{W}{2}$, and a strut at AC, or a tension-bar BE equivalent to this strain must now be inserted to restore stability. Hence the centre panel requires diagonals proportionate to the weight of the rolling load.

Now, if the beam, instead of being cut through at the centre, be cut through at any point CE, it is evident that a strut and a chain will no longer restore the stability of

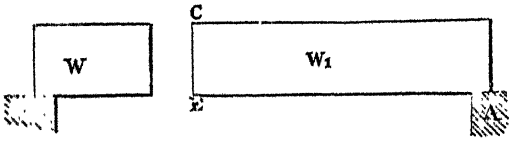


Fig. 29.

the system, the portion of the beam EA, supposing its weight to be W_1, acts with a downward pressure $\frac{W_1}{2}$ at the point E, which exceeds the downward pressure $\frac{W}{2}$ of the other portion. We therefore have a true measure of the vertical force at every point of the vertical rib, which is always equal to half the difference of the weights sustained on the two sections of the beam into which the point divides it, and at once determines the requisite dimensions of the diagonals, which are consequently in exact proportion to their distance from the extremity; so that if a beam be supposed 10 feet long, and to have 10 panels, with 1 ton placed upon each panel, the vertical strains commencing from the extremity will be as follows:—

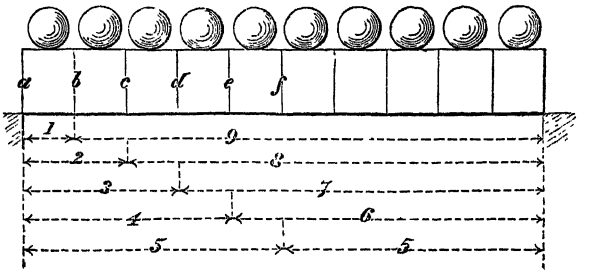


Fig. 30.

The vertical strain at $a = \frac{10-0}{2} = 5$

... ... $b = \frac{9-1}{2} = 4$

... ... $c = \frac{8-2}{2} = 3$

... ... $d = \frac{7-3}{2} = 2$

... ... $e = \frac{6-4}{2} = 1$

... ... at centre $f = \frac{5-5}{2} = 0$

In addition to these strains, we have evidently to add the strain produced by the rolling load.

The strain on the verticals throughout is easily determined when the strain on the diagonal is known, the vertical becoming a strut when the diagonal is a tie-bar, and a tie-bar when the vertical is a strut. When a plate is used, the vertical evidently becomes a strut; and when a diagonal strut as well as a diagonal tie-bar is employed, or when the plates become very thick, as in cast-iron girders, it has evidently no duty to perform, and may be omitted. We have therefore all the elements of a perfect beam in the following arrangements (1, 2, and 3, fig. 31), in which ties are represented by dotted lines, and struts by full lines.

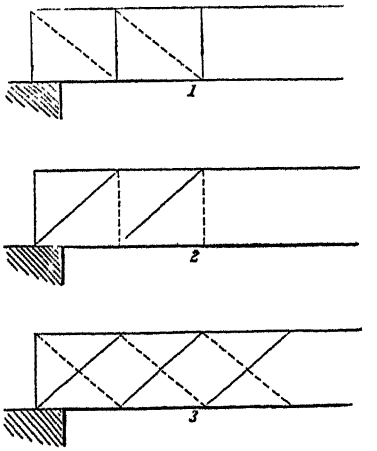


Fig. 31.

In No. 3 of fig. 31, we have evidently two systems of struts and ties, and omitting either of them, we have the ordinary

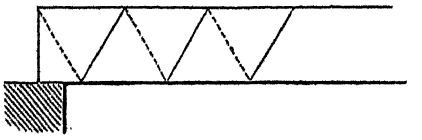


Fig. 32.

Warren and Kennard girder as in fig. 32, which is doubtless

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the simplest possible form of trellis girder that can be constructed, and of which a magnificent example exists in the Crumlin Viaduct in South Wales.

We shall, however, first describe the Newark Dyke Bridge, which, with the exception of some small and badly designed cast-iron girders, was the first, and is still, as regards span, the largest bridge constructed on this principle. Newark Dyke Bridge carries the Great Northern line over a branch of the Trent near Newark, and was erected under the direction of Mr Joseph Cubitt.

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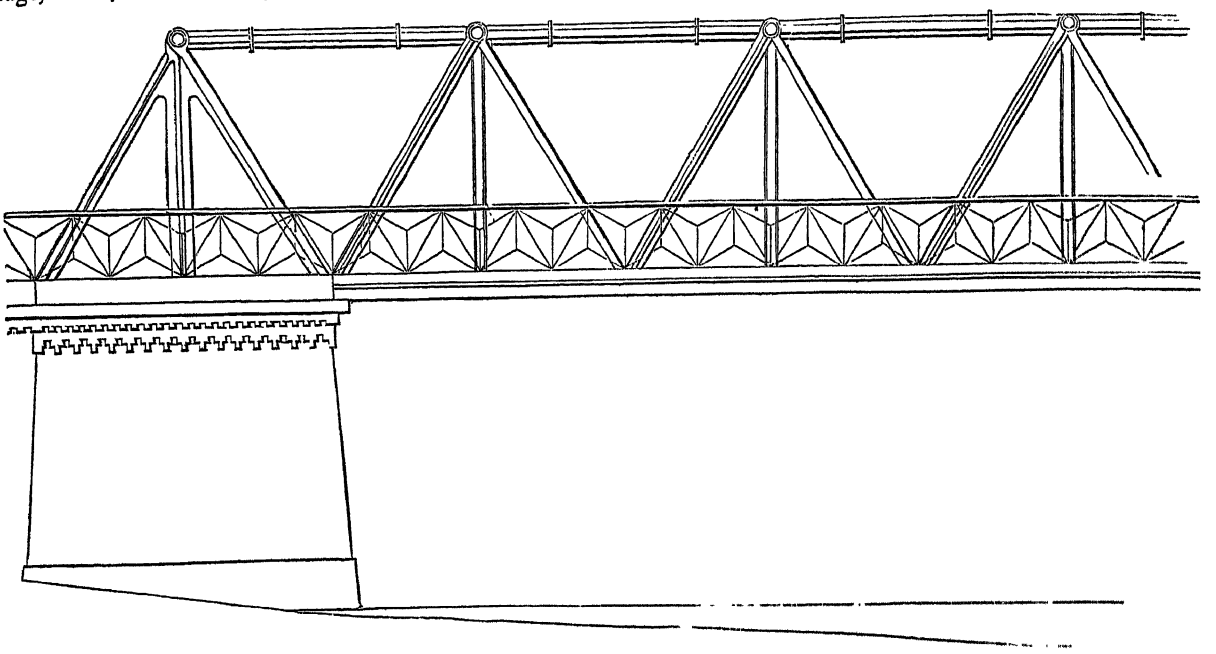


Fig. 33.—Newark Dyke Bridge.

This bridge (see fig. 34) consists of four independent girders, viz. two for each line of railway. The roadway is beneath the girders. The top flange of each girder consists of a series of cast-iron pipes butting end to end; the lower flange consists of wrought-iron links, and the flanges are connected by diagonals forming a series of equilateral triangles, and these diagonals are alternately struts and ties. The ties are formed of wrought-iron, and the struts of cast-iron: the length of each side of these triangles is 18 feet 6 inches.

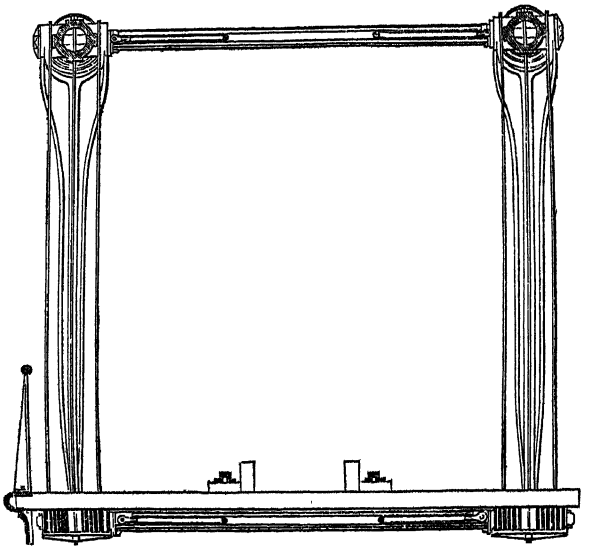


Fig. 34.—(Section).

The top tube, which is 259 feet long, is formed of 29 lengths of cast-iron pipe; at the centre of the span, their diameter is 1 foot 6 inches, and the thickness of metal 2⅛th inches; over the abutments the diameter is 13½ inches, and the thickness 1½ inch. They are turned and fitted into each other at the joints, where they are connected by eight bolts and nuts.

The diagonal struts and ties are connected with the top flange at the centre of every alternate casting by means of joint pins 5½ inches diameter, passing transversely through the cast-iron pipes which are bored to receive them.

The bottom flange consists of wrought-iron links 18 feet 6 inches long, rolled in one piece of the uniform depth of 9 inches. They vary in number and thickness, increasing in total sectional area from the abutments to the centre, where there are fourteen links ⅞ths inch thick. Their ends are swelled laterally to receive the joint pins by which they are connected with the diagonals.

The diagonal links are of the same form and dimensions as those of the bottom flange, as regards length and width, but are increased in thickness from the centre towards the abutments.

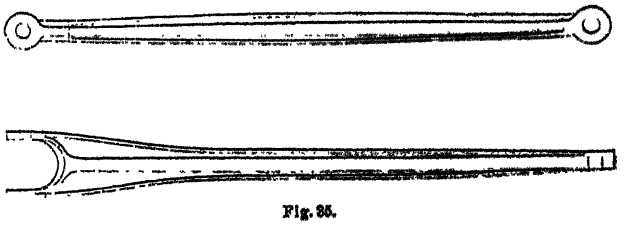


Fig. 35.

The diagonal struts are of cast-iron, the general section is that of a cross like the sign +, two sides of which are gradually increased in width from the lower to the upper end, in which is formed a jaw embracing the top tube and the diagonal links on each side of it. The joint pins pass through the two sides of this jaw (see fig. 35), through the two links and the tube, and then extend across the road to the opposite girder, and thus form part of a system of bracing between each pair of girders and over the roadway.

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At the bottom of the strut there is a circular end piece (see fig. 35), 13¾ inches diameter and 5 inches thick, through which is inserted the joint pin similar to that at the top, fastening together the bottom ties and diagonal struts and links, and extending in like manner across the whole width of the bridge.

The horizontal bracing by which the top and bottom of each pair of girders are connected together, and their lateral stability is insured, consists of hollow cast-iron pipes extending across the road, and through which the joint pins also pass.

These struts are cross-braced by diagonal wrought-iron bars 2½ inches wide, and connected with them by bolts.

The platform consists of a flooring of Memel fir 8 inches thick, resting on the links of the bottom tie. These links are suspended at the middle of their length by a pair of 1⅛th inch rods secured to the top tube at the junction of the diagonals.

On the bearings at each end of the girders are cast-iron triangular frames, strengthened by a perpendicular rib from the apex to the base. They are braced transversely by arched ribs of cast-iron above, and by girders with bracket pieces below, to prevent any rocking motion. At the top of these frames are placed blocks of gun metal 10 inches square, upon which the ends of the top tubes rest. The whole weight of the bridge is thus supported on these frames.

The total length between the supports is 259 feet, and the depth from centre to centre of the joint pins is 16 feet. The clear span between the abutments is 240 feet 6 inches.

The total weight of iron is 244 tons 10 cwt., of which 106 tons 5 cwt. is wrought iron, and 138 tons 5 cwt. cast iron, to which must be added 50 tons for the platform, making the total weight of each bridge 294 tons 10 cwt. The cost, exclusive of the masonry of the abutments, and of the permanent rails, but inclusive of the staging for fixing and the expense of testing, was L.11,003.

The Crumlin Viaduct.

As a further example of these girders, we have no engineering monument in this country more remarkable for lightness and novelty of construction than the viaduct, 150 feet span, which crosses the valley of Crumlin in South Wales, at an altitude of nearly 200 feet.

The lofty piers on which it is supported are equally novel, and in perfect keeping with the girders; they are composed of groups of cast-iron columns only 12 inches in diameter, cross-braced, with wrought-iron ties; and the slender and elegant appearance of this gigantic system of skilfully combined struts and ties can scarcely be imagined without seeing it. The merit of this design is due to Mr T. W. Kennard, by whom the viaduct was also erected.

The gradations are evident between the simple form of girders last described, through trellis work of greater and greater closeness until we arrive at the plate in which the trellis bars may be considered infinite in number. We shall not stop to investigate the actual deflections of such girders, which we have already seen is less as the trellis bars are more numerous, nor the effects of counter bracing on initial strain. These investigations, as well as other applications of these principles, such as in the construction of roofs, do not come within our present scope.

The great importance of the subject, however, cannot be too strongly urged upon the attention of the engineer. The evident defects which characterize most of our trellis bridges arise entirely from the want of any generally established principles as to their construction, and the too common error of believing that any number of mere tension bars, however arranged or thickly interlaced, can form an efficient vertical rib to a girder, or in any way modify the central strain on the top and bottom flanges which depends solely on the depth of the girder, and is perfectly independent of the system which connects them.

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As the best examples we can introduce of well designed trellis girders we shall select the Boyne Bridge, and some simple trellis girders of peculiarly light construction, erected by Mr Edwin Clark on the Victor Emmanuel Railway in Piedmont.

Boyne Bridge.

In the first timber bridges constructed in America on the trellis principle, the trellis work, and, in fact, the section of all the parts throughout, was nearly uniform. As all the trellis rods in one direction act as ties, and in the opposite direction as struts, there is thus a tendency in such beams to buckle or twist unless the trellis work is proportioned for such strain. It is evident, also, from what we have stated, that as regards trellis work the distortion will be greatest near the extremities of the beams. In fact, this has been experienced in some of our first iron trellis bridges, including the Boyne Bridge, which is the largest, and one of the earliest of these structures, though great skill has been evinced in proportioning the various parts to the strains to which they are subjected.

This magnificent bridge or viaduct was erected by Sir John M'Neil on the line of the Dublin and Belfast Railway over the River Boyne, near the town of Drogheda.

It consists of three spans, viz., of a centre span of 264 feet, and two side spans, each of 138 feet 8 inches. The height above high-water spring tides to the soffit of the bridge is 90 feet.

The bridge is approached at each extremity by a series of arches 61 feet span.

The roadway is supported by two wrought-iron girders, braced together at intervals over the top. Each span is not isolated, but the whole are united into one continuous beam throughout the bridge, and every advantage is taken of the extra stiffness and strength thus obtained.

When several consecutive girders are thus united so as to form one single continuous girder, the pressure and the strains, from the weight of the bridge itself or its load, are entirely modified. Not only is the absolute deflection at the centre of the span decreased, but there are points of contrary flexure in its length, the portion over the piers presenting a concave surface at the under side, and the centre portion between the piers having a convex under surface.

The horizontal strains by this arrangement are now due only to the effect of the load on the spans between the points of contrary flexure, and the beam is virtually shortened. This shortening amounts in a perfectly continuous beam of equal spans to about two-thirds of the entire span.

In the bridge we are describing each girder has double sides formed of wrought-iron bars crossing each other at right angles, and at an angle of 45° with the horizon. The diagonal distance across the meshes, or distance from centre to centre of joints, is 7 feet 5 inches, and the total depth is 22 feet 6 inches.

The pairs of diagonal bars which sustain compression are inside, and connected together by lattice work; the tension bars being placed on the outside, and rivetted to the compression bars wherever they cross.

At the centre of the middle span the bars are 10½ inches wide by ⅝ths inch thick, and decrease towards the piers, where they are 4½ inches wide by ⅝ths inch thick.

The cross section of each beam is thus rectangular; the distance between the sides being 2 feet 3 inches, and the total width of the top and bottom flanges three feet.

The trellis sides are not attached directly to the top and bottom tables but to a vertical continuous plate, ⅜ths inch thick and 17⅛th inches broad, which is reckoned as part of these tables. The trellis work is thus only 20 feet 10 inches in depth, there being 2 feet 10 inches of side plate, which

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is made to form part of the sectional area of the top and bottom chords, though really its centre of effort to resist horizontal strains can scarcely be considered to coincide with that of the actual chords.

The main girders are placed 24 feet 6 inches apart, and are braced at intervals across the top with trellis cross-beams.

The platform is 24 feet 6 inches wide, and is formed of 6 inch Memel planking resting on transverse lattice beams, 3 feet 4 inches deep at the centre, and placed 7 feet 5 inches apart.

The effective area of the upper flange of each beam is about 113·5 square inches in the centre of the centre span, and 127 inches at the lower flange. These areas diminish towards the points of contrary flexure, where they are at a minimum. They then increase again towards the piers, where the areas are at a maximum.

The following table will show the areas at various sections of each main beam :—

	Square inches.
The top table at the middle has a section of	113·5
The bottom ditto, ditto, ...	127·0
The top table, 45 feet from the piers ditto, ...	68·5
The bottom ditto, ditto, ...	68·5
The top table over the piers, ...	132·6
The bottom ditto, ditto, ...	127·0

The total combined effective area in the centre of centre span is said to be 227 square inches, in which, as we before observed, the area of the connecting side plates is also included.

It is evident that in this bridge the centre span is not a portion of a perfectly continuous beam, the points of contrary flexure being probably about 210 feet apart.

The centre span was constructed with a camber of 4 inches in the middle, which decreased on removal of the scaffold to 1½ inch.

In testing the bridge with a load of 2 tons per foot run, the deflexion was 1·9 inch.

The weight of iron work in the two beams forming the centre span, and which carry two lines of railway, is as follows :—

	Tons.
Top chords...	105·5
Bottom chords.....	109·1
Lattice work in the sides	82·8
Tranverse beams overhead	6·8
Roadway beams	46·1
Bracing at top and bottom	10·9
Pillars, stays, &c., over the piers	24·8
	386·0

Bridge over the River Isere.

The bridge was opened for traffic on the 5th April 1855.

The bridge constructed to carry the line of the Victor Emmanuel over the River Isere, at a point between the villages of Montmeillen and Aiguebelle, in Savoy, is on the lattice principle, in which the diagonals forming the web are placed at an angle of 45° with the horizon.

The railway has but a single line of way, and is supported by two girders, which are continuous throughout, forming a total length of 558 feet.

The bridge has four uniform openings of 130 feet 4½ inches, and is supported by stone abutments at each end, and by three piers of solid masonry in the river.

The foundations of the piers are on cast-iron cylinders, three to each pier, 6 feet 6 inches in diameter.

The thickness of the masonry is 8 feet 10¼ inches.

The level of rails is about 18 feet above the bed of the river; but the water in floods occasionally rises fully to this height, and, in the spring of 1856, it carried away a similar bridge a few miles lower down, and deposited the entire structure about 20 yards from its site in a perfect state.

The piers and abutments form an angle of 45° with the direction of the stream.

The depth of the girders is uniform throughout, being $\frac{1}{11}$th of the span, or 11 feet 9 inches in extreme.

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The usual width of the squares formed by the vertical gussets is 11 feet 3 inches, therefore there are twelve of these bays over each opening.

Over each pier, and at the abutments, large cast-iron frames are placed on each side of the girder to support the top flange and provide for the additional strain on the web caused by continuity; and beneath these are sets of cast-iron bed plates, between which rollers are inserted to allow of free expansion.

The diagonals of the web that have to withstand principally the force of tension are simply bars of which the width is reduced as the strains become less. For compression the struts are formed of T iron rivetted back to back, and likewise graduated in size.

The gussets or vertical struts are made up of small angle irons and plates, which latter are stiffened on their edges by light T iron.

The diagonals and centre plates of the gussets fit between, and are rivetted to the deep vertical plates and angle irons of the upper and lower flanges.

The section of the top of the girder is of the form of a T, while that of the bottom flange is an inverted T.

The horizontal parts are formed of one row of plates, with their covers and packing pieces, and the vertical parts of two plates placed far enough apart to allow of the diagonal struts and ties fitting between and fastened to the horizontal chords by two heavy angle irons.

The roadway is supported by very light transverse open girders of wrought-iron rivetted beneath the lower flanges of the main girders with which they form right angles.

They are placed 3 feet 9 inches apart, and the weight is distributed over several of them by similar open wrought-iron girders fixed in a longitudinal direction under the lines of rail.

The flooring is simply of 2½ inches timber planking, laid parallel with the rails, and bolted to the transverse girders.

The sectional areas of all parts of the girders vary according to the calculated strains when their continuity as affected only by the weight of the permanent load is considered, but the strain under the testing load of a ton per foot run does not cause a strain of more than 3½ tons per square inch for compression, and 4½ tons for tension.

The greatest possible strain that can be brought upon the diagonals is much less.

The tendency of the upper part of the girder to lateral motion is constrained by a few light wrought-iron arches fixed immediately above the gussets, which being fastened to the roadway girders, the whole form strong rings or frames at such points as effectually preserve the rectangular shape of the trough. For this purpose it was necessary to use great care in fixing the main girders so that the gussets of each pier should be in a direct line.

The weight of iron work in each pair of main girders for each span was 50 tons, and of its proportion of roadway 21 tons. The total weight of iron in the whole structure is 322 tons wrought and 15 tons cast-iron.

On the same line of railway there are also two other bridges, similar in every respect, but of only a single span each.

The girders being therefore independent, the weight is slightly increased; that of the pair of girders to each bridge being 72 tons, and of the whole bridge with roadway 96 tons.

Bridge over the Yssel.

We will now give an example of a bridge with flanged girders, which also belongs to the class "Simple Girders." The bridge we are about to describe crosses the River Yssel, and carries the extension line of the Dutch Rhenish Railway.

The River Yssel, during the melting and breaking up of

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the ice, becomes a wide and deep stream, and very dangerous. The project of a bridge to carry the railway over it was at first considered by the Dutch engineers as being so very difficult of execution, and so impossible to make secure, that, when definite plans were submitted, an enormous increase of strength in the design was required to withstand the action of the ice, which they considered would become jammed together into one mass across the whole of the river, and thus, being acted upon by the whole force of the stream, would carry away the entire structure unless extraordinary strength and solidity were used. To meet these views the girders were made on the close boiler-plate principle, and the bridge was supported by cast-iron cylinders (two to each pier) each 15 feet diameter, except the centre cylinder, which carries the roller path of a swivel bridge, and is 28 feet diameter.

The bridge has six openings, of which the two centre ones are each 50 feet in the clear, and are crossed by continuous wrought-iron girders, which revolve on the 28 feet cylinder, forming the swivel bridge with two openings. The other openings are each 164 feet in the clear.

The bridge carries a double line of railway, which it supports by three parallel girders, the centre ones being double the strength of the others. These principal girders are made perfectly continuous for the two spans on each side of the centre, and therefore their height is uniform between the centres of these spans. Since there are but two cylinders used for each pier, the centre girder is supported on "sandwich" girders, consisting of wrought-iron plates placed vertically, with wood bolted between them. By this arrangement the clear span is increased to 172 feet.

The upper flange of each main centre girder is formed of cast-iron, the extreme halves exactly corresponding, so that, if brought together, they would form an arch; but, as they are constructed, appear like an arch cut asunder, spaced apart by a parallel beam. The tensile strain in the top, induced by continuity, is entirely borne by wrought-iron plates attached to the web above the cast-iron, which extend throughout the parallel part, but vary in section proportionately to the strain; and therefore over the centre piers there is no strain whatever on the cast-iron, which, in consequence, is much reduced in size.

The lower flange of the centre girder is made up of four rows of plates, and four rows of angle iron. The web is made double, forming a box between which the cast-iron of the top flange is inserted. The side girders are simply of the ordinary I shape, but a single web plate being used, the castings of the top flange are attached outside the web, and are surmounted at the central part by a wrought-iron plate. The bottom flange is also formed of four rows of plates, of less width and thickness than those in the centre. These main girders are fixed in the centre, and the ends resting on rollers can readily expand. The roadway throughout the bridge is of 12-inch balks, placed 12 inches apart, suspended to the lower flanges of the girders. The swivel bridge turns on a central steel pivot and twenty rollers, each 2 feet 8 inches diameter, fixed to radial arms, and retained in place by a strong wrought-iron girder ring. They are of cast-iron, turned, and revolve between the planed conical surfaces of the upper and lower tram-plates. The adjustment for the bearing at the ends of the girders is by wedges moved by machinery.

The weight of wrought-iron used in the whole superstructure was 851 tons, and of cast-iron 336 tons, and the weight of wrought-iron in the lower ends of the cylinders was 64 tons, and of cast-iron 508 tons. Much of the above weight was unnecessary, and was merely added to overcome the scruples of the Dutch government engineers. Other examples of similar construction may be adduced, in which the bottom flange and web of the girders are formed of solid boiler plates, and the top flange of a combination of wrought and cast-iron, the latter being generally in excess. Amongst those remarkable for their large span may be mentioned the bridge that carries the line of the Manchester South Junction and Altringham Railway over the River Mersey in the town of Warrington, which is of 180 feet clear span; and another, but larger structure, connecting the same line of railway with the Birkenhead, Lancashire, and Cheshire Junction Railway at Walton, near Warrington, which is parallel to the brick viaduct on the London and North-Western Railway, and also crosses the Mersey and Irwell Canal. The centre span of this bridge is 172 feet, and the others are of the respective spans of 63, 60, and 37 feet, with a bridge constructed to open of the clear span of 53 feet. The larger girders bear on 9 feet cylinders, and the smaller on cylinders of 6 feet diameter.

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(4.) *Trussed Girders.*

It must be remembered that the only material employed in the construction of girders on their first introduction was cast-iron.

Its uncertainty and weakness when exposed to tensile strain, as in the lower flange of a girder, soon attracted the notice of engineers. Little benefit was obtained by increase of thickness; for the treacherous character of the material increased rapidly with the mass in which it is cast, and simple girders were thus limited in their dimension to very moderate spans. The difficulty of uniting cast-iron rendered impracticable the attempt to build up such girders of separate castings, and nothing remained but to attempt to strengthen the lower flange by the addition of wrought-iron tension rods. The first difficulty that presented itself was to secure a due degree of tension on the rods so employed, as the mere attachment of them to the lower member of the girder without initial strain, though it might prevent the destruction of the girder in case of the fracture of the lower flange, would evidently do but little towards preventing such fracture. It was with this object that the rods employed were attached at each extremity of the girder to its upper flange, and at the centre only brought down below the bottom flanges, and were then brought into tension. It is evident that by tightening the screws by which these rods were suspended any amount of initial strain could thus be put upon the wrought-iron ties, causing a corresponding counter strain in the girder itself; and while the rolling load was sufficient to cause a deflection equal to the counter strain thus given, no strain could come upon the lower flange of the girder itself. Provided the upper flange were sufficient to resist the thrust to which it is subject, it is evident that such girders are far less liable to accident than simple castings, and are capable of application to much larger spans.

The determination of the strength of such girders is, however, a difficult task. A serious accident, moreover, which occurred from the failure of a girder of this description at the Dee Bridge, near Chester, has entirely put an end to their employment. In these bridges, the cast-iron girder formed the whole depth of the truss, the tension rods passing beneath its lower flange; it therefore possessed considerable strength as an independent girder, without counting on any assistance from the truss. Such girders are, in fact, compound girders formed by combining the truss with the simple girder, the upper flange doing duty as a compression bar in both systems, and being thus subjected to two independent strains.

It is evident, therefore, that if the upper flange is simply proportioned to its duty as the top flange of the simple girder, it will be of insufficient strength for its additional duties as part of the truss. It has been argued, that from the perfect union of the top flange with the vertical rib, a

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considerable portion of the whole girder might be taken as forming part of the truss. It is, however, evidently impossible by calculation to say how far such assistance may be relied on; and a still greater objection exists in the fact that such girders consist of two systems, the ultimate deflections of which are utterly different,—the girder, for instance, may be broken before the truss attains half its ultimate deflection, or has done half its duty. The objection to this girder is common to all girders in which two independent systems are attempted to be blended; and, as a general principle, all such arrangements should be avoided. It has always been usual, in order to obtain additional strength in the attachment of the three castings of which such girders are composed, to increase their depth where they are united as well as at each extremity of the girder, and the tie-rods, instead of being in a line with the upper flange of the girder, are attached to the upper portion of this increased depth. It is certain that in such an arrangement we have no right, in calculating the strength of the truss, to count on the additional depth so obtained, and it has been contended that girders so trussed may in some cases have been actually weakened. This appears, however, to be scarcely possible, when we reflect that in all such girders as are usually constructed the tightening of the ties increases the camber of the girder. It is useless to say more on the subject of this form of girder, as since the adoption of wrought-iron for girders they have been entirely superseded; they were designed when no other means existed of obtaining iron girders of great span; and the melancholy accident which occurred at Chester is the only existing instance of their failure, while the evidence given on that occasion renders it highly probable that even in that case the fracture was occasioned by the train running off the line. In the trussed girders over the River Arno, in Italy, strained tie-rods were introduced beneath the lower flange from end to end of the girder, and the experiments made on this girder were highly satisfactory.



Fig. 36.

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One example of this system exists in the bridge carrying the road from Banbury to Lutterworth over the London and Birmingham Railway (fig. 37). Span 64 feet.

There are six ribs which have a double curved form, or rather that of a parabolic spindle; the lower curve being formed by a wrought-iron tie-bar, and the upper one by a cast-iron arch; the space between the two is filled by cast-iron ornamental panels, which are made to act as struts, and for the purpose of keeping the bottom tie-bar in the proper line of curvature and strain. The tie is in two parts, with eyes at each end, and pins passing through them, which take the ultimate strain. A very ingenious arrangement is applied at the centre of the rib for the purpose of adjusting the degree of tension upon the tie-beam. It consists of a vertical tubular strut, attached to the top arch by a screw, which is also used to force it down upon the tie. On the top of the arch there is a kind of plate-band cast with it, which forms the level for the cast-iron road plates. The structure is exceedingly tasteful in appearance; and the nice arrangement in the parts makes it something more of a mechanical contrivance than is generally understood by an iron bridge.

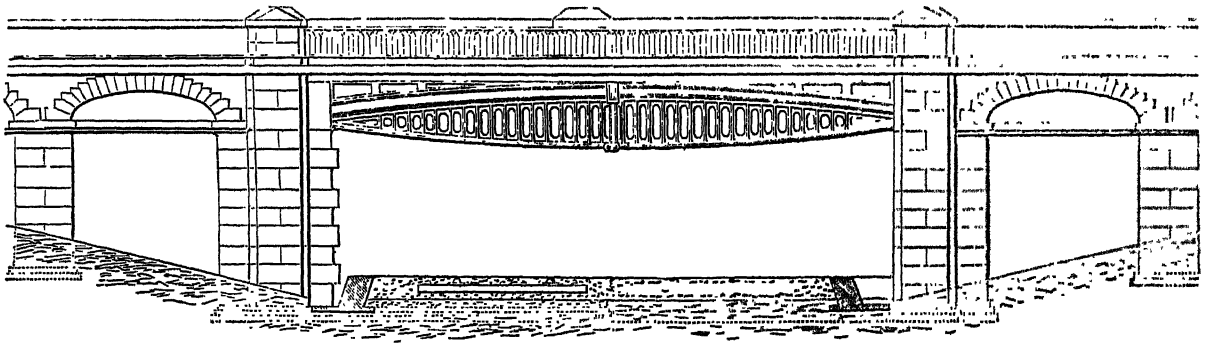


Fig. 37.—Banbury Bridge.

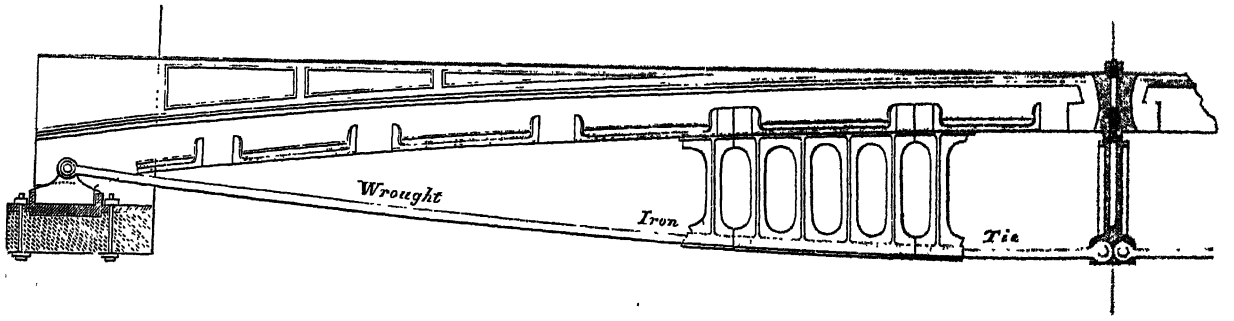


Fig. 37.—Elevation of back of Main Rib.

Minories Bridge.

As an example of these bridges, we shall describe one of the earliest and largest, viz., the trussed girder bridge of 63 feet span, erected by Mr Bidder, for carrying the Blackwall Railway across the Minories in London. This structure, as well as all the bridges on the line, was not originally designed to carry locomotives, the line being worked by a rope. It is fortunate that in this, as in most of our early railway works, sufficient excess of strength was given to allow of the greatly increased weight of our present railway traffic as compared with what was then anticipated. The bridge consists of 6 girders, viz., two outside girders and 2 girders beneath each line of rails. Each

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girder is formed of three separate castings with upper and lower flanges. The upper flange is 8 inches wide, and the bottom 2 feet wide. The general depth is 3 feet, but the depth is increased at each extremity of each casting to 4 feet 6 inches. The joints by which they are bolted end to end is thus 4 feet 6 inches deep. The joint is farther strengthened by wrought-iron clips beneath the bottom flange.

The trussing rods, by which the tensile strain on the lower flange is relieved, and by which an initial camber was given to the girders, consist of wrought-iron bar 5 inches wide and 1 inch thick, placed in pairs on each side of the girders. These links are attached to the top flanges of the girders at their extremities, and descend diagonally to the bottom flanges at each joint, where they are connected with each other, and with the girder by a pin passing through the latter. They are tightened up by means of keys at each end of the girder.

The bridge has subsequently been widened by moving one of the outside girders so as to admit of the introduction of another line of rails, the girders being strengthened by the addition of top pieces which are firmly bolted to the upper flange, making the total depth of altered girders 5 feet.

After the accident which occurred at Chester, similar additions were made to many then existing girders, an additional top flange being inserted in a direct line between the attachment of the tie-rods.

The above girders resemble in principle another ordinary form of trussed girder used for travelling cranes and other purposes where light girders of considerable span are required, timber being frequently used for compression, and wrought-iron tie-bars for tension. The depth in such cases is generally obtained by the insertion of one or more light cast-iron standards or struts between the tie-bar and the timber. The principles on which the strength of such girders is calculated are perfectly identical with those given at page 592, inasmuch as the centre of the timber strut may be taken as a fulcrum, and the strain on the rods depend upon the distance from this point. The stiffness of such girders is of course greatly increased by the addition of diagonals between the standards, and in this

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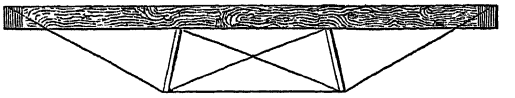


Fig. 38.

form, when made of durable materials, they become excellent girders for all the purposes where moderate spans only are required.

We have, however, two examples of bridges of enormous dimensions constructed on the same type, viz., the Chepstow and Saltash Bridges, both of which have been erected by Mr I. K. Brunel, and both of them equally remarkable for their gigantic proportions, and the engineering difficulties which had to be overcome, not only in the superstructure, but in their foundations.

Chepstow Bridge.

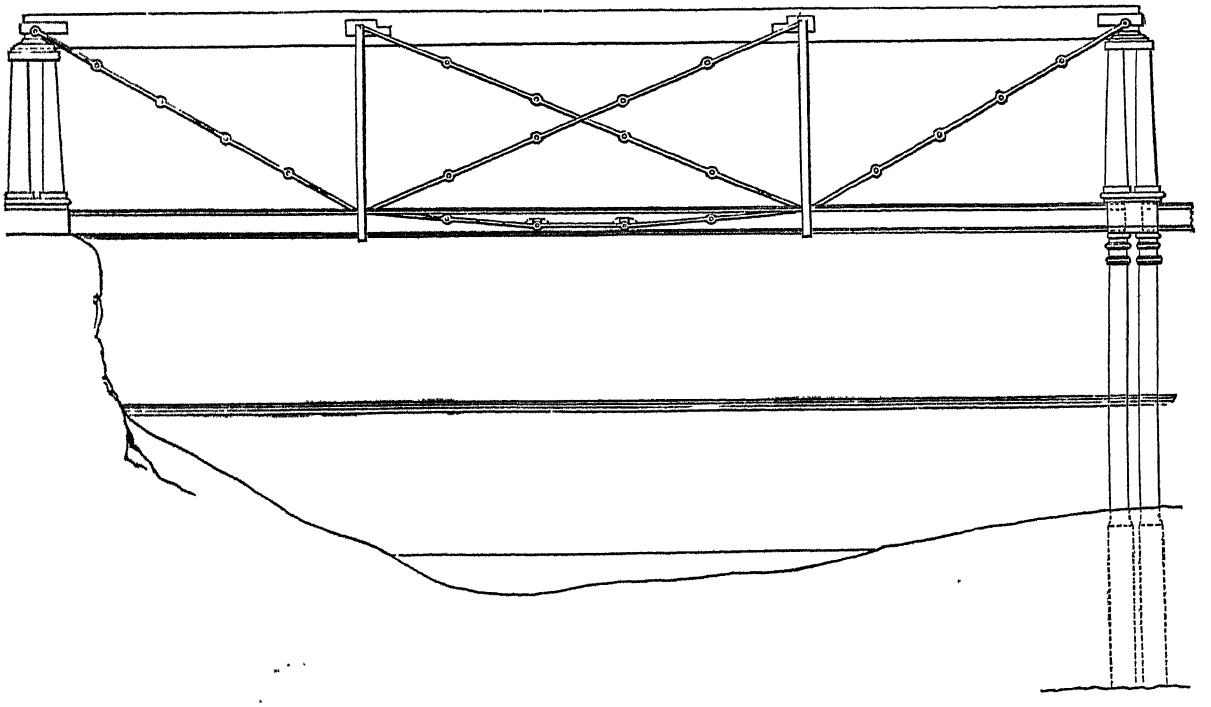


Fig. 39.—Chepstow Bridge (Elevation of Central Span.)

The Chepstow Bridge (fig. 39) carries the South Wales Railway over the River Wye at a height of 46 feet above high water. The remarkable rise of the tide which characterizes the Bristol Channel is well known, and at Chepstow is no less than 41 feet; at high springs the elevation of the bridge above low water is thus nearly double. In this bridge two kinds of girder are employed,—one half of the bridge consists of ordinary wrought-iron girders of 100 feet span, resting on cast-iron columns; in the other half, the roadway is carried over the river by the trussed girders, which have a span of no less than 305 feet. This portion of the bridge is in fact a rigid suspension bridge, the tension of the chains being resisted not as an ordinary bridge by attachment to the ground at each end, but by a horizontal cylindrical wrought-iron column, or strut, 9 feet in diameter and $\frac{5}{8}$ths inch thick, which reposes on the towers at each end

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of the bridge. Instead of the ordinary catenary, the chain consists of three straight links only. The rigid form of the chain is preserved, and the flexure of the horizontal column is prevented by their mutual attachment by diagonal and vertical bracing, the girders which carry the roadway are suspended from the chain at two points only, viz., at each end of the centre link. These girders are thus divided into three nearly equal spans, and are supported at each end by cast-iron.

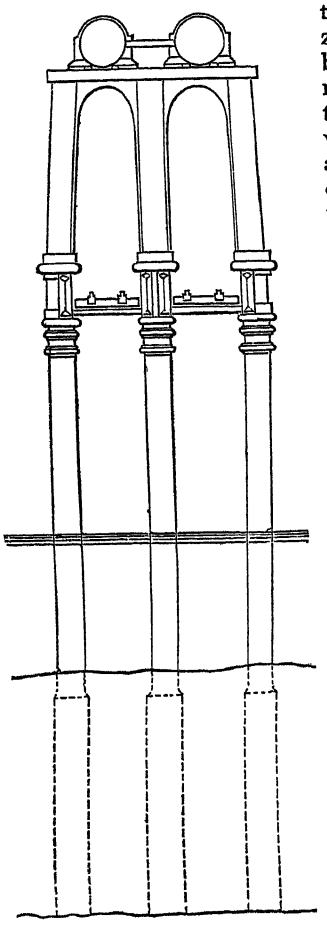


Fig. 39 (End View).

The tower at the extremity of the bridge rests upon the precipitous rock which bounds the river, but at the other end upon a pier consisting of six cast-iron columns, which pass through 50 feet of mud down to the rock beneath. The mode of sinking these cylinders was novel. They were placed in their position on the site of the pier, which is dry at low water, and the mud was excavated till they began to sink with their own weight, when fresh lengths were added on the top as the previous lengths sank down. They were thus ultimately bedded on the rock, and filled up with concrete. The cylinders are carried up to a height of 190 feet, and are connected at the top by the cast-iron framing and tower which carries the tubes.

The weights of the various parts are as follows:—

298 feet run of tube and butt plates	127½	Tons.
Hoop of ditto over piers	7¾	...
Side plates, bottom ditto, for attachment of main chains	15	...
Side plates for attachment of diagonal chains...	2½	...
Stiffening braces, 26 feet apart	4½	...
Rivet heads and snaps	4¾	...
Total weight of one tube...	161¼	...
Main chains, eyes, pins, &c.	105	...
Diagonal chains, ditto	23	...
Vertical trusses	18½	...
Saddles, collars, &c., at points of suspension...	22	...
Main roadway girders, transverse floor girders, &c.	130	...
Total weight of iron in one roadway...	460	...

The tubes or struts are of uniform section throughout, and are formed of sixteen equal plates ⅝ths inch thick, and two side plates ⅝ths inch thick. The plates are all 10 feet long, lapped together at sides, and butt-jointed at the ends with double butt plates, and rivetted together with two rows of rivets.

(5.) *Bowstring Girders.*

The difficulty of obtaining abutments capable of resisting the thrust of large arches, more especially when the use of iron in their construction allowed of great diminution of their rise or versed sine, led naturally to the addition of a chain or tie to resist their thrust. Again, the outline of ordinary girders with parallel top and bottom flanges, when of any magnitude, is by no means agreeable. Depth being the only visible element of strength, the eye does not fail to perceive that such an outline implies equal horizontal strains throughout, where we feel that the strains at the ends of a beam merge entirely into a vertical direction, and that depth is there useless. In large girders the depth at the centre was therefore alone increased, and the top took an arched form, the curve being generally a parabola; the analogy of such a girder with the bowstring arch is at once apparent. It is, however, of great importance to understand thoroughly the difference between these two systems.

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The strain at the centre of each of them is, as we have before seen, perfectly identical. The weight supported at the ends is also in both cases equal to half the weight of the girder; but the manner in which these similar vertical forces are converted into similar horizontal forces between their origin at the points of bearing and their mutual equilibrium at the centre of each girder, is in each case entirely different, and the horizontal strain in the top and bottom flanges varies accordingly.

In an uniformly loaded ordinary girder, with parallel top and bottom flanges as we have already shown, the horizontal strain varies at any point of the flanges as the rectangle of the segments into which the point divides the span. We must, therefore, in order to insure equal strains throughout, either diminish the section of the flanges in that proportion as we recede from the centre, or we must diminish the depth of the girder in a similar proportion, preserving uniformity of section in the flanges. In either case the strain per square inch remains constant throughout the whole length of the flanges; but, as their actual section at corresponding points is entirely different, it is evident that the actual strains to which they are subjected are also entirely different. Now, as these strains arise entirely from the action of the vertical rib which connects the flanges, it is evident that the duties of the vertical rib are entirely different in the two cases.

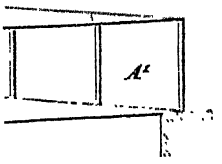


Fig. 40.

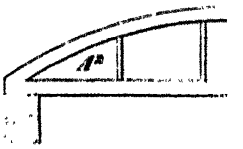


Fig. 41.

In the parallel-sided girder (fig. 40), in which the upper and lower members taper off to 0 at the extremities, the plate A^1 requires sufficient stiffness and strength, both vertically and diagonally, to support half the weight of the girder, and will be the thickest side plate in the girder; but in the parabolic-shaped girder (fig. 41), where the flanges maintain their full section to the end, the plate A^2 requires no such additional strength, and may be reduced to nothing. In fact, if we now omit the vertical rib altogether, fig. 41 is a bowstring girder. These girders, therefore, have little analogy except as regards the strain at their centres, or, which alone is identical on both; the difference between the two girders is evident.

In fig. 40 the horizontal strain in the flanges is at a maximum at the centre, and decreases to 0 at each end, and the section varies in a similar proportion.

In fig. 41 the horizontal strain on the flanges is constant throughout their length, and the section is also uniform throughout.

In fig. 40 the vertical strains from the point of support are thrown gradually into the flanges by the action of the ver-

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tical rib. They are nothing at the centre, and at a maximum at the ends where they are entirely resisted by the vertical rib.

In fig. 41 the vertical strain is thrown directly into the flanges without the intervention of any vertical rib.

Now, a bowstring girder is such an arch, with horizontal ties to resist its thrust in lieu of abutments, and as regards supporting its own weight, if the arch be one of equilibrium, and the ties are suspended from the arch to preserve their horizontal position, no diagonal bracing or vertical rib of any kind is necessary. We may, therefore, at once apply all the principles applicable to the ordinary arch in investigating the strains of such a girder.

It is evident, however, in the same manner as with the arch, that such a structure in equilibrium would not support any unequal load. The best means of giving rigidity to this skeleton arch is a problem on which much ingenuity has been expended. There are three methods by which the rigidity has been obtained,—1*st*, By giving sufficient rigidity to the arch itself, or the ties themselves, or both, to ensure the requisite stiffness as in the High-level Bridge at Newcastle; 2*d*, By cross-bracing between the arch and the ties as in the Monkland Canal Bridge; and, 3*d*, By an independent system of trussing or framing, combined with the arch and ties as in the proposed girders for the Mayence Bridge, and in most American timber bridges. By any of these additions, or rather by a combination of them all, it is probable that this system of girder is capable of very great extension. An example of each of these bridges is here given.

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The earliest railway bridge on the bowstring principle is that over the Regent's Canal, near Chalk Farm, on the London and Birmingham Railway (see fig. 42).

It is composed of three main ribs of cast-iron open panel-work, whose outline is parallel, but which includes an arc extending to its extremities of length and depth, and intersecting the vertical bars which form the panels. The span is 50 feet and the height of the ribs 10 feet. The section of each rib is in the form of a hollow rectangle 2 feet 11 inches wide, and the space between its sides is filled with diagonal bracing-frames 5 feet 10 inches apart.

The railway is carried by cast-iron girders of the fish-bellied shape, 28 feet between bearings and 1 foot 10 inches deep in the middle; they are suspended from the bracing-frames in the main ribs by wrought-iron suspension rods 2¼ inches diameter; there being sockets in the bracing-frames to receive their upper ends, and in the ends of the cross-girders to receive their lower ends.

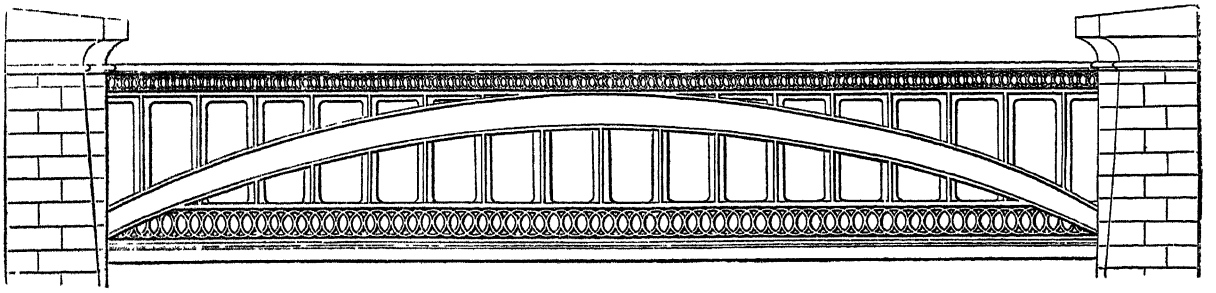


Fig. 42.—Regent Canal Bridge.

The centre main rib performs double duty; and its bracing frames have double sockets, and carry two suspension rods. In addition to the ribs themselves in resisting the strain of the load there are longitudinal tie-bars under each rib, there being four under each outside rib in a horizontal row, and eight under the centre rib in two horizontal rows. These tie-rods are secured to the bearing ends of the main ribs, and are in three lengths, each united by sockets, gibs, and keys. Upon the cross girders are oak sleepers for the rails; and the entire space between the rails is filled in with cast-iron plates perforated in the form of trellis-work. The outsides of the outer ribs are ornamented with cast-iron mouldings and fret-work. This bridge is of very bold design, and certainly a novelty as regards construction.

The finest example of the kind of structure we are alluding to is undoubtedly the High-level bridge at New-

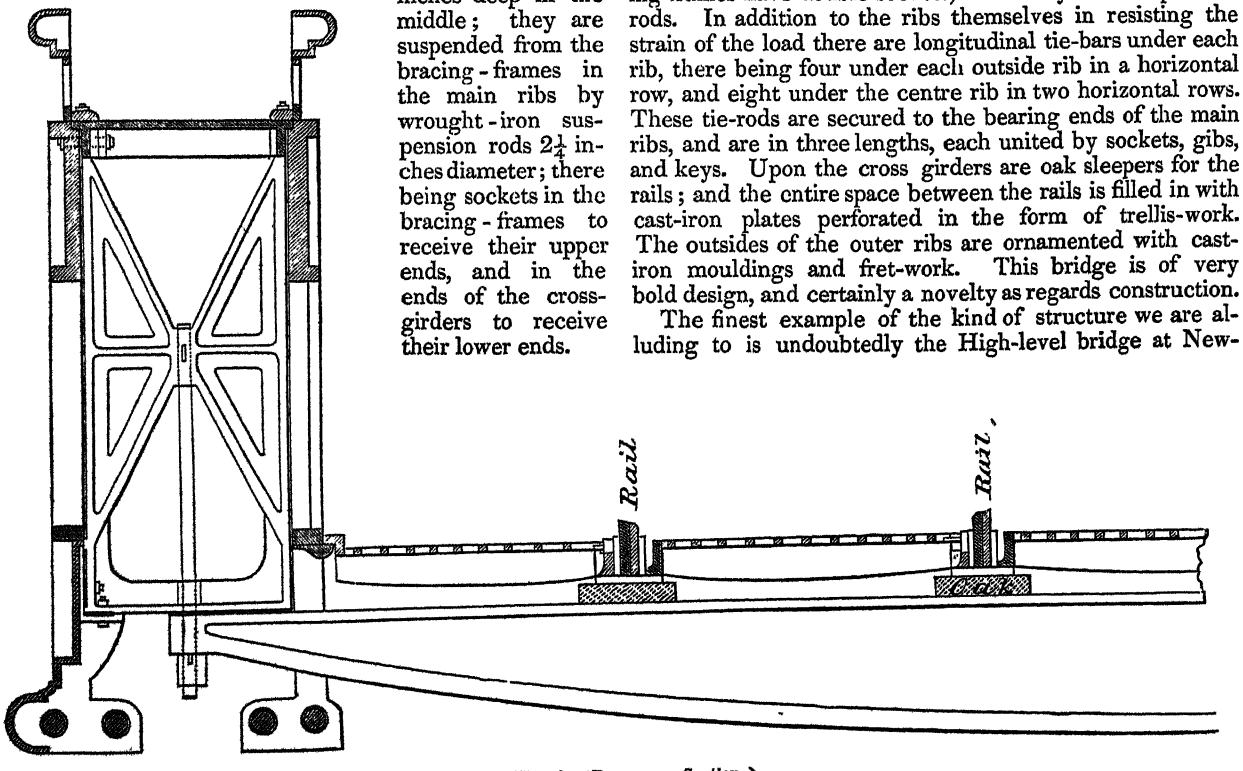


Fig. 42.—(Transverse Section.)

castle-on-Tyne. This bridge (fig. 43), which crosses the River Tyne, unites the towns of Gateshead and Newcastle. The Tyne runs through a deep valley or ravine, on each side of which these towns are built. The old bridge crosses the river at the bottom of the valley, and the want of a bridge at the high-level was long severely felt by the in-

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habitants for the accommodation of their local traffic. So far back as the commencement of the present century, various plans were projected to meet this requirement; but the great cost of the undertaking rendered it at that time impossible to carry any of them into effect, and they were reluctantly abandoned.

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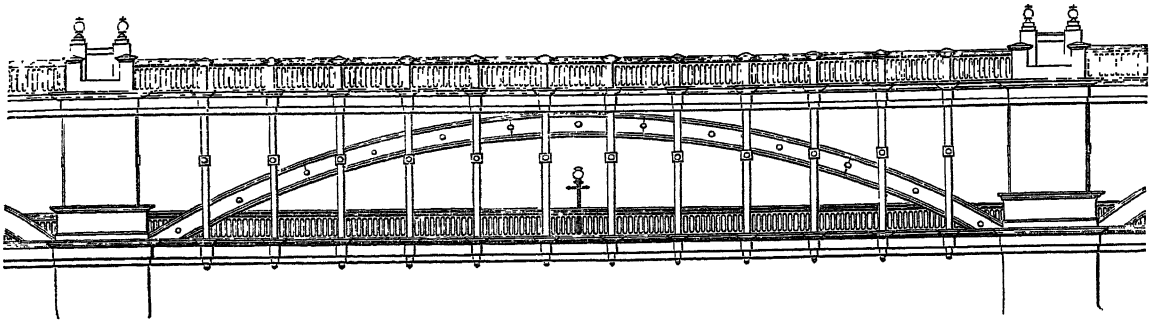


Fig. 43.—High Level Bridge.

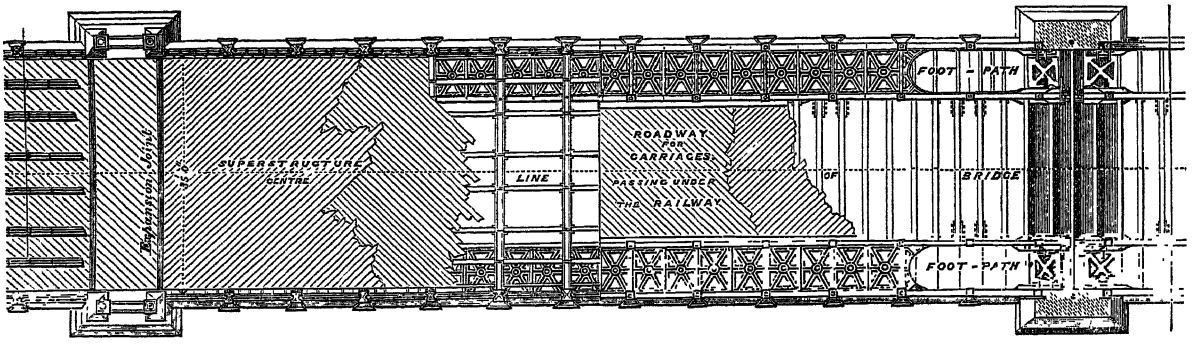


Fig. 43.—(Plan.)

The traffic between the two towns, however, rapidly and constantly increased, especially when Gateshead became the terminus of the Southern Railways, which were thus entirely isolated from the lines north of the Tyne; some other means of communication between the termini at Gateshead and Newcastle became now, in fact, indispensable, the cost of conveyance of passengers and merchandise by coaches and omnibuses across the old bridge reaching the enormous amount of L.1000 per week.

In a work so indispensable for both interests the local authorities gladly co-operated with the railways, and it was at length determined to construct the present bridge, and to carry both a public road and the railway across it.

There are two platforms, the upper platform carries three lines of railway, while the lower forms the common public road.

The breadth of the river at this spot, at high water, is 515 feet, but the whole distance between the Gateshead station and the central terminus on the Newcastle side is about 4000 feet. The approaches of the railway (as will be seen by the engraving) are curves in contrary directions, but those of the public road below are straight.

The bridge is in six spans, each of 125 feet, and the superstructure is supported on stone piers and abutments, at a height to the soffit, above high water, of 83 feet.

The foundations consist of piles, the spaces between which are filled up with concrete. Many of the piles are 40 feet long, and all are driven through the hard sand and gravel, forming the bed of the river, until they reach the solid rock.

Many difficulties occurred in driving the piles which considerably retarded the progress of the work, and, among others, the peculiar effect of ebb and flow during this operation is worthy of note. At flood-tide the sand became so hard as almost totally to resist the utmost efforts of driving, while at ebb the sand was quite loose, and allowed of doing so with facility. It was therefore found necessary to abandon the driving on many occasions during high water.

The difference between high and low water is 11 feet 6 inches.

Another difficulty arose from the quicksands beneath the foundations. Although the piles were driven to the rock bottom, the water forced its way up, baffling the attempts to fill in between them; this, however, was remedied by using a concrete made of broken stone and Roman cement, which was continually thrown in until the bottom was found to be secure.

Nasmyth's Pile-engine.

The piles were driven by Nasmyth's Steam Pile-driver, this being one of the first cases in which this valuable engine was used, a foundation was thus obtained, which certainly would not have been possible by the ordinary means.

The ram weighed a ton and a-half and had a fall of 2 feet 9 inches. It was worked incessantly, night and day, driving at the rate of sixty or seventy strokes per minute. In several instances the pile heads burst into flame, and burnt fiercely under this rapid action of the ram.

Guage piles.

In setting out the spans previous to the driving of the permanent piles, guage piles were driven with the ordinary pile-engine as deep as they would go. When the steam pile-driver was introduced, an experiment was tried with it upon one of them, which was driven to a farther depth of 15 feet.

Test of piles.

One of the foundation piles was tested with a load of 150 tons which was allowed to remain several days, and upon its removal no settlement whatever had taken place. The piles are 4 feet from centre to centre, and the utmost that can come upon one of them is 70 tons, supposing none of the weight to be carried by the intervening space of planking and concrete.

Foundation for abutments, &c.

The foundations of the abutments are upon a bed of strong clay, under-lying the sand and gravel at a depth of 18 feet; no piles are used; the abutments are of stone similar to the piers. The roadway is carried for a considerable distance upon each side of the bridge upon masonry arches of very durable construction. Designs for the proposed

entrances to the bridge, and in keeping with the architectural features of the structure were designed by the engineer, but have not yet, for financial reasons, been carried into effect.

The cofferdams for the piers (none being used for the abutments) were formed in double tiers, filled in with puddle. The piles were not drawn, but were cut off level with the bed of the river by a circular saw, the lower part remaining to protect the foundations as well as to avoid disturbing the bottom by their extraction.

Stone work.

The foundation course lies about 2 feet below low water. The stone is of a hard and durable quality, and came from the neighbourhood, viz., a portion from Heddon-on-the-Wall, and the remainder from Corbridge.

Dimensions of piers, &c.

The dimensions of the piers are as follows:—

Area of foundations	76·4	by 22·6	wide.
Base, including cutwater to about 5 feet above high water	67·4	by 19·6	...
Footing or springing of piers on cutwater	48·4	by 16·6	...
Shaft of piers up to level of superstructure	45·10	by 14·0	...
lengthened by an arched opening of 11 feet 10 inches.			

The most novel features, however, in this structure are the bowstring arches over the centre portion of 900 feet. This space is crossed by six similar spans. The four centre spans cross the river, the remaining two are on the slopes on either side.

Each bay is crossed by four main arched ribs with horizontal tie-bars to resist the thrust. The upper roadway rests upon the arches, the lower is suspended from them by wrought-iron suspension rods.

Each arch is cast in five segments, strongly bolted together, and when entire is 125 feet in span, with a rise of 17 feet 6 inches from the centre of the tension bars, and of 18 feet 1½ inch from the upper surface of the bed plates. The depth of the arch at the crown is 3 feet 6 inches, and at the haunches 3 feet 9 inches. The section is that of a double-flanged girder, the flanges being 12 inches wide, and 2 inches thick on the outer arches, and 3 inches thick in the internal arches, which have a greater weight to support. The vertical ribs are of the same thickness as the flanges.

The sectional area of the external rib at the crown is 133 inches, and of the internal ribs 189 inches; the combined area of section at the crown in the four arches being 644, and at the haunches 706 square inches.

The ties consist of flat wrought-iron bars, 7 inches by 1 inch of best scrap iron, with eyes of 3½ inches diameter, bored out of the solid, and pins turned and fitted closely.

Each external rib is tied by four of these bars, and each internal rib by eight. The sectional area of each external tie is 28 inches, and of each internal tie 56 inches, giving a total area of 168 square inches.

These bars were all tested to 9 tons on the square inch.

The four ribs are disposed in pairs (see cross section); the two internal ribs being 20 feet 4 inches apart in the clear for carriage road, and the space between the internal and external ribs is 6 feet 2 inches, forming a footpath on each side.

The arched ribs are braced between the footpath space by cast-iron vertical and longtitudinal bracing-frames, with 2-inch tie-bolts passing through them, which extend as near as possible to the haunches, allowing only a sufficient headway for the passengers.

The spandrils between the arches and the beams which carry the railway, are filled with cast-iron vertical square pillars, also braced across with diagonal bracing frames, similar to those between the ribs. On the tops of these spandrel pillars are trough-shaped longitudinal girders, which extend along the bridge as continuous beams.

The ribs have square bosses cast on them, corresponding with the spandrel pillars, and forming horizontal tables for them to stand on; these were all truly bored and faced.

The spandril pillars are continued downwards, concealing the suspension bolts, and add great stiffness to the superstructure.

On the longitudinal top-girders are the cross-girders, also of a trough form, cast in one length, extending across the whole four ribs. The cross-girders have pockets or shoes cast on them, to receive the ends of the longitudinal timber-bearers upon which the road-planking is spiked.

All butting joints were planed on their upper surfaces to receive the bearing ends of the ribs, which were also planed.

On the abutments all the bearings are allowed to expand and contract, but on the next bearings they are fixed down firmly with four 1¾-inch bolts and nuts; on the next pier again they are free, and so on alternately fixed and free.

There are no rollers, but the bearings have sliding surfaces provided for the purpose.

The motion caused by expansion and contraction, ascertained by observation, was, during a variation of temperature of 32 degrees, ·92 inch in the whole six spans—·153 inch per span.

Each arch was temporarily erected at the contractor's works, and tested before removal, and all the other detailed parts received a separate test previously to this final trial.

The planking is 3 inches thick, jointed and tongued with hoop iron, and laid in two courses crossing each other at right angles. The upper course is caulked and pitched with as much care as would be bestowed on a ship's bottom.

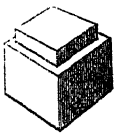


Fig. 44.

The lower roadway is formed of cross planking in a similar manner, and is paved with wooden blocks 4½ inches cube of a new construction. The blocks are cut at the upper surface, in form of a shoulder (fig. 44), so that when they are all in close contact they show so many grooves, which extend to half their depth (fig. 45), the channels being an inch in width.

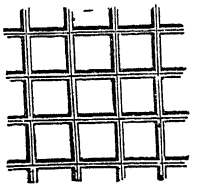


Fig. 45.

The surface on which the blocks were laid was covered with pitch; the blocks were dipped in hot pitch and laid, and the grooves filled with broken stone and gravel; a layer of pitch, and finally of sand was spread over all. Six years' wear has made but little impression upon this paving.

The quantity of masonry was,—

In the abutments and approaches, 360,222 cubit feet ashlar; 2434 yards rubble.
In the five river piers, 321,387 cubit feet ashlar; 877 yards rubble: 1712 yards concrete.
Total, 681,609 cubic feet ashlar; 4311 yards rubble; 1712 yards concrete.

The total weight of cast-iron was	4728½ tons.
The total weight of wrought-iron was	321½ ...
Total	5050 ...

The cost of the bridge was,—

Masonry, including coffer-dams	L.119,000
Iron work, including road, railway, &c.	114,000
Temporary bridge	10,000
	L.243,000

The first heavy portion of the superstructure was cast in February 1847, and the bridge was opened by the Queen in September 1849.

Monkland Canal Bridge.

As an example of one of the simplest forms of bowstring girders which have been constructed, we shall describe the large wrought-iron girders designed by Mr Edwin Clark for replacing a timber bridge over the Monkland Canal on

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the Caledonian Railway. The laminated timber arches of the old bridge were always much distorted, and as in many similar bridges which were constructed on our early railways, were beginning rapidly to decay, from the play of the timbers and the infiltration of water into the joints and between the planks of which the arches were composed. Such arches are undesirable for exposed structures in a damp climate, though peculiarly adapted for roofs where the arches are sheltered from the weather, as in many stations on the Caledonian line, and more especially on the magnificent roof of the Great Northern Railway station at King's Cross. The railway passed over these arches, which, from their dangerous state, were shored up, and it was of the utmost importance to replace them by some other structure without interfering with the traffic over more than one line at a time. Wrought-iron bowstring girders were therefore used on account of their lightness and the facilities they gave for adding but little weight to the old bridge during their construction upon it. The arch or top member of these girders is partly wrought, and partly cast-iron, and this construction has been found advantageous and economical. A similar combination has been adopted by Mr Clark in the bridge at Arnheim over the Yssel, on the Walton Viaduct, the large girder-bridge at Warrington, &c.

The lower flange or tie consists of wrought-iron plates as in the bottom of an ordinary flanged wrought-iron girder. The stiffness of the tie is secured by a deep vertical rib which forms a portion of its effective section, and which renders it sufficiently rigid not only for supporting the roadway, but also for assisting materially in preserving the arch from vertical change of form. This is farther secured by a similar vertical rib which forms a portion of the effective section of the arch. The vertical and diagonal bracing which connects the arch and the tie are attached conveniently to these vertical ribs. The arch consists of three ribs, the centre being nearly double the strength of the external ribs. The total length of the girders is 148 feet, and the depth is about $\frac{1}{10}$th of the length, or 15 feet.

The duty of the diagonal bracing is simply to preserve the form of the girder under a rolling load, and in order to insure a sufficient connection between the arch and the tie at each extremity, the panels at the extremities are filled in with close plates. The transverse timbers which carry the roadway, and which are simply bolted up beneath the lower flange, are 8 inches deep, and are placed close side by side, running across the whole bridge. Such a roadway is renewed with extreme facility, and occupies the least possible depth. The arches are braced together over the roadway.

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The whole weight of these girders for the double line is only 128 tons, and their substitution for the old bridge did not occasion the least interruption to the traffic. The sectional area of the top flanges is 120 square inches, viz., 60 square inches of wrought-iron, and 115 square inches of cast-iron. The sectional area of the lower flange or tie is 150 square inches.

As examples of the third method of securing vertical rigidity in such girders we may refer to most of the large timber viaducts erected in America, where the arch is combined in numberless ways with horizontal trussed or trellis girders with great ingenuity and simplicity of detail. Wrought-iron arches of a somewhat similar description have been designed by Mr Clark for the bridge at Mayence on the Rhine.

In this case the arches have a versed line of about one-tenth of their length, and are connected over several spans as well as rendered rigid by a continuous wrought-iron trellis girder of half the depth of the arch which is in section a wrought-iron rectangular box.

This roadway girder is extremely light, its duty being only to distribute the weight of the rolling load. It offers great facilities for the erection of the arches, and secures them from lateral motion by partially filling in the spandrels over the piers. It also breaks the extremely undulating outline which independent arches would present. It is moreover evident that great benefit is derived from the continuity thus given to the various spans. It is believed that, in cases where the roadway can be placed on the top of this continuous girder to allow of cross-bracing beneath it, this system is peculiarly applicable to spans of great magnitude.

There is a peculiar bow-string bridge erected on the Gloucester and Birmingham Railway, by Captain Moorsom (fig. 46), which is worthy of notice.

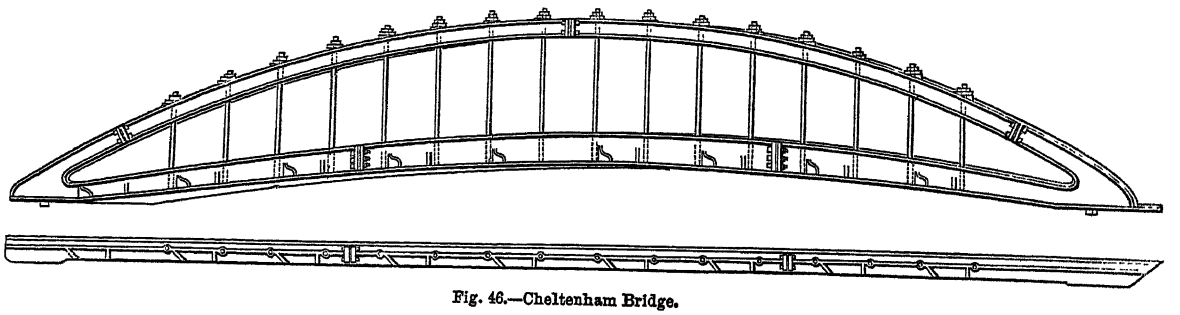


Fig. 46.—Cheltenham Bridge.

The roadway is carried by two main ribs of 45 feet span, each of which is in form of an arch with an arched chord; the top member is 9 inches deep by 3 inches in thickness, and the lower member or chord is one foot 6 inches deep, and is of the double-flanged form. The whole rise of the top member of the rib from the springing is 7 feet 3 inches, and that of the lower member or chord is 1 foot 6 inches; the space between them at the centre being 4 feet 3 inches.

Each rib is in five castings; and the top and bottom members are tied together by vertical bolts, 2 feet $5\frac{3}{4}$ inches apart.

The roadway plates are carried on a series of cast-iron beams on the skew, one end resting on the walls, the other in shoes, provided on the lower member of the ribs. Three of the cross beams bear at both ends on the walls; the beams themselves are curved with a camber of 1 foot 6 inches, and are tied together with bolts. The whole platform is carried by roadway plates of cast-iron, on which the road materials are placed.

(6.) *Tubular Girders.*

In the ordinary plate girder we seem to have arrived at the limits of simplicity of construction. A top and bottom flange with a vertical rib, all composed of plates, and united by angle irons, form a beam, the calculation of the strength of which is within the reach of every one. As soon, however, as we exceed very moderate limits, difficulties arise entirely beyond the reach of theoretical research, which are in fact quite independent of the action of such a beam as a girder, but arise from the distortion of form to which such a system, supported only on two distant and limited

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bearing surfaces, must as a whole be liable, more especially as expansion and contraction prevent any rigid attachment even on these contracted supports.

It is in meeting such difficulties in large structures that the skill and judgment of the engineer is really taxed when he exceeds the limits of actual experience. In the design of the Britannia Bridge, it was the mere arrangement of materials to resist the transverse strain which composed the difficulty of the problem. It was rather the practical construction of any such structure at all; the difficulty of obtaining the materials required, or of adopting such as were obtainable to such new purposes, and of devising a beam not merely of sufficient strength for its ultimate use as a bridge, but of sufficient independent rigidity for retaining its form not only when in place, but during its erection on its temporary scaffold, its floatation on unstable pontoons, and the ultimate raising of it into its place suspended isolated from four simple chairs.

The tubular girder alone seems really adapted to such varied strains; and it is difficult to conceive even now, with all our subsequent experience, any other means than those adopted of solving the great problem which thus inaugurated a new epoch in the history of bridge construction, and led directly not only to our present theoretical knowledge of the principles of beams, but to all those numberless elegant and ingenious practical combinations of wrought-iron in bridge construction, which it has been our province to describe.

These remarks on a subject now becoming old, are necessary, because great misapprehension exists as to the real objects in view in the construction of the first tubular bridges, and which, though probably the only constructions possible under such circumstances, and unsurpassed in point of simplicity of construction or economy by any other kind of beam, are yet not necessarily of universal application. The chief examples existing at present of tubular bridges of any magnitude are the following:—

1. The Conway Bridge.
2. The Britannia Bridge.
3. The Brotherton Bridge over the River Aire.
4. The bridge over the Nile.
5. The Victoria Bridge over the St Lawrence.

In all these cases, a tubular bridge simply means a pair of girders, with their top and bottom flanges of sufficient horizontal extension to meet and combine, forming a rectangular tube or trough, through the interior of which, or upon the top of which, the roadway may be laid.

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It may here be stated, that the result of experiments made with that object had directly proved that which might at first sight appear problematical, viz., that with such extensive horizontal development of the top and bottom flanges, the whole of their sectional area acts effectually in resisting extension or compression throughout the entire width; and, in fact, in cases of absolute fracture, where such beams have been broken in the experiments, the tearing asunder of the bottom plates actually commenced at about the middle of the tube, and not at the outside edges. The whole of the principles applicable to simple girders are thus directly applicable to these bridges, and full details of these principles and of their application, with a minute description of the construction and erection of the Britannia and Conway Bridges, together with an account of the extensive series of experiments made in connection with these works, and of the practical deductions thus arrived at, will be found in Mr Edwin Clark's work on this subject, to which the reader has before been frequently referred. We shall here merely give a few details, and draw attention to some of the circumstances which must be taken into account in considering these works as simple beams.

The Britannia Bridge, which carries the Chester and Holyhead Railway over the Menai Straits (see figs. 47 and 48), consists of two independent continuous wrought-iron tubular beams 1511 feet in length, and weighing 4680 tons each, independent of the cast-iron frames inserted at their bearings on the towers. They are 15 feet wide, and vary in depth from 23 feet at the ends to 30 feet at the centre. They rest on two abutments and three towers of masonry, at a height of 100 feet above high water. The roadway is laid along the bottom, viz., one line of rails in each tube. The centre or Britannia tower, which is altogether 230 feet high, is built on a rock in the middle of the Straits. The bridge has thus four spans, viz., two spans of 460 feet over the water, and two spans of 230 feet over the land. On each side the weight of a single span of 470 feet is 1587 tons, and of a span of 242 feet 630 tons. These tubes repose solidly on the centre tower, but repose on roller beds on the land towers and abutments. Now, these gigantic dimensions are by no means the only remarkable features in this work. The opponents of the Holyhead Road had imposed conditions on the Chester and Holyhead Railway, which were thought insurmountable with respect to this bridge. The navigation

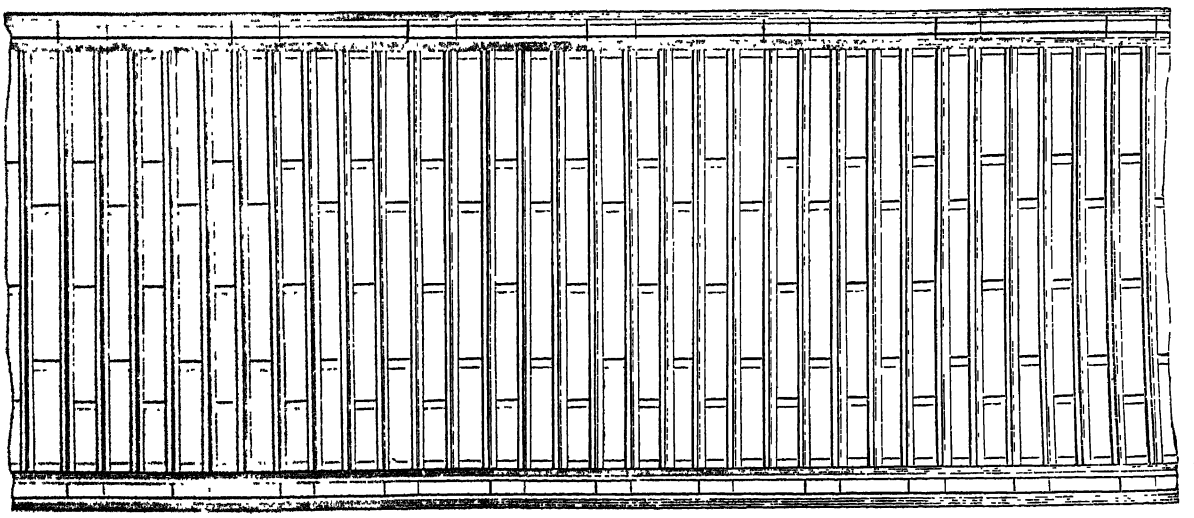


Fig. 47. Britannia Bridge—(Part Elevation).

was not to be interrupted—no scaffolding could thus be used—and the clear height of 100 feet was to be retained throughout; arches being objected to unless the springing and not the centre was at this elevation. The tides set through this portion of the Strait with a velocity of 9 miles per hour, and the quiet water at each turn of the tide lasts but for a

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very short space of time. The tubes were designed to meet all these requirements; they were so constructed at a

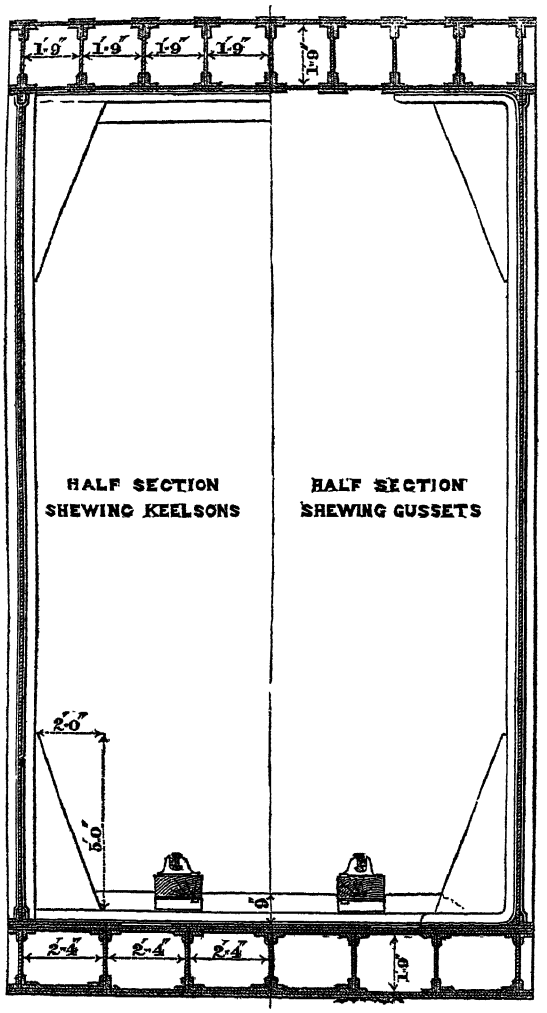


Fig. 48.

considerable distance from their permanent site on the shores of the Straits, they were floated upon pontoons upon these rapid tides to the base of the towers, and they were then drawn up by hydraulic presses to their required height. They were here united through the towers by the insertion of shorter lengths, and ultimately brought into the conditions of continuous beams as regards strain, by the means employed for their junction. It is evident such structures would be designed specially for such varied circumstances, for example,—

As soon as they were completed on temporary platforms, these platforms were removed, and they became isolated beams; the ends were accordingly strengthened with cast and wrought-iron framing for this special object, and had they always remained there the sides might have been throughout considerably lighter than they are; they now weigh nearly 40 per cent. of the whole weight. But in the next operation, that of floating, the tubes were liable to be supported at *any point* of their length, besides being subjected to chances of considerable distortion, and to disasters which on more than one occasion did actually threaten their entire destruction. The stiffening frames and gussets, which in an ordinary girder would have only been necessary at the ends, became therefore necessary throughout the whole length, and even the top and bottom were considerably modified, as it is evident that while overhanging the pontoons on each end to the extent of 70 feet, that the top, instead of being in compression was thrown into extension; the weight of the tubes was consequently much increased by these arrangements. Again, they had to be raised by being suspended freely from four chains. Provision for this suspension from such limited attachment had also to be made of a totally opposite character from that made for their vertical support when on their bed; and, ultimately, when raised to their place, they remained no longer independent beams, but were converted into continuous beams,—parts before in tension being now thrown into compression, and *vice versa;* while the ends which were before subject to no horizontal strain were now exposed to greater strain than even the centre of the span. And, last of all, during the act of raising one of these enormous masses, the press from which it was suspended burst, and one end of the beam fell through a space of no less than 9 inches on to a loose uneven heap of planks beneath it, bulging in the bottom plates, breaking all the castings, distorting seriously the sides and stiffening frames; while the broken press itself, which descended from a height of about 100 feet above, broke through the top plates and completed the crippling of the whole section of support. It may surely be doubted whether anything but a tube could have stood such unexampled violence; and in proportioning the parts of a structure destined for such usage, the mere consideration of the strain to which as an ordinary beam it would be subjected, formed but a part of the problem; no direct comparison can therefore be made between the weight of this bridge and an ordinary beam. If this were the case with the large spans, it is still more so with the small spans of 230 feet, which as simple beams would weigh only 230 tons each, whereas their actual weight is 650 tons. But it must be borne in mind that as regards the bridge itself these small spans were not required at all, and that they were merely designed and used as counterpoises for the large tubes, for the important purpose of converting them into continuous beams by their overhanging weight. By examining their detail, it will be found they are designed solely for this special purpose, their use as beams being made entirely subsidiary.

Some misapprehension exists on the object and importance of the cells of which the top and bottom of these tubes is composed. These cells are rectangular, there being eight of them in the top and six of them in the bottom, and they run throughout the bridge. With respect to their importance, it must be observed that the whole section of the top of the Britannia tube at the centre is 648·25 square inches, and of the bottom 585·43 square inches, and that the tube is 15 feet wide; the thickness of a single plate to ensure this section would therefore have been 2·7 inches for the top, and 2·3 inches for the bottom; and had such a plate been procurable, nothing better could have been desired, and the cells would be unnecessary. Such a thing, however, is evidently impossible, and the engineer in this, as in numberless other details, had to adopt what he could obtain; now the arrangement of the plates in cells is almost the only conceivable arrangement possible for obtaining the required section, allowing access, at the same time, to every part for construction and future maintenance. This alone led to their use in the bottom of the tube, where their form was totally unimportant. With respect to the top, however, it was of great importance, since thick plates could not be had, to ascertain the best form of cell for resistance to compression that could be devised with thin plates. A series of valuable experiments by Mr Eaton Hodgkinson led to the use of the rectangular cells as actually used, not because such form presented any peculiar advantage over any other form, as some have imagined, but because these experiments demonstrated that cells of that magnitude and thickness were independent of form, and are crushed only by the actual crushing of the iron itself; under these cir-

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cumstances, the square cells were used as the best practical method of obtaining the sectional area required.

Similar misapprehension also exists as to the considerations which led to the rectangular form of the tubes themselves. Now, the result of direct experiments made with round, oval, and rectangular tubes—there being precisely the same section and weight in all three, and, consequently, different depths—was, that the circular tube was the weakest, and the oval tube the strongest, the rectangular form being intermediate. The oval tube was, indeed, first studied with a view to its use. Its form, however, was not favourable, neither for its actual construction, nor for its connection with the suspension chains, which were originally intended to be used in the erection; and practical considerations, in this case, also compelled the use of the rectangular tube. It must also be remarked, that the result of experiments made on round, oval, and rectangular wrought-iron tubes, when reduced to the same depth and compared, was in favour of the rectangular form, although within ordinary limits the form was not proved to be a matter of very great importance. It may be added, that this bridge has now been in use six years, that the deflection has been carefully tested, from time to time, with the utmost precision, and that not the slightest perceptible increase has taken place during that period. The care with which the painting has been attended, and the protection afforded by the roof, have also entirely preserved it from the slightest damage by oxidation; and it is difficult to conceive that even the lapse of centuries can in any way affect such a structure, or to doubt that it will remain one of the most durable, as it certainly is one of the most remarkable monuments of the enterprise of the present century.

The Conway Bridge is in most respects similar to the Britannia Bridge, the local peculiarities of site being nearly similar. It consists of only two tubes of 400 feet span, placed side by side, and weighing each 1180 tons. The same provisions, as regards its strength, were made for floating it to its place and raising it; but, as the span is single, and it is not a continuous beam, the general arrangement of the plates is entirely different on the two bridges.

Bridge over the Aire.

In the Brotherton Bridge, on the York and North Midland, the span of which is nearly identical with the small spans of the Britannia Bridge, viz., 225 feet, it was possible to compose the top of a single plate, and no cells whatever have been used, either on the top or bottom.

The depth of these tubes is 20 feet, and their width between the side plates is 11 feet.

Each tube rests on two sets of rollers at one extremity, the other being bolted down to the pier. The rollers are placed at the extreme outsides of the tube, immediately under the sides, extending inwards only 2 feet 3 inches.

The roller-plates are bedded on creosoted timber. The bearings are stiffened by cast-iron standards, three on each side, firmly bolted to the side plates. Each standard is about 40 inches in sectional area at the bottom, and tapers to about 30 inches section at the top.

The rails are laid on longitudinal timbers, which are supported at intervals of 5 feet by angle iron brackets, riveted to the cross beams or keelsons.

The weight of one tube is as follows:—

Between the bearings the wrought-iron	198	Tons.
On the bearings the wrought-iron	13	...
Cast-iron on the bearings	14½	...
Cast-iron in rollers and plates	9½	...
Total weight	235	...

The rigidity of the tube exemplifies remarkably the advantage of solid or close sides in diminishing deflection. A circumstance also occurred in the construction of this bridge which illustrates one of the great advantages peculiar to tubes, viz., their independent strength.

The form given to these tubes is not rectangular, but the top was narrower than the bottom, so that their section was slightly pyramidal; their width at the bottom was 11 feet 10 inches, and at the top only 11 feet. Now, after the opening of the bridge, the width at the level of the carriage windows was objected to by the government inspectors, although they had previously sanctioned the width on the first tube erected. It became necessary, therefore, to widen the tubes, and this was done in a very interesting manner, viz., by literally opening the top of the tube down a centre line throughout its length, and inserting in the opening a longitudinal plate, 10 inches broad, from end to end. In this manner the sides were evidently moved farther apart to a less extent at the level of the carriages. By these means, and the removal of a portion of the projecting rib of the T irons, the whole was sufficiently widened. No other kind of beam could evidently have retained its form during so extraordinary an operation.

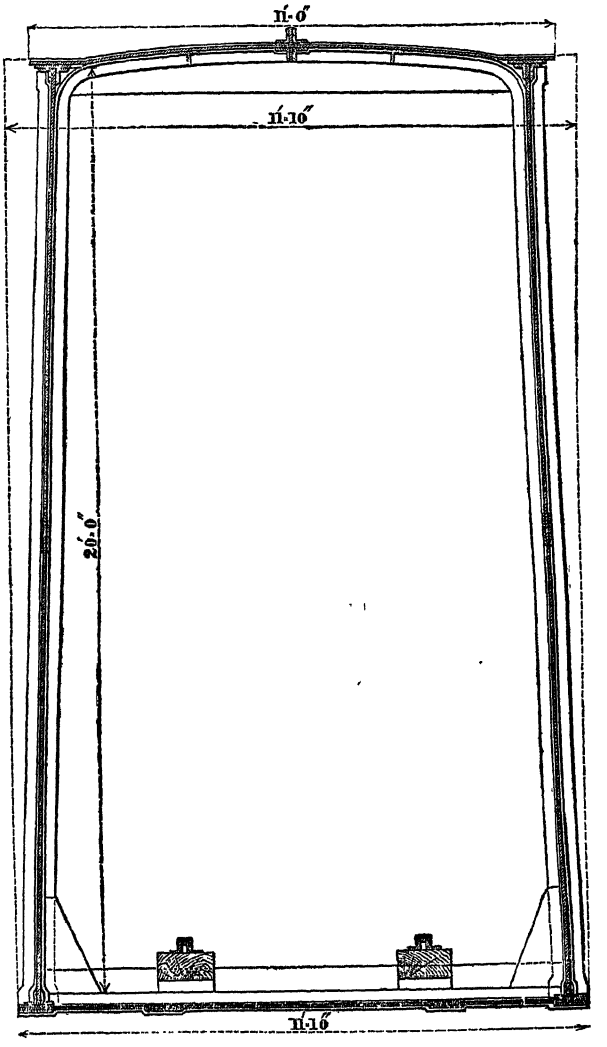


Fig. 49.

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The principal feature in the Egyptian Railway Bridges is, that the road is carried upon the top of the tubes, and not in their interior. Egyptian Railway Bridges.

There are two tubular viaducts upon the Egyptian Railway. The larger one crosses the Damietta branch of the Nile near Benha, and the smaller one crosses the Karrineen Canal at Berket-el-Saba (Lake of the Lion). These viaducts unite two old roads, formerly connected by a ferry, and each is contiguous to a vice-regal palace.

In the larger viaduct there are ten spans or openings, the

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two centre ones comprising one of the largest swing-bridges that has been attempted.

The total length of the swing-beam is 157 feet; it is balanced at the middle of its length on a large central pier. When open to the navigation a clear water-way is left on either side of the central pier of 60 feet. Each half of the beam sustains its own weight as a cantilever, 66 feet long.

The eight remaining spans are 80 feet in the clear, arranged four on each side of the centre portion; and the total length of the viaduct between the abutments is 865 feet.

The piers consist of wrought-iron cylinders, 7 feet in diameter below the level of low Nile, and 5 feet diameter above that level. They were sunk by a pneumatic process to a depth of 33 feet below the bed of the river, through soil of a peculiarly shifting character, and are filled in with concrete.

There are six of these cylinders in the central pier which supports the swing-bridge; and the adjacent piers on either side of the centre have each four cylinders; each of the remaining piers has two cylinders only. The tops of the cylinders are covered by cast-iron circular plates which rest entirely upon the concrete, special care being taken to prevent any contact with the cylinders. On these circular plates rest the upper cast-iron plates which connect the piers, and form a seating for the bearing-plates of the beams.

The beams or tubes are 6 feet 6 inches deep, and 6 feet 6 inches wide at the bottom, tapering to 6 feet wide at top, and they rest at their ends on rollers working between planed surfaces to admit of the motion caused by expansion and contraction.

The tubes carry a single line of way on their tops, the rails being laid on longitudinal sleepers, and there is also a roadway 4 feet wide on either side, supported by wrought-iron brackets bolted to the sides of the tube.

These roadways are of corrugated iron, resting on the brackets, and stiffened by strips of bar-iron placed transversely on the top.

The six cylinders for the central pier are also provided with cast-iron circular plates, as before described, and surmounted by a framework of cast-iron, uniting the tops of the cylinders, and serving as the lower tramway for the rolling machinery.

The revolving machinery consists of a turn-table containing eighteen accurately turned conical rollers, their angle being determined to the greatest nicety, and corresponding with the angular surfaces of the tram-plates between which they revolve.

The diameter of this turn-table is 19 feet from centre to centre of the rollers.

The whole of the rollers, together with the wrought-iron circular frame to which they are attached, form an independent system, usually termed the "live-ring," held in its position by the central pivot. The frame of the "live-ring" is connected with the rollers by radial spindles with gun-metal gudgeons at the periphery and centre. And, to prevent any difference in angular speed between the rollers and centre portion, a very excellent arrangement is adopted, which consists in a diagonal strap passing over the central wheel, and extending to the outer periphery. This strap is keyed up to any adjustment in which it firmly keeps the radial spindles.

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The swing-tube is firmly attached to the upper tram-plate by a system of cast-iron bracket-work and strong bolts and nuts; forming, in fact, as is most essential at this point, an exceedingly rigid attachment. The centre pivot is of forged iron, 9 inches diameter, and turned accurately to fit its bearings. To insure a firm fixing for this pivot, it is made to pass through the entire depth of the lower tram-plate into a socket provided for the purpose, in which position it is firmly keyed. The bridge is turned with facility by a capstan worked by two men, with gearing communicating with the large rack surrounding the lower tram-plate.

To prevent accident to the swing-bridge when open, "Fenders" are placed up and down stream, similar in construction to the piers of the bridge. At the bearing ends of the swing-bridge arrangements are made for locking it in its position. These consist of fixed inclined planes attached to the under surface of the bearing ends of the tube and corresponding wedges which slide on the piers, which are made to recede and advance by means of a screw turned by gear-work.

In the Birket-el-Saba Viaduct the swing portion forms spans on each side of 43 feet, and the fixed portion consists of two spans of 70 feet each. In other respects the viaducts are precisely similar.

Both were commenced in May 1853, and completed for traffic in October 1855.

It may be here remarked that the duties of a swing-bridge in resisting strain are greatest when the bridge is open and only sustaining its own weight. This will be readily understood by considering the entire swing-bridge in the condition of a beam supported in the middle, and loaded at the ends, the action being, in fact, similar to that illustrated by fig. 17. The centre point in the figure may represent the centre pier of the swing-bridge; therefore it is evident that the depth must be proportioned to the entire length of the swing-beam and not to the mere span on each side of the centres; and by the simplest reasoning it will be found that the load of a railway train, if amounting even to one ton per foot, will not produce so much strain on the bridge when it is resting at its ends on the outer piers, as the beam will produce itself when open and overhanging; for in the former position, the load, though probably double the weight per foot run of the beam itself, is acting on a span supported on each end, equal to less than half the length of the beam, whereas in the latter case the weight of the entire beam is acting at a span which gives it more than twice that leverage.

There are numerous other iron railway bridges of which we could give examples, but those already given comprehend the whole of the principles of construction adopted. The engraving (Plate II.) of some of the most important bridges will give perhaps a more comprehensive idea of their magnitudes. (R. S.)

Irrawaddy || Irrigation.

IRRAWADDY, a river of Asia, rising at the eastern extremity of the Himalaya range of mountains, in Lat. 28. 5., Long. 97. 58. It flows in a direction from N. to S., traversing the heart of the Burmese empire, which it separates into two nearly equal divisions. After a course of 790 miles, it reaches the southern frontier of Burmah, and, crossing over into the British province of Pegu, pursues its course for a further distance of 270 miles, reaching the Bay of Bengal by several mouths, which form the delta of the Irrawaddy. At the distance of 550 miles from its source, it flows past the city of Ava, the capital of the Burmese Empire, 65 miles below which it receives its great confluent the Khyendwen. Fifty miles below the southern frontier of Burmah, the Irrawaddy passes the British town of Prome, 90 miles below which it divaricates into two principal channels, each measuring about 130 miles in length. The more westerly of these branches is known as the River of Bassein, from the town of that name upon its banks, and discharges itself into the Bay of Bengal, in Lat. 15. 50., Long. 94. 26. The other main branch is designated the Rangoon River, and falls into the Gulf of Martaban, in Lat. 16. 28., Long. 96. 24. Irrigation.

IRRIGATION.

IRRIGATION was the first application of science to agriculture. Nature by it was impressed into the service of man. Her quiet and unaided processes having been noticed, they were gradually systematized to a beneficial result. And as toiling man dug and laboured at the stubborn earth to make it yield his corn, he found that bountiful nature, if rightly directed, would, through the fertilizing influence of water, produce perennial crops of grass to feed his cattle and enrich his corn land. The elements which are diffused in the air and water are concentrated in the grass. The grass feeds the cattle, and the cattle support man. In all countries in which agriculture has made progress, meadows and corn land are found conjoined. On them is developed that assimilating vegetation which gives unceasingly to the farm without receiving anything. Hence, wherever farming is understood, irrigated meadows are highly valued, and, though the art as practised in different countries varies both with the skill of the people and the necessities of the climate, it has from remote antiquity engaged much of the attention of agriculturists.

If, in our comparatively moist climate, we find our crops in some seasons diminished grievously by a continued drought, we may have some conception of the necessity under which those lie who cultivate a soil where rain seldom or never falls, to call in the aid of irrigation. With us the water of irrigation may supply either the food of the plant, or the moisture needed for its vegetation. But in Peru, Egypt, some parts of Persia, India, and China, the plant could not even strike root without the aid of water artificially applied to the parched soil.

Though the operations of irrigation and drainage seem exactly opposed to each other, they are not in reality so. The main advantage of irrigation is the deposit of nutrition to the grass from the water passing over its surface. The great use of drainage, though at first sight it appears to act merely by carrying off stagnant water, which would cool the earth and starve the plant, is to render the soil like an open filter, through which the water, as it passes off, is deprived of much of its fertilizing qualities, and these are found stored up in the porous soil, ready for the use of the roots of plants in search of food. Grass is the surface filter which retains the fertilizing qualities of the water of irrigation; the soil is the underground filter which acts in the same capacity on the water of drainage. Stagnation is equally injurious to both. The water of irrigation must *pass* over the surface, and that of drainage through the soil and substratum, before any benefit can arise from its presence.

According to the parliamentary return of agricultural statistics for England in 1854 (the accuracy of which under this head we feel inclined to receive with some doubt), the extent of land under irrigated meadows is 1,292,329 acres, which is equal to nearly one-half of the land under clover and artificial grass. The produce of these meadows and cultivated grasses is chiefly consumed by live stock, the manure of which goes to a considerable extent to enrich the arable corn land. Taking England and Wales alone, the proportions under corn and under cultivated grass are as 3 to 1. In France, according to Lavergne, the proportions under these crops are as 9 to 1. That is to say, while in England every three acres of corn land are enriched by the manure produced from one acre of meadow, in France the same manure has to be spread over nine acres. The result is that the average produce per acre of wheat in England is double that of France. Hence we see the importance of attention to irrigation as a means of increasing the general productions of our soil. It has indeed been asserted by M. Bousingault, the eminent French agricultural chemist, that such is the influence of irrigation that, where the system can be introduced in connection with an arable farm, the advantage accruing from it in bringing the elements of fertility on to the farm is greater than the loss sustained by the land through the sale of its marketable produce.

The *quality* of the water employed exercises a great influence on the effect produced. New facts are constantly arising in proof of this.

There are four ways of irrigating land with water; and in order to preserve a command over its motions, it must in all cases enter the land to be irrigated at a higher level than where it leaves it. This disposition of materials is the only way to make water move in a sensible and equable current. 1*st*, One kind of irrigation is called Bed-work Irrigation, which is the most efficient, though also the most costly kind by which currents of water can be applied to level ground. 2*d*, Another kind is called Catch-work Irrigation, which is suited to both level and uneven ground. 3*d*, A third gets the name of Subterraneous Irrigation, from the water being supplied upwards to the surface through drains in the subsoil. 4*th*, And the fourth kind is called Warping, when the water is allowed to stand over a level field till it has deposited the mud it contains.

In addition to these a novel application of the principle of irrigation has been lately introduced into the farm practice of England, and which consists of the application, by pipes or hose, of the liquid manure of the farm, more or less diluted with water, to the growing crops, and especially to the growth of Italian rye grass. As this process is yet only in an experimental state, we can do no more than refer to it here.

Several particulars require deliberate consideration before determining on forming any kind of water meadow. The vicinity of a river is desirable, not so much on account of the supply of water, for that may be obtained in winter beside a mountain torrent or a lake, but on account of the fertilizing matter which is generally suspended in the waters of a river. Hence a river, flowing through an alluvial and cultivated country is preferable to one through a mountainous and rocky country. An ample supply of water is absolutely

Irrigation. necessary to beneficial irrigation. It is folly to incur the expense of forming the most perfect water meadow without an ample supply of water to fill the channels to overflowing. The supply of the water must be on a higher level than the ground to be irrigated. The fall need not be more than is necessary for a pretty rapid current of water, which, in ordinary cases, may be 10 inches or 1 foot, for 100 or 200 yards, and about 2 feet for 300 yards. The water, if possible, should be taken as far above the meadows as to have a sufficient fall without damming up the river. When this plan is impracticable, but only when impracticable, a dam should be thrown across the stream at such a distance above the meadow as to secure not only a sufficient fall, but to protect the fields on both sides from inundation, whether the fields belong to different proprietors or not. For, in regard to dams across small streams which form the boundaries of farms or estates, it may not be irrelevant to mention that altercations have frequently arisen from supposed damages arising from inundations or infringements on the rights of waters. In every case, therefore, of constructing a dam for irrigation, it will be wise to avoid the chance of disputes, by acquiring, in the first place, the right for such an erection by purchase or otherwise. When a dam is inevitable, it should be constructed substantially. The first cost will be less than the repairing of a dam which has blown up from under or burst out at the sides. When water cannot be obtained under these prerequisites, conjoined to an ample supply, then the formation of water meadows at that place should be altogether relinquished. But should the requisite desiderata be available, the field to be converted into a water meadow should in the first place be thoroughly drained. The most perfect piece of workmanship as a water-meadow will be comparatively useless, unless the water which has passed through the soil to the subsoil find a free egress by drains. Without drains the water will inevitably stagnate on the subsoil, unless indeed the subsoil consists of very porous materials, such as chalk, sand, gravel, or fissured rock.

Besides the particulars enumerated, two essential rules in the formation of water-meadows should never be neglected, namely, that no part of them, however small, should be on a dead level; and that every drop of water, while irrigating, should be kept constantly in motion. These rules are founded on the very principle of irrigation which has been illustrated in the prefatory remarks. True inclined planes can be the only form of surface to which these rules will strictly apply; but although it may not be possible to stretch such planes along a great extent of surface, as ground is proverbially uneven, yet every portion of it which is watered directly from the main supply should be so exactly inclined. The spirit-level should be the *vademecum* of the irrigator, the eye being deceptive in regard to the levelness of ground; and even with that indispensable instrument, the irrigator will find the formation of a complete water-meadow on an irregular surface no easy task. Superficial observers may see little difficulty in the operation; but the practical irrigator knows how nice a thing it is to adjust irregularities of ground to the constant and equable flow of water. So great is this difficulty that none but professional irrigators ought to attempt the formation of water-meadows, and they ought to be of established character and experience.

The first thing to be done for any water-weadow is to make the conductor or drain which brings the water from the river to the meadow. The size of the conductor depends entirely on the quantity of water which the meadow requires. Its bottom, at its junction with the river, should always be as low as the bottom of the river, in order to carry away as much mud as possible to the meadows. Its course should be as straight and as near an inclined plane as possible. The stuff taken out of the conductor should be employed in equalizing its banks, or filling up irregularities in the meadow. These general directions naturally lead to the examination of the particulars of which the different kinds of water meadows enumerated consist. Irrigation.

I. BED-WORK IRRIGATION.

This species of irrigation is eminently applicable to level ground, and under it, as the name implies, the ground is thrown into *beds* or *ridges*. After the conductor has been brought from the river to the meadow as directed, it should be led along the highest end or side of the meadow in an inclined plane; and should it terminate in the meadow, and not have to proceed farther on to another, its end should be made to taper when there are no feeders, or to terminate in a feeder. The tapered end will retard the motion of the water, and containing, of course, less water, the water will overflow the banks of the conductor. The main drain to carry off the water after it has irrigated the meadow should next be formed. It should be cut in the lowest part of the ground at the lower end or side of the meadow. Its dimensions should be capable of carrying off the whole water used, so quickly as to prevent the least stagnation, and discharge it into the river. The stuff taken out of it should be used to fill up irregularities in the meadow. In case the river takes a turn along the lower end or side of the meadow, the turn should be used as a main drain to carry off the water, and save the expense of cutting a drain. It may be imagined that as a portion of the water will be absorbed by the soil, the main drain need not be made so large as the conductor, merely to carry off the water that has been used; but in practice it will be found, that when the water is muddy, very little of it comparatively will enter the ground, because the sediment, acting as an impervious covering, prevents much of the water from descending into the ground. The next process is the forming of the ground intended for a water-meadow into beds or ridges. That portion of the ground which is to be watered by one conductor should be made into beds to suit the circumstances of that conductor; that is, instead of reducing all the beds over the meadow to one common level, they should be formed to suit the different swells in the ground, and should any of these swells be considerable, it will be necessary to give each side of them its respective conductor. The beds should run at or nearly at right angles to the line of the conductor. The breadth of the beds is regulated by the nature of the soil and the supply of water. Tenacious soils and subsoils, and a small supply of water, require as narrow beds as thirty feet. Porous soils and a large supply of water may have beds of forty feet. The length of the beds is regulated by the supply of water and the fall from the conductor to the main drain. If the beds fall only in one direction longitudinally, their crowns should be made in the middle; but should they fall laterally as well as longitudinally, as is usually the case, then the crowns should be made towards the upper sides, more or less according to the lateral slope of the ground. The crowns should rise a foot above the adjoining furrows. The beds thus formed should slope in an inclined plane from the conductor to the main drain, that the water may flow equably over them. The beds are watered by what are called *feeders*, that is, by channels gradually tapering to the lower extremities, and their crowns cut down, wherever these are placed. The depth of the feeders depends on their width, and the width on their length. A bed two hundred yards in length requires a feeder of twenty inches in width at its junction with the conductor, and it should taper gradually to the extremity, which should be one foot in width. The taper retards the motion of the water, which constantly decreases

Irrigation. by overflow as it proceeds, whilst it continues to fill the feeder to the brim. The stuff which comes out of the feeders should be carefully and evenly laid along the sides of the beds. The water overflowing from the feeders down the sides of the beds is received into small drains formed in the furrows between the beds. These small drains discharge themselves into the main drain, and are in every respect the reverse of the feeders; that is, their tapering extremities lie up the slope, and their wide ends open into the main drain, to accelerate the motion of the departing water. The depth of the small drain at the junction is made about as deep as that of the main drain, and it gradually lessens towards the taper to six inches in tenacious, and to less in porous soils. The depth of the feeders is the same in relation to the conductor. The stuff obtained from the small drains is employed to fill up inequalities in the meadow. For the more equal distribution of the water over the surface of the beds from the conductor and feeders, small masses, such as stones, solid portions of earth or turf fastened with pins, are placed in them, in order to retard the momentum which the water may have acquired. These *stops*, as they are termed, are generally placed at regular intervals, or rather they should be left where any inequality of the current is observed. Heaps of stones answer very well for stops in the conductor, particularly immediately below the points of junction with the feeders. Solid portions of earth are usually left in the feeders, or tough pieces of turf fastened down with wooden pins; but care must be taken to keep the tops of the pins below the reach of weeds floating on the surface of the water. These stops, however, are nothing but expedients to rectify work imperfectly executed. It must be obvious that a perfectly formed water-meadow should require few or no stops. The small or main drains require no stops. The descent of the water in the feeders will no doubt necessarily increase in rapidity, but the inclination of the beds, and the tapering of the feeders, should be so adjusted as to counteract the increasing rapidity. At all events *notches* cut into the sides of the feeders to retard the velocity of the water, is much more objectionable than stops, although some writers recommend them; but where they have been observed, the spectator may depend on having seen an imperfect water-meadow. The distribution of the water over the whole meadow is regulated by the sluice, which should be placed at the origin of every conductor. By means of these sluices any portion of the meadow that is desired can be watered, whilst the rest remains dry; and alternate watering must be adopted when there is a scarcity of water. Each sluice should be placed according to the elevation or depression of the ground which it supplies with water. All the sluices should be substantially built at first with stones and mortar; because a carelessly constructed sluice will permit the leakage of water at all times; and should the water from the leak be permitted to find its way into the meadow, that portion of it will stagnate and produce coarse grasses. In a well formed water-meadow it is as necessary to keep it perfectly dry at one time, as it is to place it under water at another. A small sluice placed in the side of the conductor opposite to the meadow, and at the upper end of it, will serve to drain away the leakage that may haply have escaped from the head sluice. The laying out of the beds, feeders, and small drains, constitutes the nice part of the formation of a water-meadow; it constitutes the test by which the skill of the irrigator is tried; and it is impossible to acquire the skill without practice.

To obtain a complete water-meadow, the ground will often require to be broken up and remodelled; for it is rare to find a piece of ground naturally possessing the requisite qualifications of a water-meadow. Such a remodelling will no doubt be attended with cost; but it should be considered that the first cost is the least; and remodelling the only way of obtaining the desired object of having a complete water-meadow which will continue for years to give satisfaction. Irrigation. To effect a remodelling when the ground is in stubble, let it be ploughed up, harrowed, and cleaned as in a summer fallow; the levelling-box employed when required, the stuff from the conductors and main drains spread abroad, and the beds ploughed into shape. All these operations, as of the farm, can be performed at little expense, and they form the substantial foundation of the nicer operations of the spade, the barrow, and the level. The meadow should be ready by August for sowing with grass-seeds. The seeds best suited for a water-meadow are perennial rye-grass (*Lolium perenne*), sweet-scented vernal grass (*Anthoxanthum odoratum*), crested dog's tail grass (*Cynosurus cristatus*), meadow fox-tail grass (*Alopecurus pratensis*), rough-stalked meadow-grass (*Pou trivialis*), and fiorin (*Agrostis stolonifera*). The fiorin is the prevailing grass in all good water-meadows, and it makes a most delicious hay. It is best propagated by sowing the stems chopped into pieces like chaff. These grasses do not always produce a good crop the first year, but the rye-grass will assist to thicken the crop. Some writers, and particularly Mr Smith in his *Essay on Irrigation*, assert that it is of no importance what grasses are sown in water-meadows, as the most congenial kinds will in time spring up and banish all the others; but is it not better to supply the ground at once with the best grasses than wait for the extirpation of the worst? The method now described of forming a water-meadow is attended with one great disadvantage; the soft ground cannot be irrigated for two or three years after it is sown with grass-seeds. This disadvantage can only be avoided where the ground is covered with old turf which will bear to be lifted. On ground in that state a water-meadow may be most perfectly formed. Let the turf be taken off with the spade, and laid carefully aside for relaying. Let the stript ground then be neatly formed with the spade and barrow, into beds varying in breadth and shape, according to the nature of the soil, and the dip of the ground; the feeders from the conductor, and the small drains to the main drain being formed at the same time. Then let the turf be laid down again and beaten firm, when the meadow will be complete at once, and ready for irrigation. This is the most beautiful and most expeditious method of making a complete water-meadow where the ground is not naturally sufficiently level to begin with.

The water should be let on, and trial made of the work, whenever it is finished; and the motion of the water regulated by the introduction of a stop in the conductors and feeders, where a change in the motion of the current is observed, beginning at the upper end of the meadow. Should the work be finished as directed by August, a good crop of hay may be reaped in the succeeding summer. There are few pieces of land where the natural descent of the ground will not admit of the water being collected a second time, and applied to the irrigation of a second and lower meadow. In such a case the main drain of the watered meadow may form the conductor of the one to be watered, or a new conductor may be formed by a prolongation of the main drain; but either expedient is only advisable where water is scarce. Where it is plentiful, it is better to supply the second meadow directly from the river, or by a continuation of the first main conductor. In some instances it may be necessary to carry a conductor over a hollow piece of ground along an aqueduct made for the purpose, called a *carry-bridge*. Such an aqueduct may be made either of wood, cast-iron, or stone and mortar.

As a real example of a water-meadow, such as has been described, will illustrate the several particulars specified more accurately than any imaginative case, fig. 1 is a design of one belonging to Mr Loch of Rachan in Peeblesshire, and executed in 1823 by Mr George Stephens, drainer

Irrigation. and irrigator, Edinburgh. The design is taken from Mr

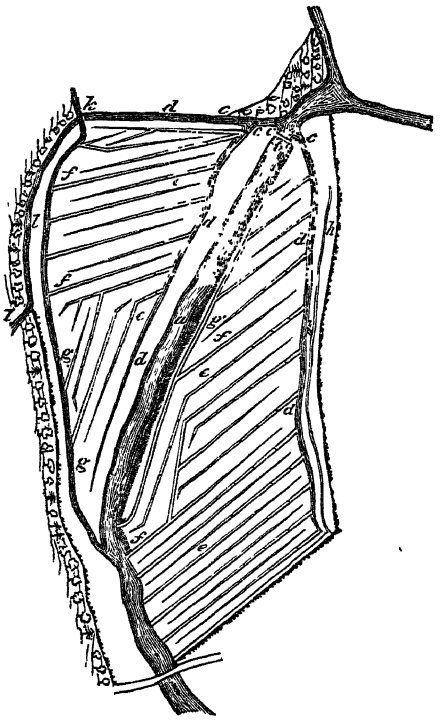


Fig. 1.

Stephens' *Practical Irrigator and Drainer*, 1834 (p. 10), a work of great practical utility. The meadow, as may be seen in fig. 1, lies on both sides of the River Biggar, and contains eight acres, partly of clay, but mostly of gravel, and both resting on a gravelly subsoil. The river supplies the meadow amply with water. The expense of straightening the river, building the dam and sluices, and forming embankments against inundations in every flood, was L.9 per acre. The work was executed late in spring 1823, and in 1825 four hundred stones of hay per acre were cropped, worth sixpence per stone, or L.10 per acre, and L.1 per acre for the aftermath, from land that was not worth L.2 per acre before being irrigated. The references to the cut are these: *a* is the Biggar water; *b* is the dam 30 inches high across it; *c, c, c, c,* sluices in conductors; *d, d, d, d, d,* conductors; *e, e, e, e,* feeders; *f, f, f, f,* small drains; *g, g, g,* main drains; *h,* a drain for cutting off natural springs; *i,* a small sluice on the side of the conductor, to carry off any leakage of water from the sluice *c*; *k,* a carry-bridge or aqueduct; *ll,* conductor to another meadow; .... stops in conductors and feeders.

II. CATCH WORK IRRIGATION.

MR BICKFORD'S IMPROVED DEVONSHIRE SYSTEM.

We have thought it right to give the details of Mr Bickford's system as the best illustration of the catch-work plan, while it has the advantage of being comparatively cheap in its first construction, and has met with the approval of eminent practical agriculturists, such as Mr Pusey, Mr Druce of Eynsham, and others, who have introduced it into other counties besides Devonshire with great success. Mr Bickford thus describes it:—

After nearly twenty years' experience of this system of watering meadows in different situations, and under nearly every variety of circumstance, I may without presumption judge of its value; and being confirmed by the experience of my neighbours, whose opinions are entitled to respect, I venture to offer it to the consideration of others, believing that the use of this system would have the general effect of improving irrigated meadows in yearly value from 10s. to 20s. per acre. I am confirmed in this opinion by long experience, strengthened by the estimate made of it by a few agriculturists who happen to have had their attention drawn to it—persons well qualified to judge of such a matter. Irrigation.

This system has the advantage over the common system of obviating the necessity for large and frequent level gutters; it has the effect of continuing (and even causing) a smooth and uniform surface to the meadow, allowing of the operations of mowing and carting over the meadow without any sensible perception of the existence of the gutters used for irrigation; and also, that of accelerating the speed of the water over the land when "turned on," and the speedily draining the water from the surface when "turned off." In fact, it becomes an instrument in the hands of the irrigator, by means of which he can do with ease whatever his judgment determines ought to be done. It also obviates that waste of land occasioned by the usually large gutters. In fine, I profess to say that it is every way better than the old system: it can be done in half the time, and for less than half the expense.

Without further preface, I shall proceed with the details of the plan, and shall endeavour to make it quite intelligible. The chief features of the system consist in causing the ground intended to be irrigated to be covered with a net-work of small gutters, intersecting each other as nearly at right angles as circumstances will permit. These gutters are about 4 inches wide and 1 inch deep; they are cut with a "*die*," fixed in a sort of plough of simple construction, drawn generally by one horse. This net-work of gutters is fed at the highest level possible, or thought desirable, by a carriage gutter of sufficient size for the purpose, to be determined by the operator.

The system will be fully brought to view in the course of the description I shall give of the manner to be pursued in laying down the levels.

Let fig. 1 be a piece of meadow; look first where the water enters the meadow, or where it *can be made* to enter. This is a matter of some importance, and should be considered well, in order to get the best supply of water, at the best place, and at the least expense. Let this be ascertained to be at A in figure 1. Then estimate roughly where it may be supposed the water will run; suppose along the dotted line 1 .... 2. Then take the level (fig. 2), and proceed to mark a line across the meadow, according to the following rule. Set the feet Nos. 1 and 2 (fig. 2) level on the ground by means of the plumb-line 3; mark the place of No. 1; then advance the level by putting No. 1 in the place of No. 2, and finding a new place for No. 2 by means of the plumb; and so proceed until you have made a level line across the meadow, subject, however, to certain variations, which I shall explain as occasion may require. Let some person follow with a spade or something of the sort, and turn up a bit of sod at every alternate move of the level, by which means you will have a bit of sod as a mark, at about every 10 feet. Begin say at B, fig. 1, and proceed as directed, and on a flat piece of ground you will probably produce a line thus, BC. The arrows marked on the line show the way the water is to be made to run on in the gutter line; to obtain which you must deviate from precise levelling, and allow the plumb-line to drop a little before the level mark when you are inclining *down* the meadow, and a little behind it when you are inclining *up* the meadow. This will have the effect of running the water *out* of the *low* places, and *upon* the high places. Care must be taken in levelling to follow out the indications of the level, however crooked and curved the line might appear; and by all means to go *down* around *every* elevation, and to avoid every disposition to cut the line straighter, &c., as every straight cut that is made of that sort will have the effect, more or less, of causing a dry spot below the gutter, or a pond above it.

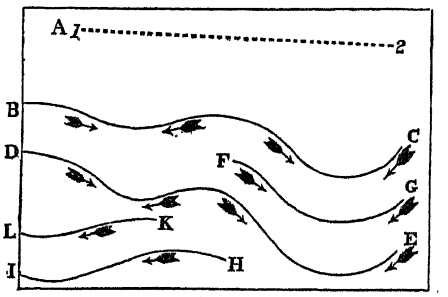


Fig. 1.

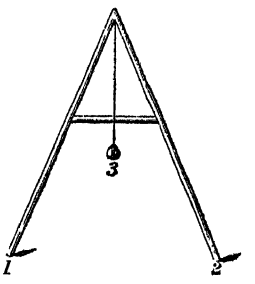


Fig. 2.

Having completed that line, return to the side you first began, and by no means level backwards. Return, say to D, which should be about 10 paces down from B; and by proceeding as in BC, you will very likely produce the line DE. The consequence will be,

Irrigation. that C and E are too far asunder; you must therefore begin at F, and produce the line FG. I have supposed the middle of the meadow to be lowest, and the meadow itself to be *flat*, rising on each side of the middle by two gentle undulations, requiring the lines of gutter to curve very considerably. The nature of the ground is supposed to make it necessary now to begin at H, and to produce HI. It will now be perceived that D and I are too far asunder, making it necessary to introduce KL, beginning at K. Then proceed to finish out the higher side in like manner.

To avoid crowding the figure, I shall draw it anew, with a few alterations introduced for the purpose of showing the next process to advantage.

Let fig. 3 represent a meadow, with all the lines of fig. 1 marked with the level and ploughed, but not "turned out;" the lines will be sufficiently perceptible to manage the next proceeding. It will be perceived that the curves of the lines form a series of loops, and that the undulations of the meadow are prettily mapped out by the curves going *down* around the hills and *up* around the valleys. You can at once perceive where the water is principally wanted, viz., just above where the curves form the greatest downward bend. In the case before us it is at A, fig. 3. The next thing to be done is, to draw the lines which, upon an average of the whole, will be at right angles to the level; but in each particular line will deviate from the right angle, more or less, according as the ground is more or less irregular. The plan I adopt is, to put some one to plough after me, and then I walk on before, and, by dragging my feet, leave a sufficient stain to mark where the plough must follow. Care must be taken to go as nearly through the centre of the downward loops as possible. In order to do this, first cut the lines 1, 2, 3, 4, 5, and then fill up the intervals by cutting *a*, *b*, *c*. They should be from 10 to 15, or more, paces apart, according to the taste of the operator. I do not at all like them to be farther apart than 15 paces, but some persons think that by placing them closer together you cut too much land.

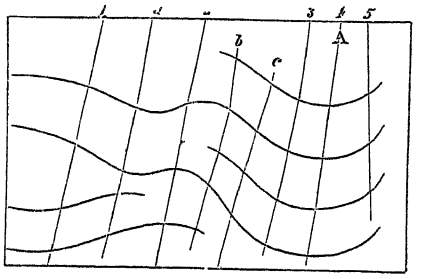


Fig. 3.

The next business is to bring in the water, after just lifting the turf out of the gutters already cut. I use, first, a spirit-level, and set a mark every 2 poles, allowing the gutter to drop 1½ inch or 2 inches if the nature of the ground will allow of it; but not less than ½ inch will do at all well. A much larger gutter is required at ½-inch drop than at 2 inches, and, besides, it will not run itself dry so well when the water is turned off. The 2-inch drop gutters will run the water off directly; the ½-inch will scarcely do it at all. Regard must be had to the supply of water required at the farther end. In the case supposed in fig. 3, it is wanted on the rising ground, at the farther end A; therefore the gutter should drop that way accordingly (and in proportion), and be of a good size; but if the water is wanted chiefly at the beginning end of the gutter, the drop need not be so much, and the gutter should taper away so as to end nearly in a point.

The next consideration should have regard to the size of the stream. If it is enough to water the whole piece at all times, one gutter, of sufficient size to do the work, should be made; and to do it without stops; stops in a gutter are decidedly objectionable. Where the stream is small, make a leading gutter, and take out from it taper gutters, each of a size suited to the stream when at its smallest, so that when the stream increases (from rain or any other cause), so many taper-gutters may be used as will disperse the whole stream. The leading gutter should continually decrease in size from the beginning to the end, *i.e.*, from the place where the first taper-gutter is taken out of it, and finish in a tapering water-gutter itself at last (see fig. 4).

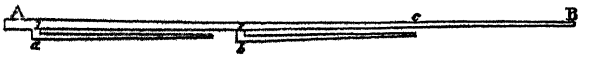


Fig. 4.

AB is a carriage-gutter as far as *c*, and a watering-gutter from *c* to B; *a* and *b* are watering-gutters taken out of it. When the stream is small, a stop at 1 will cause it to work in *a*; a stop at 2 will work in *b*; without any stop it will work in *c*B. If the stream is too much for *c*B, it will work *b* at the same time; and should there be water enough, it will also fill *a* without any stop at all. Care should be taken not to make AB larger than just to carry the full stream wanted; and in every case when the gutter is got too large by frequent cleaning out, cut it anew on one side or the other. Irrigation.

In levelling, after having marked every 2 poles with the spirit-level, mark the ground between with the plumb-level every 10 feet or so, and cut accordingly. Make the hedge-trough a carriage-gutter wherever it can be done conveniently, taking care always to make the water *run* in them when so used; and by no means to have stagnant water in the troughs. Covered gutters made with large tile could also be substituted for the deep open carriage-gutter, where it is necessary to cross the middle of meadows; it would thus obviate the danger of the open gutter to sheep and lambs; and the extra expense would be partly compensated, as the tiled-gutter would never require the annual "*cleaning out.*"

General rules cannot be laid down to suit every circumstance that will occur, but practice and an ingenious mind will decide that which is most fitting on each occasion.

In watering with a small stream which happens to be insufficient for the whole meadow, the water must be confined to ground determined on by stops in the two perpendicular gutters which run on the two sides of it, thus:—

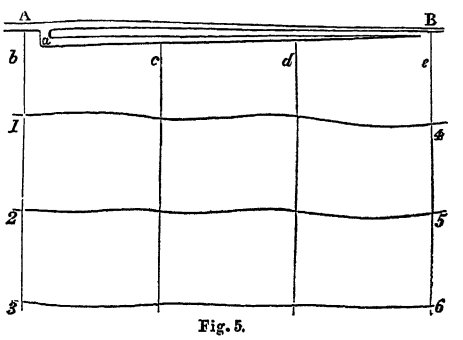


Fig. 5.

Fig. 5 is a section of the net-work of gutters; AB is the carriage-gutter; *a* is a taper watering-gutter, to the extent of which the water is supposed to be determined to be confined; *b*, *c*, *d*, *e*, are the feeding gutters (perpendicular to the levels); the cross-gutters are the "level" ones; *b* and *e* serve as the two side gutters of the proposed section to be watered. The water is confined to the ground between them by stops at the crossings, arranged thus:—*b* is a crossing on the feeder (*b*, fig. 5); and *e* is a crossing on the feeder (*e*, fig. 5); 1, 2, 3, 4 are stops, the purpose of which is obvious enough. The arrows show the direction the water is made to run. The stops are pieces of the turf taken out of the gutters, which, being cut with a "*die*," of course fit the gutters with exactness; by this means *any* stoppings that may be required are done instantly, without any trouble or loss of time.

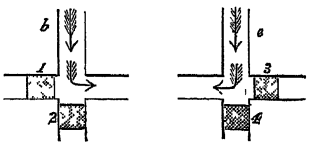


Fig. 6.

The gutters are not to be cut in the same places two years following, but on one side as near as can be conveniently done, say about a foot and a half from the former ones; and the turf of the new gutter used to fill in the old one, taking care *not* to cram the old gutters too full. By this means the gutters are always new and always the proper size. If cut on the *right*-hand side and *above* one year, the next year they should be cut the *left*-hand side and *below*; thus they will always retain their original position, and be as efficient at any future period as they were the first year they were made.

The objection generally raised against this plan is, that the only carriage-gutter being at the head (highest level) of the watered ground, the best of the water is expended on the first part of the meadow (which is generally the best and healthiest land), and the lower part of the meadow (which we have said might want it most), is irrigated with the water after having been deprived of its best material. Such an objection is more plausible than valid; experience constantly denies that such is the result. I have always seen the lower parts of meadows formerly on the old system improve when put under this system, for however gutters on the old system might be *provided* for carrying the water down to a certain place, the machinery is so cumbrous that it is seldom used. I mean, there are so many heavy *stops* and *bays* to be interfered with, to be removed, adjusted, put in and readjusted, and so on, that it is seldom undertaken—seldom or never used. What is wanted is a machinery that can be used readily—with pleasure and not with difficulty. The plan I advocate is just such a thing; it is easy to use, and, therefore, pleasant to do; and, for that reason, sure to be done. And I shall presently show that it is quite effectual for the purpose even of carrying the water fully charged with matter in solution to the extreme distance desired.

Irrigation. In the first place, I must admit that the stones, gravel, grit, and even sticks and leaves with which a stream might be charged in case of flood, would not be carried to the extreme end of a meadow by the means I employ; but then I say they *ought not;* and I may add, in the case of the old plan, they *are not;* for although gutters are cut ostensibly for the purpose, they never answer to the effect of carrying the *heavy* material. This is much better than allowing violent gushes of water to create a number of artificial hills and gullies in the usual way. It is well known (to those who know practically anything about it) that, when water is allowed to descend a gutter in a full violent stream, it frets the earth away from the sides and bottom of the gutter, and the material is washed down to settle when the current ceases to rush, thus causing two unsightly evils—a deep gully in one place, and an inconvenient hillock in another.

It will be proper now to call attention to the manner in which the water is carried, with its suspended matter, to the extreme end of the meadow, by the plan we are pursuing. You will observe that the ground is covered by a sort of net-work of little gutters, from the "leading-in" gutter at the head, to the extreme end of the piece of ground lying *downward* from *that leading-in* gutter; one set of gutters, as we have shown, being, in a sort, parallel to each other, intersected by gutters at right angles to them, and also parallel to each other: this would be strictly true were the surface strictly a plane surface; but this being very rarely the case, both sets deviate from a strictly parallel condition (as we have shown), in order to meet the undulations of the ground; these deviations compensate each other on the aggregate. Now, instead of carrying the water "down to the lower end" by means of one large gutter, and then dispersing it by another large gutter (a level one), we do it by twenty or so little gutters which feed the dispensing gutter about every ten or fifteen paces; being so small they never fret away; being newly cut every year they never increase in size. These advantages are too manifest to require pointing out.

The sections for watering on our plan are perpendicular sections (I call them so for want of a more appropriate term), *i.e.*, from the "leading-in" gutter to the end of the *piece*—the *running* way of the water; and *never lateral* sections. That is, our section will be *a, b, c, d* (fig. 7), for one section, and *b, e, d, f* for another; and never 1, 2, 3, *c, d, f.* The water is not impaired in quality while running down these upright gutters, 4, 5, 6, 7.

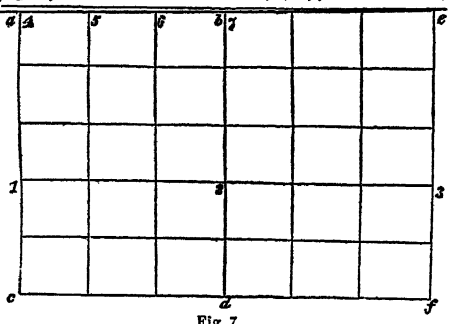


Fig. 7.

We see the reason of this while we keep in memory that water is only good (as water) from two circumstances,—viz., 1*st*, from the purity of its composition (freedom from mineral properties), in which case the water will be as good at last as at first; and, 2*dly*, for what it holds in solution, not for what it carries in an insoluble state, for that should be deposited. Now, as long as this water is kept in motion it carries its solved substances with it, and the plant (grass) that takes up the material solved takes up the water also; so that as the water loses its quality it also loses its volume, partly by evaporation and partly by absorption by the grasses, consequently the water that remains must be just of the same quality as at first.

I have not tried any analytic experiment to prove the truth of what I have here stated, nor do I think it necessary to do so, as it is of no consequence whether it be true or not to a few quarts of diminution more or less; but this we *know*, water does evaporate, and that vegetables do decompose water for their own nutrition; and we know that evaporation carries off little or none of the solved matter. Upon this I found an argument, and take it as proved, that as the water diminishes in volume as well as in quality, and that if those diminutions went on in exact ratio, then the water would remain, under all circumstances, precisely of the same quality; and that for all practical purposes which we have now under consideration, it does so remain. The most satisfactory proof of the truth of this argument is found in the answer given by the meadows themselves, viz., that it is true. Experience has assured that the above reasoning is correct; the water is good to the last.

It is very difficult to prove it by experiments in nature in every case. The water will act best upon the best land; therefore to expect water to exhibit as much good effect on the lower end of a meadow, where the soil is inferior in quality, as it shows on the higher end, where the soil is superior in quality, is to expect what reason ought not to ask, and that to which nature will never respond. Irrigation.

But these small gutters are sufficient when the little stops are taken out of the perpendicular gutters, and the level gutters are stopped so as to confine the water to the perpendiculars, to carry down as much water as ought to be carried down. The level gutter of a lower section (if it is determined that a lateral section shall be watered), instead of being fed by a large stream at the end, is supplied every ten or fifteen paces by one of those little gutters, thus giving an uniform supply throughout the length of the level gutter. A larger supply than this will afford is an evil, not a good; you do not want to *wash* the surface of your land, you want to *irrigate* it. But this fashion of sending down the water is not what I advise; I only say it can be done if required. I advise that the sections begin at the head: a surplus will be found to run into the little gutters sufficient for the land below.

When the water is shut out from the "leading-in" gutter it is not necessary to move any of the little stops; the same perpendicular gutters that are effectual to run the water on, are as effectual to run it off, leaving the surface of the meadow dry and solid—a most manifest advantage.

The water is evenly distributed over the surface of the land by these minute gutters, which are made to follow all the undulations of the land, which can never be done by the large gutters; and also, from the draining effect of the perpendicular gutters, the water is never suffered to accumulate in ponds. The water on the meadow is, therefore, never "over-shoe" anywhere.

These gutters are no way dangerous to sheep or lambs, are never in the way of mowing, have an elegant rather than an unsightly appearance, are not perceived either in raking or carting, and suit the horse-rake or hay-making machine admirably.

I am not aware of any circumstances under which this has not the advantage over the "old plan." For wetting the ground in summer this plan has the decided superiority, as less water will do the work than will be required merely to fill the level gutters under the old system. It will be proper to remark, that grass so raised is scarcely safe for sheep; it certainly rots their livers. I found out this at the expense of many sheep. It is perfectly analogous to a plentiful rain after long drought; grass resulting thus, proves equally as fatal to sheep as that produced by summer watering in a hot dry season, and *vice versâ*.

Where the stream is small, a pond should be made, capable of holding as much water as will run a good stream for four hours or more; such a pond would make such a stream valuable as is really insignificant in itself. A small stream so collected will damp over thirty acres sufficiently well to secure a crop of hay.

I would just advert to the fact that the leading-in gutters can be so arranged as to tend themselves in cases of flood; but the opportunity does not present itself just now for going into that branch of the subject.[1]

This comparatively cheap system is rapidly extending, and is much more worthy of imitation than the ancient and costly bed-work plan. Though it was at first chiefly used on the sloping sides of the Devon and Somersetshire valleys, it has been lately applied to levels as flat as the banks of the Thames. A new meadow of Lord Poltimore's on this system has a fall of not more than 1 in 528. And when it is considered that a catch-work meadow can be formed at a cost of about L.4 an acre, while on the bed-work system it will cost from five to ten times that sum, there cannot be a moment's doubt of the comparative advantage of the two systems for general adoption.

MANAGEMENT OF WATER-MEADOWS.

The formation is not the only difficulty attending water-meadows; their good management is a nice business, and essential to the deriving of benefit from them. It must be confessed that much ignorance and negligence prevail in their management; and when the risk is considered of losing the whole of the fine herbage, and getting coarse in its stead, by bad management, a skilful irrigator is a character who ought to be highly appreciated. The particulars which

[1] *Journal of Royal Agricultural Society of England*, 1852.

Irrigation. require constant attention are,—the state of the water in the river, whether there is sufficient to water the whole, or only a part of the meadow; the regulating of the sluices, so as not to permit more nor less water than the part of the meadow intended to be watered requires; the length of time the water should be allowed to remain on the meadow at different periods of the season; the proper time at which hay harvest and pasturage should commence and terminate; the state and nature of the soil to be irrigated, whether porous or impervious; and the removal of all minute obstructions to the perfect irrigation of the meadow.

Every size of river is not equally suitable for irrigation. A large flowing stream, supplying sufficient water at all times, affords facilities for irrigating a part or the whole of a meadow, much better than a brook which swells and falls with every shower of rain. At the same time, whatever may be the command of water, it is an error to attempt to irrigate too large a surface at one time. The attempt to force a larger quantity of water than the feeders and drains can easily convey, will end in deluging one part, whilst another will be stinted; and where there is inequality of irrigation, there will be inequality in the quantity and quality of the grass. Where there is an ample supply of water, therefore, no more ground should be irrigated at one time than can be covered equally to the requisite depth by the natural force of the water. Where the supply is short of this, which is more frequently the case, the water should only have as much ground allotted to it as it can effectually irrigate. The intervals between the irrigations will be greater when the supply of water is scanty than when plentiful; but notwithstanding this, the effects produced on the meadow in both cases may be nearly equal, according as the weather is favourable or otherwise. The adjustment of the water by the sluices is a delicate operation under every circumstance, but particularly so when there is at times a deficiency of water. The falling or rising of the water in the river requires particular attention, and the changing of the water from one part of the meadow to another, or even from one bed to another, according to its abundance or deficiency, particular dexterity. Attention to the sluices for a short time every day, will obviate many risks of bad management. A great error may be committed by permitting the water to remain too long on the ground at a time. Unless the ground gets the air and becomes dry at stated periods, the finer grasses will be destroyed, and those of coarse quality will spring up. The watering may be continued for as long as fifteen days in the beginning of the irrigating season in November, but the time should be gradually lessened till March or April, when it should cease altogether. Between the intervals of watering, the land should be laid completely dry. Precautions are particularly necessary in letting the water off and on in frosty weather, frost taking quick hold of wet grass land, and throwing the plants out by the roots. The water should be let off on the morning of a dry day, and the land thus becoming dry in the course of the day, the frost will not injure the grass at night. Or, what is a still safer method, the water should be taken off in the morning and put on again at night, but few persons will take the trouble of attending so minutely to irrigation. In spring the new grown tender grass will be easily destroyed by frost, if the utmost attention be not paid to the state of the ground, either by protecting it with water, which is the surest protection it can receive, or making the ground thoroughly dry in dry weather. There is another error which should be guarded against: when water remains too long on the ground in the spring, it generates a white scum, of the consistence of melted glue, which, when left on the grass, inevitably destroys it. Instances may be observed of water being permitted to remain on meadows from the autumn till eight or ten days before the cutting of hay. The consequences are, that the hay is of the coarsest quality, and the early bite for sheep entirely lost. It seems to be a judicious recommendation to depasture the early grass on water-meadows with ewes and lambs in March and April, and to eat it barely down before May with a heavy stock. On good land, and in good seasons, a second and even third crop of feed may be got before the 1st of May, the water being let on after each feed. After that the grass is allowed to stand for hay; but it should be irrigated for a few days to clean the pasture. There is some doubt that grass, after being irrigated in summer, will affect sheep with rot; but whether that which has been irrigated in May, before the hay has been cut down, will so affect them on the aftermath, is not so decidedly known. Irrigation.

When it is determined to irrigate, the drains and feeders should be previously inspected, all obstructions removed, and dilapidations amended. Whatever difference of opinion may exist on irrigating at this particular period of the season, all irrigators are agreed that early irrigation in autumn produces greater effects than late, and that water should be used largely during the winter, and scantily during the spring. It is possible that the benefits derived from early irrigation, especially after rains, may arise from the good effects of manure of various kinds, accumulated on the land during summer, being washed down by the rains, and mixed with the irrigating water; and it is certain that abundant irrigation in winter protects the grass from cold, as the temperature of grass under water in winter is seldom under 40° Fahr. The signs of early and luxuriant vegetation observable on water-meadows in spring, when the rest of the ground may be covered with snow, evince the warmth communicated by the water. After the hay is carried off, the water is sometimes let on, to promote the growth of the aftermath, which it will no doubt do; but the rank grass encouraged by this summer irrigation will undoubtedly rot sheep. Where sheep are kept, and intended to depasture meadows, there should be no irrigation in summer. "Damping" the land only is allowable. Cattle are not affected as sheep.

Should the irrigation be postponed till the autumn, in the beginning of October the first duty of the irrigator is to see that all the feeders and drains are cleared of every obstruction, occasioned by the treading of sheep or cattle. The sluice is then drawn up, and if the water be abundant, the conductor and feeders will be filled with water in about half-an-hour. The motion of the water should first be adjusted in all the conductors; then in the feeders nearest the upper part of the meadow, and then in the lower ones in succession. The sluices regulate the water in the conductors, and the position of the stops regulates the water in the feeders. The stops should be so placed as to cause the water to overflow the sides of the feeders, by making the openings at the sides of the stops wider or narrower. This first general inundation will show any irregularities on the surface of the meadow; and that some irregularities will exist in the best-constructed water-meadows, it is not in the power of art to prevent. The earth in the filled-up hollows will subside, whilst the hard portions of ground which have been reduced will maintain their new shape. The irregularities should now be marked and rectified in the ensuing summer. At least three such adjustments of the water are necessary before an irrigator should be satisfied that the meadow is properly irrigated with the requisite depth of one inch of water. This quantity of water should be continued over the meadow during October, November, December, and January, from fifteen to twenty days in succession, according as the weather is fresh or frosty, wet or dry. Between every such interval, the meadow should be laid thoroughly dry for five or six days to give the grass air; and should the weather threaten a lengthened period of hard frost, the watering should be entirely discontinued for the time: for in thawing, the sheet of ice which covers the sur-

Irrigation. face of the meadow will draw every plant of grass out by the roots, and make the soil like a mass of fermented dough. In Devonshire, however, the rule is neither to *lay on* or *take off* the water in frost. During the period of irrigation, the meadows should be regularly visited and inspected once in every three or four days, to correct any deviation from regular watering, such as may arise from collections of weeds, petty depredations of men and beasts, sticks, stones, or leaves, that may have fallen in and been detained in the conductors and feeders.

In February, great attention is required from the irrigator, as the grass will now begin to vegetate. The periods of watering must be shortened, and those of drying must be proportionally lengthened. White scum, frost, and such like evils, should be carefully avoided, as the tender grass will sensibly feel their injurious effects.

In March, the same precautions are requisite; but in the south of England, where grass is sufficiently abundant for stock in this month, the irrigation should be dispensed with. In Scotland, irrigation may be continued all April, but with such caution, that the water should be allowed to run only five or six days at a time, and gradually lessened towards the end of the month; and in the beginning of May dispensed with altogether, and the meadow laid thoroughly dry for the summer. It should be borne in mind, that this is the most trying season for young grasses in Scotland; and also, that if watering is continued after this month, the blades of grass will be covered with a gritty sediment, which not only injures the quality of the hay, but renders the mowing of it a difficult process.

The annual expense of keeping a water-meadow in repair may be about five or six shillings an acre. The greatest expence in keeping a meadow will be incurred in the second year, on account of the sinkings of those places which had been made up with loose earth having to be brought up to the common inclination.

III. SUBTERRANEOUS IRRIGATION.

This species of irrigation is so named because the supply of water is derived from under the surface of the ground to the upper soil. It is only applicable to perfectly level ground, so raised above the supplying river as to admit of a complete drainage of the field to be irrigated. This system of irrigation consists, in the first place, of ditches being formed around all the sides of the field. These act the part of conductors when the field is to be flooded, and of main drains when it is to be laid dry. The water flows from the ditches as conductors into built drains or conduits, formed at right angles to them, in parallel lines through the fields, and it rises upwards in them as high as the surface of the ground, and again subsides through the soil and the conduits into the ditches as main drains, and thence into the river. Sluices are requisite to convey the water from the river into the ditches. This submersion, as it may be called, rather than overflow, of the ground in water, must be conducted with great care, and the water let on very calmly; for were the water let on or taken off with a forcible current, the finer particles of the soil would be detached, and carried off into the river. Indeed, however carefully the operation may be conducted, the only advantage derived from this species of irrigation is the moistening of dry ground in dry weather, which would otherwise be parched up; and in this respect the operation is best conducted in summer, and is as applicable to arable as to pasture land. It can therefore be of no importance to subterraneous irrigation, whether the water be clear or turbid, since all the sediment must be seethed through the soil, before it can possibly reach the surface of the ground. In the Fen counties both arable and pasture land are benefited by the system, the depth of water in the ditches which bound all the fields being regulated with a view to this. Irrigation.

IV. WARPING.

Warping is the overflowing of level ground with muddy water within tide mark. Of course, it can only be practised near the sea, and most frequently it is attempted within the estuaries of large rivers, which have flowed through alluvial cultivated countries. A good idea of the process of warping may be got by sailing up the Trent from the Humber to Gainsborough. The banks of the river were constructed centuries ago to protect the land within them from the encroachments of the tide. A great tract of country was thus laid comparatively dry. But while the wisdom of one age thus succeeded in restricting within bounds the tidal water of the river, it was left to the greater wisdom of a succeeding age to improve upon this arrangement, by admitting these muddy waters to lay a fresh coat of rich silt on the exhausted soils. The process began nearly a century ago, but has become more of a system in recent times. Large sluices of stone, with strong doors, to be shut when it is wished to exclude the tide, may be seen on both banks of the river, and from these great drains are carried miles inward through the flat country, to the point previously prepared by embankment, over which the muddy waters are allowed to spread. These main drains being very costly, are constructed for the warping of large adjoining districts, and openings are made at such points as are then undergoing the operation. The mud is deposited, and the waters return with the falling tide to the bed of the river. Spring-tides are preferred, and so great is the quantity of mud in these rivers that from 10 to 15 acres have been known to be covered with silt from 1 to 3 feet in thickness during one spring of 10 or 12 tides. Peat-moss of the most sterile character has been by this process covered with soil of the greatest fertility, and swamps which used to be resorted to for leeches are now, by the effects of warping, converted into firm and fertile fields. The art is now so well understood, that by careful attention to the currents, the expert warp farmer can temper his soil as he pleases. When the tide is first admitted, the heavier particles, which are pure sand, are first deposited; the second deposit is a mixture of sand and fine mud, which, from its friable texture, forms the most valuable soil; while lastly the pure mud subsides, containing the finest particles of all, and forms a rich but very tenacious soil. The great effort, therefore, of the warp farmer is to get the second or mixed deposit as equally over the whole surface as he can, and to prevent the deposit of the last. This he does by keeping the water in constant motion, as the last deposit can only take place when the water is suffered to be still. Three years may be said to be spent in the process, one year warping, one year drying and consolidating, and one year growing the first crop, which is generally seed hoed in by hand, as the mud at this time is too soft to admit of horse labour.

Its immediate effect, which is highly beneficial, is the deposition of silt from the tide. To insure this deposition it is necessary to surround the field to be warped with a strong embankment, in order to retain the water as the tide recedes. The water is admitted by valved sluices, which open as the tide flows into the field, and shut by the pressure of the confined water when the tide recedes. These sluices are placed on as low a level as possible, to permit the most turbid water at the bottom of the tide to pass through a channel in the base of the embankment. The silt deposited after warping is exceedingly rich, and capable of carrying any species of crop. It may be admitted in so small a quantity as only to act as a manure to arable soil,

Irrigation.

or in such a large quantity as to form a new soil. This latter acquisition is the principal object of warping, and it excites astonishment to witness how soon a new soil may be formed. From June to September, a soil of three feet in depth may be formed under favourable circumstances. These circumstances are summer, and the very driest season and longest drought. In winter, and in floods, warping ceases to be beneficial. In ordinary circumstances, on the Trent and Humber, a soil from 6 to 16 inches in depth may be obtained, and inequalities of 3 feet filled up. But every tide generally leaves only one-eighth of an inch of silt, and the field which has only one sluice can only be warped every other tide. The silt, as deposited in each tide, does not mix into a uniform mass, but remains in distinct layers. The water should be made to run completely off, and the ditches should become dry, before the influx of the next tide, otherwise the silt will not incrust, and the tide not have the same effect. Warp soil is of surpassing fertility. The expense of forming canals, embankments, and sluices for warping land is from L.10 to L.20 an acre. A sluice of 6 feet in height and 8 feet wide, will warp from sixty to eighty acres, according to the distance of the field from the river. The embankments may be from 3 to 7 feet in height, as the field may stand in regard to the level of the highest tides. After the new land has been left for a year or two in seeds and clover, it produces great crops of wheat and potatoes.

In Great Britain, irrigation is practised to the greatest extent in Devon and Somerset, Gloucestershire, Wiltshire, and Dumfriesshire, and partially in some other counties. In England it has long been successfully practised. Into Scotland it is comparatively of recent introduction.

Warping is only practised in Lincolnshire and Yorkshire, in the estuary of the Humber, in the Rivers Trent, Ouse, and Dun, which flow into it. The silt, which is in great abundance in these rivers, is doubtless worn off the diluvial soils and chalk strata by the action of the tide. Floods invariably injure its quality, which is in the highest perfection in the driest summers. Apparently it is a mixture of sand, chalk, and clay, for it cakes on drying, and will cleanse cloth of grease like fuller's earth. By analysis the principal ingredients were found to be a fine sand, a considerable portion of lime, some mica, and a minute portion of saline matter.

Subterraneous irrigation is chiefly practised in drained morasses, which are apt to become too dry in summer, by closing up the mouths of the main drains, and causing the water in them to stand back in all the drains till it rises up to the soil. It was recommended by the late celebrated engineer Mr Rennie, to be practised on some extensive fens which he had drained in Lincolnshire, near Boston. To irrigate effectually in this manner, it is necessary to build the mouths of the main drains with strong masonry, and erect sluices for the retention of the water in the drains. This species of irrigation may also be attempted on any flat piece of ground resting on a gravelly bottom, by means of ditches which surround it, and which can command water from a lake or river. Turnips or potatoes, or any kind of crop, whether drilled or not, might be beneficially watered in this manner in a dry summer.

ADVANTAGES OF WATER-MEADOWS AND WARPING.

The advantages derived from water-meadows and warping, as stated by authors who have written on those subjects, almost exceed credibility.

In 1802 Mr Smith laid out a water-meadow on the Paisley farm, near Woburn, Bedfordshire, for the Duke of Bedford, and in 1808 its produce was as follows:—

In March, 240 sheep for three weeks, at 6d. each per week	L.18	0	0
In June, mowed 18 tons hay, at L.4 per ton	72	0	0
In August, mowed 13½ do. do.	54	0	0
In September, 80 fat sheep for three weeks, at 4d. each per week	4	0	0
It then fed lean bullocks, the feeding not valued, equal to L.16, 13s. 8d. per acre,[1]	L.148	0	0

Irrigation.

Mr Pusey gives an instance of a field of two acres on his home farm in Berkshire, good land naturally, but so much out of condition, that latterly the hay crop had been hardly worth cutting, the produce of which, after irrigation, he estimates as follows:—

	Days' keep of a sheep.
First penning, sheep put on, but grass too strong to feed, and made into hay, say only	3,000
Second feeding, 400 lambs for eight days, say 240 sheep	1,920
Third penning, 250 sheep for ten days	2,500
Fourth do., 250 sheep for fourteen days	3,500
	10,920

The total amounts to 5 months' keep for 73 sheep on two acres, thirty-six sheep to an acre. Mr Pusey compares the result with the feed afforded in Lincolnshire by a thoroughly good crop of turnips, which are said to keep ten sheep an acre for five months,—and with grass land of good quality, which fattened seven sheep to an acre in the five summer months. Admitting the seven fattened sheep to be equal to fourteen of his kept merely in store order, the account would stand thus, comparatively: *ten* sheep on an acre of turnips, *fourteen* on an acre of superior grazing land unwatered, and *thirty-six* on an acre of moderate land watered. Mr Pusey's investment in irrigation, in one of the dry inland counties, has paid him a return of 30 per cent. on the capital expended.

These two cases may suffice as examples of successful irrigation in England. The following cases occur in Scotland, a country, from its irregularity of surface, not naturally suited to that species of improvement. Nevertheless, in all the pastoral districts, both in the north and south, an abundance of early food in spring for ewes and lambs might be obtained, by judicious irrigation, in every valley which contains a river. In mountainous districts the rivers may not supply the richest quality of water for irrigation, but there the soil on the margins of rivers being generally of friable loam, would be peculiarly benefited by irrigation. Such land is invariably sound for sheep when drained; and if made dry, and then irrigated, it would, early in spring, and indeed throughout the summer, afford the finest quality of the richest herbage. Water-meadows in such situations could be inclosed by themselves, and they could supply hay, if required, for the sheep-stock in winter, or be pastured at pleasure by any kind of stock during the summer.

To begin with an instance of simple irrigation in a pastoral district. "Fallaw Meadow, on a large sheep-farm belonging to Sir George Montgomery, Bart. of Macbiehill, in Peeblesshire, containing fifteen acres, was inclosed from moorland in 1816; and by collecting the water from the surrounding sheep-drains, five acres are partially irrigated, and the remaining ten are top-dressed with the manure made from part of the produce which is consumed in winter by the sheep of the farm, in a wooden shed near the meadow. By this simple method of improvement, fifteen acres of common sheep-pasture land give the proprietor from three thousand five hundred to four thousand stones of hay per annum, averaging sixpence per stone. What an immense advantage to a sheep-farm! By this simple process of inclosing, and cutting a few small feeders and drains, the owner is enabled to provide food for his flock, when his less fortunate neighbours' sheep must either starve or be supplied from the farm-yard; but I am afraid there are very

[1] Smith's *Essay on Irrigation.*

Irrigation. few sheep-farmers who are so fortunate as to have any hay beyond what is requisite for stock at home. Sir George fed the same number of sheep on the farm as he did before the meadow was taken off and inclosed; and I am fully persuaded that the same improvement might be made on almost every sheep-farm in Tweeddale, for in almost all of them, there are situations where fourteen or fifteen acres might be inclosed and partially irrigated, as in every pastoral district there are numerous rills which might be easily collected and used to the greatest advantage, at a very trifling expense; so that, instead of being obliged, in snow-storms, to send fifty thousand sheep to a milder climate in the southern parts of Dumfriesshire (where owners are obliged to be at the mercy of their southern neighbours, not to mention the very serious injury the flocks receive by long and fatiguing journeys), by adopting the above system of improvement a considerable part of the losses generally sustained every year would be prevented."[1]

Here is an instance of the conversion of peat-bog of little value into a water-meadow of great value. "Sir Thomas Gibson Carmichael, Bart. of Castle Craig, commenced, in the year 1817, by forming five acres with the plough and spade into regular bed-work. The land, in its natural state, was a complete bog, valued at eight shillings of yearly rent per acre. The formation was difficult, on account of the great number of deep peat-holes which were obliged to be filled up, to bring the surface to a proper level. The expense of levelling and forming the beds was L.6 per acre, the crop of hay was 466 stones, of 22lb. per stone, per acre, valued at fivepence per stone, and the after-grass at 18s. per acre, making L.10, 12s. 2d. per acre of gross produce."[2]

But this enumeration of the several cases of successful irrigation would be incomplete, were the water-meadows in the neighbourhood of Edinburgh omitted to be particularized. The city of Edinburgh stands on an eminence, which commands the cultivated country around it. Commanding as the situation is, water from the Crawley Spring, in the Pentland Hills, situate at seven miles' distance, flows to the top of every house in the city. A ready means is thus provided of washing away all the filth of the houses and streets, which is conveyed in large sewers to the lower end of the town, where their contents are made to irrigate many acres of naturally rich and also of poor soil. Probably upwards of 200 acres are thus irrigated for the production of grass for the cowfeeders who supply milk to the inhabitants. The rent for which these meadows are let in small portions to cowfeeders varies on an average from L.20 to L.30 per acre. Some of the richest meadows were let in 1835 at L.38 per acre; and in that season of scarce forage, 1826, L.57 an acre were obtained for the same meadows. The largest portion of these meadows, about one hundred and thirty acres, belongs to the estate of Craigintinny; part of them, comprising land now of the richest quality, having been thus watered for nearly a century, and part of them of the poorest sandy soil. The waste land called the Figget Whins, containing thirty acres, and ten acres of poor sandy soil adjoining them, were formed into water-meadows in 1821, at an expense of L.1000. The pasture of the Figget Whins used to be let for L.40 a-year, and that of the ten acres at L.60. Now the same ground, as meadows, lets for L.15 or L.20 an acre a-year, and will probably let for more as the land becomes more and more enriched. It is stated by Mr Stephens,[3] that one hundred and ten acres of Craigintinny meadows, in 1827, yielded a profit of L.2300. The repair of these meadows costs from ten to fifteen shillings per acre, which is comparatively a large sum for repairs, but then they are not only watered during the winter, but for two or three days between the intervals of cutting the grass during the summer. The grass is cut from April to November, every three, four, or five weeks, according to the richness of the vegetation. It is exceedingly tender and succulent, and suitable to the production of a large quantity of milk; and were it not frequently cut, it would fall down, and soon rot at the roots. Irrigation.

After these striking instances of the advantages which are derivable from irrigation in a pecuniary point of view, by largely increasing the rent of land, must be mentioned the advantages which are derived from a large increase in the produce of the soil. The early grass in March, which could only be fostered by irrigation, is of the most essential use to ewes and lambs, and it offers an excellent substitute for the artificial grasses, which are usually obliged to be heavily stocked in early spring, when they are unable to bear it; and in truly pastoral districts, where artificial grasses are cultivated to a limited extent, and where old grass is generally long in springing, the breeding stock of sheep is apt to suffer in spring; but an irrigated meadow would not only supply early and abundant food, but it would enable the store-masters to raise an early crop of lambs. The large crop of fine hay which is subsequently cut from water-meadows after the pasturage of the early grass, also insures the safety of the flock, and the growing condition of the herd, in the severest winter; whilst it, at the same time, supplies the manure which fertilizes, to an increasing extent, the land kept under arable culture. Whether, therefore, in pastoral districts, or in the neighbourhood of large towns, or wherever an abundant supply of river water through an alluvial cultivated country can be obtained, irrigation will certainly repay, in a short time, all the expense and trouble which are necessary for its preparation.

The quality of the water is an important element in the process of irrigation. It has been alleged that whether water is clear or turbid, irrigation is of service to grass land. There is much truth in this allegation; but it does not declare the whole truth. No doubt moisture alone is of great service to the vegetation of grass on sandy soils in a dry season; but a deposit of mud along with the moisture would surely not benefit the grass the less, nor would it injure the bare soil.

The waters of the Nile and Ganges would alone promote vegetation on their banks, the soils of which seldom experience the refreshing sustenance of rain; but the inundations of those mighty rivers would not be hailed with ecstasy and gratitude on the return of every season, were their waters devoid of the fertilizing mud with which they are largely impregnated. Major Rennell states that the Ganges contains a two-hundredth part of its volume of mud, and that it thus carries 2,509,056,000 cubic feet of it per hour. In like manner, the Nile contains a hundred and twentieth part of its bulk in mud, or 14,784,000 cubic feet of it per hour. It is impossible but that the water of all rivers contains at all times, even when purest, some sediment; but it is obvious that those rivers which flow through cultivated countries must contain at all times the greatest quantity of sediment. In this way the rivers of plains must contain more mud than the rivers of mountains; and hence irrigation exhibits the most favourable results in the plains. But were no other proof of the superiority of turbid over clear water for irrigation to be found, the luxuriant produce of the water-meadows in the neighbourhood of Edinburgh, which are watered from the common sewers of that city, would of itself supply a convincing illustration.

Similar results could *never* be derived from clear water; nor is *it ever* found so superabundantly rich as to be necessary to be treated like the water of those meadows next the town, where holes are dug in the ground, for the purpose of catching the grosser materials with which it is charged, before it is used for irrigation.

[1] Stephens' *Practical Irrigator*. [2] Ibid. [3] Ibid., p. 77.

V. HISTORY OF IRRIGATION.

Irrigation is at least coeval in antiquity with embanking and draining. It is probably of greater antiquity. Nature had, no doubt, first taught man the art of irrigation by the inundations of rivers; but nature could teach neither embanking nor draining. Egypt was the field which was first artificially irrigated. There the fertilizing effects of the water of the Nile, after its overflow, could not fail to attract the attention of its inhabitants, and teach a simple lesson to the Egyptians, who had only to imitate nature to secure the fertility of the soil lying beyond the reach of the inundations of the Nile. The remains of canals as capacious as the beds of rivers, which are still to be seen in that sand-desolated country, evince the gigantic efforts which had at one time been made by its inhabitants to irrigate that portion of their country upon which a drop of rain never falls to refresh its languishing vegetation. These canals traverse the whole country, and are so directed as probably to have been made to receive the water of the Nile, and conduct it to every part, the inequalities of the surface not being great in Egypt. The large lakes of Mœris, Behire, and Mareotis, all probably artificial excavations, had perhaps once formed extensive reservoirs to supply the canals after the Nile had retired within its own banks. At what time all these mighty contrivances were begun, history is as silent as on the origin of the pyramids. It is, however, related that Sesostris greatly increased the number of the canals, which must have been at a period of great antiquity, for he reigned about the sixteenth century before the Christian era. Greater efforts to promote irrigation were more urgent in Egypt than in most other countries; for no rain fell in that country to cherish vegetation; and rice, which forms the chief food of its inhabitants, could not be raised without a great supply of water.

It is therefore highly probable that the remains of great canals and lakes are indicative of the majestic scale with which the Egyptians had prosecuted the art of irrigation. It is, however, prudent to speak with caution on matters connected with the agriculture of ancient Egypt; for our knowledge of its husbandry is chiefly derived from hints contained in Scripture history, and not from its own historical records. The historian of Egypt, Herodotus, was a Greek, and lived at so late a period as the fifth century before the Christian era, long after the glory of Egypt had departed; whereas the Scriptures supply us with facts of Egyptian agriculture of much greater antiquity, isolated though they certainly are. Such circumstances as the following indicate the existence of irrigation in Egypt at a very remote period of the world. When Abraham and Lot journeyed together in search of a country to abide in after they had left Egypt, they agreed to separate, when they found that the land they were then in could not supply sufficient food for their united flocks and herds; and we are told that Lot chose the plain of Jordan, because it was watered as well as the land of Egypt. "And Lot lifted up his eyes and beheld all the plain of Jordan as thou comest into Zoar, that it was well watered everywhere, before the Lord destroyed Sodom and Gomorrah, even as the garden of the Lord, like the land of Egypt."[1] Egypt never contained rivers to water it, there being only the Nile; so that the similitude between "the plain of Jordan" and "the land of Egypt," to the mind of Lot, must have arisen from the rivers in Jordan being as numerous as the canals in Egypt: and Lot having witnessed the fertilizing powers of the water of these canals in Egypt, naturally supposed that the rivers would produce a similar effect on the plain of Jordan. The Egyptians had been in the habit of watering their gardens as well as their fields, and this they accomplished at pleasure, by raising water with a machine which they worked with the foot. Simply as such contrivances were, and they are to be seen in Egypt at this day, they could not fail to be troublesome. Dr Clark describes the Egyptians, when raising water for their gardens, as requiring to work stark naked, or only partially covered with a blue striped shirt. When Moses, therefore, described the promised land to the Israelites, he represented it as a land which was supplied with water in a natural manner, in contradistinction to the more difficult and artificial way by the foot in Egypt: "For the land whither thou goest to possess it, is not as the land of Egypt from whence thou camest out, where thou sowedst thy seed and wateredst it with thy foot, as a garden of herbs: But the land whither ye go to possess it, is a land of hills and valleys, and drinketh water of the rain of Heaven: And it shall come to pass, if ye shall hearken diligently unto my commandment which I command you this day, that I will give you the rain of your land in due season, the first rain and the latter rain, that thou mayest gather in thy corn, and thy wine, and thine oil."[2]

By irrigation, the soil of Egypt had been rendered so fertile that Pliny compares it to that of the Leontines, formerly the most fertile part of Sicily. Certain it is that Egypt was very prolific in corn even in the days of Abraham, who had recourse to it in years of famine, and that was at least eighteen centuries before the Christian era.

Too little is known of the agriculture of the ancient kingdoms of Assyria, Babylon, Carthage, Phœnicia, and Greece, to enable any one to ascertain how they practised irrigation; but as they all had Egypt as an example in agriculture and the arts, it is probable that they had followed those practices in husbandry which were most suitable to their respective countries. The little that Xenophon says in his *Anabasis* of the husbandry of Persia, would lead to the belief that canals had been cut from rivers to irrigate the country after the manner of Egypt, and to this day the utmost labour and ingenuity are employed by the Persian agriculturists in the irrigation of their parched country.

The sagacious Romans, it is well known from the writings of their rustic countrymen, adopted irrigation on an extensive scale, as one of the best means of improving land. The oldest Roman rustic writer, Cato, expressed his opinion that the way to become rich quickly was "by grazing cattle well," and hence he gives the preference to meadows. He does not maintain that grass is the most valuable crop which the land can produce, for he only places meadows in the fifth degree of value, giving preference in this respect to vineyards, watered gardens, willow fields, and olive gardens, but that they yielded most profit in proportion to the expense attending them, and they were always ready; hence their ancient name, *parata*. Agreeably to this opinion, Cato recommends the formation of meadows, and particularly of water-meadows, whenever there is a command of water: *Prata irrigua, si aquam habebis, potissimum facito.*[3] Columella recommends the same precept, and enters more minutely into the kinds of soils which should be converted into water-meadows, and of the nature of the surface best adapted to them, as well as the management of the water in the time of irrigation. "Land that is naturally rich," says he, "and that is in good heart, does not need to have water set over it; and it is better hay which nature of its own accord produces in a juicy soil, than what water draws from a soil that is overflowed. This, however, is a necessary practice when the poverty of the soil requires it; and a meadow may be formed either upon stiff or free soil, though poor, when water may be set over it. Neither a low field with hollows, nor a field broken with steep rising ground, are proper; the first, because it contains too long the water collected in the hollows; the last, because it

[1] Gen. xiii. 10. [2] Deut. xi. 10, 11, 13, 14. [3] Cat. cap. ix.

Irrigation. makes the water run too quickly over it. A field, however, that has a moderate descent may be made a meadow, whether it is rich or so situated as to be watered; but the best situation is where the surface is smooth, and the descent so gentle as to prevent either showers or the rivers that overflow it from remaining long; and, on the other hand, to allow the water that comes over it quietly to glide off. Therefore, if in any part of a field intended for a meadow, a pool of water should stand, it must be let off by drains, for the loss is equal, either from too much water or too little grass."[1] But none of the Roman rustic writers give directions *how* a *water*-meadow should be made, nor say anything about the utility of sluices, although Columella gives minute directions about the formation of *dry* meadows. It does not appear, moreover, that they were acquainted with the raising of turf and laying it down again for meadows, because they only recommend hay-seeds from the hay-lofts and cribs to be sown, and deprecate the watering and pasturing of cattle on the new meadows till the surface becomes hard. There is no specific notice taken by any of them of how long a period meadows should be watered, if one sentence of Pliny be excepted, wherein he directs that "meadows ought to be watered immediately after the equinox, and the waters restrained whenever the grass shoots up into the stalk;"[2] but there is no hint whether they should be laid dry at intervals.

Pliny alone mentions watering before the first crop of hay is cut, on the principle that wet grass, whether wetted by water or dew, is cut more easily than dry: *Noctibus roscidis secari melius.*[3] The Romans were in the custom of cutting their meadows at least twice a-year, in May and August or September, and making hay of both these cuttings; but meadows for forage were cut sometimes four times. The autumnal hay was emphatically called *cordum*, and being soft, and sweeter than hay come to its full growth, it was the kind most proper to be given to sheep in winter. The produce of the Roman meadows appears to have been very considerable, and it is therefore no wonder that they put such a high value on grass-land. Both Columella and Pliny estimate it a day's work for a man to mow a *jugerum* and bind 1200 bundles of hay, of four pounds each. According to a calculation made by Dr Dickson, these quantities would give a produce of 265 hay stones, of 22 lb. to the stone, per acre (416 imperial stones per imperial acre), of prepared hay, besides the autumnal crop and the rakings taken up afterwards, and which may be estimated at one-half more.[4] This is not the proper place to describe the Roman method of making hay, which differed from the method of this country, but having alluded to hay having been bound in bundles, it may not be irrelevant to state that the Romans made up their hay into bundles of 4 lb. each before they carried it into the barns or hay-lofts, and that they never ricked it but in rainy weather.

Immediately after the fall of the Roman empire, agriculture declined, and was kept in a very depressed state during the middle ages, which depression, with respect to agriculture, lasted about ten centuries. It need therefore excite no surprise that the general agriculture of Italy was not much improved, from what it had been amongst the Romans, till after the revival of letters. Irrigation was perhaps the only branch of agriculture which received improvement or extension before the expiration of the dark ages; and its improvement at that time was even confined to the north of Italy.

The irrigation of Lombardy to this day forms the principal feature of its agriculture. The Lombard kings, following the example of the Romans, encouraged and extended irrigation, and they were ably assisted by the inmates of their numerous and wealthy religious establishments. Under these favourable auspices, irrigation had been extended on a great scale in Lombardy as early as 1037; and such expert hydraulic engineers had the monks of Chiarevalle become, that they were consulted and employed as such by the Emperor Frederick I. in the thirteenth century; and, ever since, so assiduous has been the care with which the agriculturists in Lombardy have preserved entire, and in good working order, their water-meadows, that at the present day no other part of the globe can exhibit that operation on so grand a scale and in such excellent order, and producing so rich a pasturage, verdant throughout the year. The largest rivers in the north of Italy, the Po, the Adige, the Tagliamento, and others, are put under requisition for a supply of water in summer and winter, for the purposes of irrigation; the whole country from Venice to Turin being almost one continued water-meadow. But there irrigation is not confined to grass-land; water being also conducted between the ridges of corn-land, in the hollows between drilled crops, among vines, and over the flats appropriated to the production of rice; and it is also used to deposit mud, in the manner of warping, where it contains sediment. Irrigation naturally passed from Lombardy into the south of France, where it is used to raise many of the more valuable productions of the soil. Spain to this day employs irrigation to so considerable an extent, that few crops are there raised without it. Some water-meadows in the neighbourhood of Salisbury, in Wiltshire, which are said to have existed from time immemorial, have led to the belief that irrigation has been practised in Britain from the time of the Romans. It is, indeed, extremely probable, that had the Romans constructed such works during their sojourn in Britain, the pastoral habits of their Saxon successors would have preserved them from destruction. But be this as it may, it is certain that irrigation after the method of Italy was not extensively introduced into Britain till the sixteenth century, when it was attempted on a large scale in Cambridgeshire, on the estate of Babraham, by one Pallavicino, the collector of Peter's pence in the reign of Queen Mary, but who, on the accession of Elizabeth, had the art to turn Protestant, and purchase that estate with the balance of money which he had in his possession, amounting it is said to L.30,000 or L.40,000, and appropriate it to his own use. This dishonest experiment of Pallavicino was so gross, that his example as an irrigator was not followed at the time, nor indeed were many water-meadows formed in England till the end of the last or beginning of the present century. Since that time, many of them have been scientifically made both in England and in Scotland, which all have proved how profitably irrigation might be extended, and of which a few successful examples have been enumerated. As might be expected from the nature of the climates, irrigation is extensively practised in India, China, and parts of America, particularly Mexico and Peru; but as the irrigation of those countries presents no features peculiarly different from that related of Egypt and Italy, it is unnecessary to enlarge upon it.

Irrigation.

VI. THEORY OF IRRIGATION.

The theory of irrigation, as propounded by the late Sir Humphrey Davy, is given by him in these words:—"Water is absolutely essential to vegetation; and when land has been covered with water in the winter or in the beginning of spring, the moisture which has penetrated deep into the soil, and even the subsoil, becomes a sort of nourishment to the roots of the plants in the summer, and prevents those bad effects which often happen in lands in their natural state from a long continuance of dry weather. When the water

[1] *Col.*, lib. 2, cap. xvii. [2] *Nat. Hist.*, lib. 18, cap. xxvii. [3] Ib. lib. 18, cap. xxviii.
[4] *Husbandry of the Ancients*, vol. ii., p. 321.

Irtish ‖ Irving.

used in irrigation has flowed over a calcareous country, it is generally found impregnated with carbonate of lime, and in this state it tends, in many instances, to ameliorate the soil. Common river water also generally contains a certain portion of organizable matter, which is much greater after rains than at other times, and which exists in the largest quantity when the stream rises in a cultivated country. Even in cases where the water used for flooding is pure, and free from animal and vegetable substances, it acts by causing the more equable diffusion of nutritive matter existing in the land; and in very cold seasons it preserves the tender roots and leaves of the grass from being affected by frost. . . . In general, those waters which breed the best fish are the best fitted for watering meadows; but most of the benefits of irrigation may be derived from any kind of water. It is, however, a general principle, that waters containing ferruginous impregnations, though possessed of fertilizing effects, when applied to a calcareous soil, are injurious on soils that do not effervesce with acids; and that calcareous waters, which are known by the earthy deposite they afford when boiled, are of most use on siliceous soils, or other soils containing no remarkable quantity of carbonate of lime." To show the protective power of water against cold, it is only necessary to state the well-known physical fact, that water is of greater specific gravity at 42° Fahrenheit than at the freezing point of 32°; and hence water in contact with the roots of grass is rarely below 42°, a degree of temperature not at all prejudicial to the living organs of plants. These theories establish and indicate several advantages which are derivable from irrigation. It supplies moisture to the soil, necessary in dry seasons and in tropical countries; it affords protection to plants against the extremes of heat and cold; it disseminates manure most minutely to plants; and it washes away injurious matter from the roots of plants. The benefits derivable from irrigation are chiefly mechanical. The operation of water bringing matter into minute subdivision; the sediment which it contains when used in irrigation being minutely distributed around the stems of the plants; water protecting plants in irrigation against the extremes of heat and cold, by completely covering and embracing every stem and leaf; and the supplying of moisture to the soil, and washing poisonous matter out of it, are all purely mechanical operations. Warping is obviously a mechanical operation. Could the hand of man distribute manure around the roots and stems of grass as minutely and incessantly as turbid water; could it place a covering upon each blade and around each stem of grass, as completely as water can embrace each plant and keep it warm; could it water the grass as quietly and constantly as the slow current of irrigation; and could it wash away injurious matter from the soil as delicately around the fibres of the roots of grass as irrigating water, there would be no need of irrigation; the husbandman could then command at will verdant pasturage for his flocks and herds throughout the year, and in the driest season. His mechanical agency would be as effective as that of irrigation. But the relative powers of things being as at present constituted, man employs irrigation as the instrument of his will, and attains the maintenance of his live-stock by inducing Nature to assist him in a work in which she undoubtedly displays her superiority over him both in industry and dexterity (H. S., J. C—RD.)

Irving.

IRTISH, a river of Siberia. See SIBERIA.

IRVINE, a royal and parliamentary burgh, seaport, and market-town of Ayrshire, Scotland, situated on the estuary of the Irvine water, 29 miles distant from Glasgow, and 10 from Ayr. The old burgh on the N. side of the water is connected with the S. side by a stone bridge of four arches. Its buildings are a townhall and six churches. The harbour has 8 feet of water at the bar in high tide; and at the port there were registered (Dec. 31, 1855) 4 steamers and 113 sailing vessels, with an aggregate tonnage of 17,719 tons. The principal export of the place is coal, the amount shipped in 1855 being 312,882 tons, or nearly a third of the total quantity shipped in that year from the Scottish ports. During the same year there entered the harbour 243 sailing-vessels, of 19,555, and 132 steam-vessels, of 26,467 aggregate tonnage; and cleared out 4008 sailing vessels, of 336,384, and 163 steam-vessels, of 29,144 aggregate tonnage. In the summer months the suburban villas on the shore are frequented by visitors for sea-bathing. Irvine was created a royal burgh by King Robert I. in 1308, and is governed by a provost and eighteen councillors. It unites with Ayr, Campbelton, Inverary, and Oban, in returning a member to parliament. Population in 1851—royal burgh, 4790; parliamentary burgh, 7534.

IRVING, EDWARD, the most powerful and impressive, if not the greatest, pulpit orator of his day, was born at Annan, in Dumfriesshire, August 15, 1792. His parents were in circumstances to give him a good education. After learning all that the little town of his birth could teach him, he went to Edinburgh, and at the university of that city distinguished himself greatly in the study of the exact sciences. Taking his degree in the ordinary course, he left college, and went to teach mathematics in the burgh school of Haddington. The next year found him settled in Kirkcaldy; where, besides teaching as before, he read deeply in divinity, with the view of entering the church. In 1819, having been licensed, he left Kirkcaldy, hoping to be sent to the East, and there become a Protestant Xavier. Accident, however, made him acquainted with Dr Chalmers, who appointed him his assistant in the parish of St John's, Glasgow. The strangeness of his doctrine, his wild prophet-like manner, and the disturbing force of his personal character, were ill-calculated to please his entire congregation. Some of them shrunk back before the strong reality of their young pastor's nature, and the stern truths which he had the courage to tell; others, warmly admiring his defiance of the comfortable old conventions to which they had been used, applauded, flattered, and perhaps helped a little to spoil him. His fame soon spread, and in 1822 he was invited to settle in London, where he was appointed minister of the church of the Caledonian Asylum. In a short time it became "the fashion" to attend his preaching. Crowds of people of every rank, from the highest to the lowest, flocked to hear him: statesmen, poets, painters, philosophers, literary men, merchants, and great noblemen, thronged his church, and the whole world of fashion soon lay at his feet. To retain his hold over it, he thought that on all occasions he ought to shine. Time for fresh study and thought was denied him. His old stores began to fail. The excitement he had created soon became too powerful for even his strong understanding and noble spirit to control. At any cost *it* must be kept up. To pause, were it but for a moment to steady his whirling brain, was to fall. Every new effort demanded something equally great and stimulating for the next display. In the zenith of his fame he published a volume of discourses under the title of *For the Oracles of God, four orations; For Judgments to Come, an argument in nine parts.* Three editions of this work were sold in less than half a year. Aimless, and without a wide or lasting interest, curiously quaint in style and manner, while the matter generally bears upon the topics of the passing hour, it contains many passages of extraordinary beauty and depth, many an outpouring of lofty devotion, and frequent bursts of the most passionate eloquence. As time wore on, the mysticism and strangeness of his written style became sensible also in his oral discourse. The

Isæus.

opinions and personal influence of Coleridge began to tell upon him. Turning to the Bible, he sought to explain all its difficulties through the medium of the unfulfilled prophecies. He next estranged many of his adherents by proclaiming and advocating the advent of the millennium. Then, comparing the early with the modern history of the Christian church, he thought that it was only the want of faith which prevented the ministers of the one from doing what had been done by the apostles of the other. This led him to preach the possibility of working miracles and speaking in unknown tongues. His conduct, which had long been watched with uneasiness and suspicion by the Church of Scotland, now came to be openly discussed in her courts, and Irving was deposed from her ministry. But his adherents were numerous and devoted, and built him a chapel, in which he continued to preach to them to the end. Even after his health began to give way his zeal remained unabated, and he persisted in squandering his energies as freely as in the first vigour of his strength. In 1834 he set out on a tour through Scotland, in the hope of re-establishing his shattered nerves, but he only reached Glasgow, where he died on the 8th of December, in the forty-third year of his age. He was buried in a crypt of the cathedral of that city.

No more devout or earnest spirit has appeared on the stage of time in the nineteenth century than Edward Irving. He was born to be a Christian minister, and, as was said of him by a friend who knew him well, "he strove with all the force that was in him to *be* it. He might have been so many things; not a speaker only, but a doer,—the leader of hosts of men. For his head, when the fog Babylon had not yet obscured it, was of strong far-searching insight. His very enthusiasm was sanguine, not *atrabiliar;* he was so loving, full of hope, so simple-hearted, and made all that approached him his. A giant force of activity was in the man; speculation was accident, not nature. There was in him a courage dauntless, not pugnacious, hardly fierce, by no possibility ferocious; as of the generous war-horse, gentle in its strength, yet that laughs at the shaking of the spear. But, above all, be what he might, to be a reality was indispensable for him." In another place the same friend exclaims—"But for Irving, I had never known what the communion of man with man means. His was the freest, brotherliest, bravest, human soul mine ever came in contact with. I call him, on the whole, the best man I have ever, after trial enough, found in this world, or now hope to find." Similar was the judgment of all Irving's friends, and even of most of those whom the laws of their church compelled to take part in deposing him. All admired the man, his many virtues, his matchless eloquence; all deplored his fall, and the gulf of separation which it created between them.

ISÆUS, the fifth in order of the ten Attic orators comprised in the Alexandrian canon, was most probably a native of Chalcis, though Athens, the scene of his oratorical triumphs, claimed him for her son. The dates of his birth and death are alike unknown; but this much is certain, that he rose into eminence in the interval between the close of the Peloponnesian War, B.C. 404, and the accession of Philip to the throne of Macedon, B.C. 348. His father's name was Diagoras. In his youth he seems to have been at one time rather dissipated and extravagant, but with advancing years he reformed his mode of life, and became frugal and self-denying. Little more is known of his life, except that having mastered the arts of eloquence under Lysias and Isocrates, he opened a school of oratory, taught with great success, numbered Demosthenes among his pupils, and enjoyed the friendship of all the leading literati of his day.

In the *Lives of the Ten Orators*, attributed to Plutarch, Isæus is mentioned as the author of sixty-four orations. Fourteen of these were condemned by the ancient critics themselves as spurious. Of the remainder, only eleven have come down to us entire; but fragments are preserved of no fewer than fifty-six attributed to him. The eleven extant are all forensic, and bear on subjects connected with disputed inheritances. Their chief value to us lies in the knowledge they afford of Athenian law in matters relating to wills, the transmission of property, the rights of succession in cases of intestacy, and many of the forms of procedure. Of all these Isæus seems to have been thoroughly master. Little was written by the ancients themselves upon the place and character of Isæus as an orator. Indeed the only extant criticism of him is in the parallel drawn by Dionysius of Halicarnassus, between him and his master Lysias. This, along with the actual remains of Isæus, supplies materials for a pretty accurate estimate of him. With infinite grace Lysias combined an artless and natural simplicity that gained belief for his statements, even when they were known to be false, and conviction for his reasoning when it was plainly untenable. Isæus, on the other hand, disregarded nature too much, and was too manifestly an artist. More polished, and at the same time more vehement than his master, he always seemed to study effect, and to aim at conviction more by his manner of stating the case than by a regard to the ultimate truth. On this account, says Dionysius, "Lysias was believed, even when he stated what was false; people hesitated to believe Isæus even when he was known to speak the truth." Isæus, however, is entitled to special praise as the first who practised and recommended the scientific cultivation of political oratory. To him is due the credit of introducing that powerful and impressive style, which was afterwards perfected by his pupil Demosthenes. Ten of the eleven extant orations of Isæus have been known since the revival of letters. The eleventh, on the *Inheritance of Menecles*, was first published by Th. Tyrwhitt, Lond., 1785, from a manuscript out of the Laurentine library of the Grand Duke of Tuscany at Florence. In 1815 Angelo Mai discovered the larger half of the oration on the *Inheritance of Cleonymus*, which he published at Milan, and afterwards at Rome. There have been numerous editions of Isæus in the collective works of the Attic Orators, of which the best is Bekker's. There have been also several separate editions, of which the best is that of Schömann, Greifswald, 1831. In 1779 Sir William Jones published an English translation of Isæus, with a learned commentary, and critical and historical notes. Besides being somewhat loose and feeble, this version is said to be not even very correct.

This Isæus ought not to be confounded with Isæus, another celebrated orator, who lived at Rome in the time of Pliny the younger, about the year 97.

Isaiah.

ISAIAH, or the evangelical prophet, one of the earliest and most celebrated of the Jewish seers whose utterances have been committed to writing. Of his personal history very little is known. He was the son of Amoz (not Amos the prophet, as the fathers erroneously supposed); was married, and had two sons. The place of his abode was Jerusalem, and his dwelling near the temple. His long prophetic career included the reigns of Uzziah (partly), Jotham, Ahaz, and Hezekiah.

During Uzziah..... 1 or 4 years (B.C. 763 or 759.)
... Jotham 16
... Ahaz 16
... Hezekiah.....14

47 or 50 years (B.C. 713.)

The arguments adduced to show that he lived till the reign of Manasseh are of little weight. The sublime passage in the sixth chapter is not to be interpreted simply of Isaiah's call to be a prophet. This he had received before, but was now solemnly consecrated to a very lofty and im-

portant display of his office. The extent to which he was absorbed by the solemn duties he had to perform may be seen in the few notices which we have of himself and his family, as well as in the exalted strains of his seraphic utterances. His wife is called a *prophetess*, not simply because she was married to him, but because she possessed the gift of prophecy, like Miriam, Huldah, &c. In the names which he bestowed upon his two sons may be seen the leading centres of judgment and mercy round which all his utterances were clustered.

That the prophecies of Isaiah emanated from one man had been but little doubted till the last quarter of the eighteenth century, when it became fashionable to view them as an anthology of gleanings from various quarters. A summary of the ever-varying and mutually-destructive opinions on this subject is given by Professor Alexander, in his *Prophecies of Isaiah, Earlier and Later.* "It is commonly agreed among them that the first six are genuine productions of Isaiah, to which it can hardly be considered an exception that chap. ii. 2-4 is supposed by many to be still more ancient. The only observable dissent from this general judgment seems to be the paradoxical opinion of the Dutch writer Roorda, that chap. ii. 2-4 is the only portion written by Isaiah, and that all the rest of the first five chapters is the work of Micah. Chap. vii. 1-16 is regarded by Gesenius as probably not the composition of Isaiah, who is mentioned in the third person. This opinion is refuted by Hitzig, and repudiated by the later writers. Koppe's idea that the twelfth chapter is a hymn of later date, after being rejected by Gesenius, and revived by Ewald, has again been set aside by Umbreit. The genuineness of chap. xiii. and chap. xiv. 1-23, is more unanimously called in question, on account of its resemblance to chaps. xl. to lxvi., which this whole class of critics set aside as spurious. Chaps. xv. and xvi. are ascribed by Koppe and Bertholdt to Jeremiah; by Ewald and Umbreit to an unknown prophet, older than Isaiah; by Hitzig, Maurer, and Knobel, to Jonah; by Hendewerk, to Isaiah himself. Eichhorn rejects the nineteenth chapter; Gesenius calls in question the genuineness of verses 18-20; Koppe denies that of verses 18-25; Hitzig regards verses 16-25 as a fabrication of the Jewish priest Onias; while Rosenmüller, Hendewerk, Ewald, and Umbreit vindicate the whole as a genuine production of Isaiah. The first ten verses of the twenty-first chapter are rejected on the ground of their resemblance to the thirteenth and fourteenth. Ewald ascribes both to a single author; Hitzig denies that they can be from the same hand. Ewald makes the prophecy in chap. xxi. the earlier; Hitzig proves it to be later. Koppe, Paulus, Eichhorn, and Rosenmüller look upon it as a *vaticinium ex eventu*; Gesenius, Ewald, and the other later writers, as a real prophecy. The twenty-third chapter is ascribed by Movers to Jeremiah; by Eichhorn and Rosenmüller to an unknown writer later than Isaiah; by Gesenius and De Wette to Isaiah himself; by Ewald to a younger contemporary and disciple of the prophet. The continuous prophecy contained in chap. xxv. 27, Knobel shows to have been written in Palestine about the beginning of the Babylonish exile; Gesenius, in Babylon, towards the end of the captivity, and by the author of chaps. xl. to lxvi.; Umbreit, at the same time, but by a different author; Gramberg, after the return from the exile; Ewald, just before the invasion of Egypt by Cambyses; Vatke, in the period of the Maccabees; Hitzig, in Assyria, just before the fall of Nineveh; while Rosenmüller, in the latest editions of his *Scholia*, ascribes it to Isaiah himself. Chaps. xxviii. to xxxiii. are supposed by Koppe to contain many distinct prophecies of different authors, and by Hitzig several successive compositions of one and the same author; while most other writers consider them as forming a continuous whole. This is regarded by Gesenius and Hitzig, notwithstanding the objections of preceding critics, as a genuine production of Isaiah; but Ewald doubts whether it may not be the work of a disciple. Most of the writers of this school join chaps. xxxiv. and xxxv. together as an unbroken context; but Hitzig no less confidently puts them asunder. Rosenmüller, De Wette, and others set these chapters down as evidently written by the author of chaps. xl. to lxvi.; while Ewald, on the other hand, maintains that this identity is disproved by a difference of style and diction."

Although such a host of conflicting opinions springs more from a determination to rid the text of every thing supernatural, than a desire to expound it, and rests more on metaphysical arguments, which are adduced to prove all prophecy impossible, than on the philological considerations, which are rather their pretext than their reason, still, on philological grounds alone, the plea for the dismemberment of the Isaian prophecies can be successfully refuted. For example, we may urge the title of the book itself in chap. i. 1, where Isaiah is mentioned as the author of the following writings. Nor can it be said that, from the use of the word *vision*, only a small part of the prophecies can be referred to in the title, for the period involved is expressly mentioned as extending over four reigns, and the word *vision* is used to mean a whole series of prophesies.

To regard the collection as an anthology is a purely gratuitous assumption, destitute of foundation in the history of prophetic literature, and resting on a series of assumptions equally invalid, such as the existence of two authors of the name of Isaiah, who lived 200 years apart, and whose writings somehow became hopelessly intermingled. Besides this, the assertion of Josephus, that the prophecies of Isaiah induced Cyrus to pass the edict allowing the restoration of the Jews, referring, as it does, to parts of the book eliminated by critical taste as spurious, would prove that the false Isaiah prophesied truly; for the supposition that the prophecies are *ex post facto*, and palmed off upon the true Isaiah, involves too many impossibilities.

A fatal objection to the creation of a *pseudo*-Isaiah is found in the fact, that though he is placed subsequent to Jeremiah, yet this latter often imitates him! The expression, *Holy One of Israel*, often used by Isaiah in reference to Jehovah, is also found in Jeremiah l. and li., and so striking is their coincidence, that De Wette and Von Cölln are driven to the desperate extremity of declaring the passage in Jeremiah spurious! The texts in Isaiah thus imitated are in the chapters (xl. to lxvi.) deemed spurious and of later date, which we here see cannot be the case. This view is further corroborated by a passage in *Ecclesiasticus*, where Jesus Sirach, in the third century B.C., passes a high eulogium upon Isaiah, and gives obvious reference to the chapters which the eighteenth century has doomed to be cut out of his prophecy. No prophet in fact existed in the iron age towards the close of the Babylonian Captivity, who could have penned the classic passage from chaps. xl. to lxvi., that part of the book usually assigned to a later hand.

In attempting to show the spuriousness of parts of Isaiah, great use has been made of the fact, that a few Aramaic words and expressions are occasionally to be met with, which they regard as proving a later origin than that ascribed to Isaiah. This whole argument, the main support of Bertholdt, Umbreit, and others, has been proved by Hirzel to be fallacious. Chaldaisms occur in the most ancient of the Hebrew records; and this is accounted for by the fact that the patriarchs were surrounded by nations who spoke Chaldee. It is also curious enough, that the earlier or admittedly genuine prophecies in the collection contain more Chaldaisms than those supposed spurious and therefore of later origin. The usual plea of variety of style has little foundation, and if it had, it has little force. The same author may vary his style according to his subject, as Jeremiah does in his prophecies against Judah, when contrasted with those against other nations. Who would

Isauria.

dream of discarding the *Ars Poetica* of Horace, because it contains numerous words and forms of expression not to be found in any other Horatian composition? Isaiah is admittedly one of the greatest men in Jewish literature; and an important part of this greatness consists in the versatility of his genius.

In regard to the origin and arrangement of the collection little is known. It has been urged, that Isaiah himself could not have arranged the present collection, as it contains no prophecy which can be referred to the reign of Jotham. But this may have been owing to the fact, that there was nothing to distinguish this reign from the previous one, so that chaps. i. to v. may embody the substance of such revelations as took place during Jotham's time. Some have tried to show from the headings that the work of a later hand than that of Isaiah is visible in the collection. But the only case that requires notice is chap. xvii. 1. It begins, "The oracle (or burden) concerning Damascus;" but the prophecy which follows refers rather to Samaria. It is urged that a mistake like this would not have been made by the author; but there is no mistake. All prophecy is primarily for the church, and it is by reason of the relation which they may happen to bear to the church that foreign nations are noticed at all. Damascus is mentioned in the example quoted, because of the connection between it and Ephraim. The Talmudists say, that the men of Hezekiah collected the writings of Isaiah, but this is a mere conjecture founded on Proverbs xxv. 1. According to Hengstenberg, the prophecies are in the main arranged in a chronological order. The few exceptions which occur, are found, he says, upon examination, to be prophecies grouped together on account of the similarity of their contents.

Looking at his writings generally, Isaiah stands in the first rank of the prophets by the simplicity, clearness, sublimity, and freshness of his compositions. The very comprehensiveness of his writings have misled mere critics, so as to suppose that several authors were necessary for what he singly accomplished. His threatenings are like a tempest, and his consolations are as the gentle words of a mother comforting her child. His authority was great in his own day, his writings were continually referred to by our Lord and his apostles, the fathers are full of his praises, and he will stand high in the Christian world when the mists which German criticism has gathered around his prophecy shall have long been cleared away and forgotten.

ISAURIA, in *Ancient Geography*, a tract of country in Asia Minor, on the northern side of Mt. Taurus, which separated it from Cilicia, and bounded on the E. by Lycaonia, on the N. by Phrygia, and on the W. by Pisidia. Practically it may be considered as forming part of Pisidia, especially as strong affinities subsisted between the inhabitants of the two countries. The Isaurians were a wild and half-barbarous race, who lived by rapine and plunder. When resisted by superior numbers they fled to their mountain strongholds, where few either cared or dared to follow them. On sea they were equally formidable. Along with their Cilician neighbours they ranged the eastern seas as pirates, and at one time nearly swept the Roman flag off the Levant and adjoining waters. So formidable did they now become, that in B.C. 78, the Romans set on foot a special campaign against them, and reduced them into a kind of temporary submission. When Pompey put an end to piracy in the east, the Isaurians, though surrounded on every side by the Roman power, were still unsubdued, and by their incessant raids and forays kept their more peaceful neighbours in constant alarm. The Romans then proceeded to surround their country with a chain of fortresses, but the Isaurians broke through them and remained as untameable as before. Under the empire, army after army was sent against Isauria, which stood to Rome, and afterwards to Constantinople, very much in the relation that Circassia now does to Russia. In the 8th century their national vanity was gratified by seeing a countryman of their own appointed to the throne of the Eastern empire in the person of Leo. III. From this date they gradually ceased to be formidable. The only city of importance in Isauria was Isaura, its capital. It was a large, rich, and well-fortified place, at the foot of Mt. Taurus on its northern slope. The country itself was rocky and barren. The only useful plant that throve in it was the vine, which was cultivated with care.

Ischia.

ISCHIA, the ÆNARIA or INARIME of the Romans, and the Pithecusa or Pithecusæ of the Greeks, an island in the Mediterranean, belonging to the kingdom of the Two Sicilies. It lies S.W. of Cape Miseno (*Misenum Pr.* of the Romans), and is separated from it by a strait 8 miles in breadth, in which lies the little island of Procida, the ancient Prochyta. It forms the northern boundary of the Bay of Naples, and is distant about 16 miles from Capri, the southern boundary. Its circumference is about 15 miles, and its area 24 square miles. The origin of the island is evidently volcanic, and though it has now no regular crater, it has always been subject to strong volcanic action. The Monte di San Nicola, or Mount Epomeo (the ancient Epomeus), rising to a height of 2513 feet, shows near its top the traces of two large craters, while its sides are covered with cones. From this peak the island slopes gently to the sea on all sides except the north, where the descent is bolder and more abrupt. As seen from the sea the island presents a picturesque and pleasing appearance, and on landing, the favourable impression is fully justified by the beauty of the landscape and the fertility of the soil, and the general air of prosperity and comfort that everywhere prevails. The wine, which the island produces in large quantities, is excellent of its kind, and the crops of chestnuts, olives, figs, and corn, are large and good. Game, especially partridges, is also very abundant. Sulphur and other minerals are abundant; and clay of excellent quality is found near Camasicciola, and furnishes the material for several large potteries. The hot springs that abound in all parts of the island attract great numbers of invalids from all parts of the Italian mainland.

Ischia forms part of the province of Naples, and is divided into two cantons. Its largest towns are Ischia, on the N.E. (described by Swinburne as "a pretty town of white buildings, and the residence of a bishop"), with a population of about 5500 inhabitants; Foria, on the W., with a good harbour, a considerable trade, and a population of about 6000; Camasicciola, with about 4000 inhabitants; and near it, on the sea, Lacco, with a fishing population of somewhat less than 2000. The entire population of the island is estimated at about 25,000.

Ischia was first colonized by Greek settlers from Chalcis and Eretria, who gave it the name of Pithecusa or Pithecusæ. The common idea is that they gave it this name from "Pithekos," the Greek for an ape; but as apes are not known to have ever existed in the island, the etymon is more reasonable which derives it from "Pithos," the Greek for an earthen vessel, as it seems that even in that remote period potteries were established by the colonists. Pithecusa soon rose to great wealth and importance, and continued to prosper till civil dissensions broke out among the settlers. Frequent earthquakes and volcanic outbreaks at length drove them altogether from the island. In the fifth century B.C. another colony was settled there by Hiero, the tyrant of Syracuse, which had hardly begun to establish itself when it too was driven from the island by similar causes. It next fell under the sway of Neapolis, and finally of Rome. Under the Romans it does not seem to have acquired any importance, and it is rarely mentioned in Roman history except as a favourite resort of invalids. In ancient as in modern times the hot springs and baths of Ischia were renowned for their curative properties.

Ischl ‖ Isère.

ISCHL, a market-town and fashionable watering-place in Upper Austria, at the junction of the Traun and Ischl, 60 miles S. by W. from Linz, and 170 from Vienna. It is situate on a small plain surrounded by hills, and in the neighbourhood of extensive forests. Ischl is resorted to for its excellent climate and the efficacy of its waters. The mineral springs contain a solution of sulphate of soda and common salt, and have a purgative effect. Here the emperor of Austria and many of the nobility have summer residences. Permanent population about 2000.

ISERE, a department in the S.E. of France, on the Sardinian frontier, formerly comprised in the old provinces of Dauphine and Viennois, and lying between N. Lat. 44. 41. and 45. 52., and E. Long. 4. 44. and 6. 22. It is bounded on the N. by the department of Ain, E. by Savoy, S. by the department of Hautes Alpes, and W. by those of Drôme, Loire, and Rhone. Area 3201 square miles; length from N. to S., 70 miles; breadth from E. to W., 60 miles. The surface of the country is generally irregular, and is especially so in the southern parts, where it is crossed by offshoots from the Alps. The highest elevations in the province are the Col de Saysse, Col de Sept-Laux, Pic de Granier, and Pic de Belledonne, reaching a height of from 9000 to 11,000 feet. The valleys are celebrated for their extent and fertility. Those of Isère and Grésivaudan, both traversed by the same river, are together about 50 miles in length, and are justly reckoned the richest in France; while the numerous glens that branch off from them are rich in pasturage and forest trees, extending up the sides of the mountains to the very summit. In one of those glens or upland valleys, 4000 feet above the sea level, is the famous convent of the Carthusian order of monks, known by the name of "La Grande Chartreuse," for which see CHARTREUSE, LA GRANDE. In the N.W. the surface of the country is less hilly, and in some places the low grounds are marshy. The principal rivers are the Rhône, the Drac, and the Isère. The first, forming the N. and W. boundaries, separates this department from those of Ain, Rhone, and Loire, and is navigable, except after long drought. Its tributary, the Isère, rises in Savoy, and traverses the department. It is navigable, but only for very light barges. The Drac joins the Isère a short distance below Grenoble, but is not navigable. All the rivers and streams of the department are subject to inundations, which in 1846 and 1856 devastated the country to a most alarming extent. The climate, from the irregularity of the surface, is various. Agriculture is almost wholly confined to the valleys, where the soil is very rich and water abundant. There are cultivated wheat, barley, rye, oats, maize, potatoes, and hemp, which in some places grows to the height of 15 feet; while on the hill sides, with a southern exposure, the vine, mulberry tree, walnut, and almond, are grown to a greater extent than in any other portion of France of the same size. The silkworm is reared easily and with profit, while in the pastures sheep and small cattle feed in considerable numbers. Of 2,048,638 acres contained in Isère there are 781,835 arable; 499,693 woods and forests; 425,011 waste (marsh, rocks, &c.); 164,854 under grass; 68,443 vineyards; 44,826 roads, buildings, &c.; 38,273 rivers, canals, &c.; 25,703 various, gardens, &c. This department, moreover, is celebrated for its mineral wealth, as well as for the richness of its soil and the grandeur of its scenery. Iron, lead, copper, and anthracitic coal are worked in various parts; and both gold and silver exist, but not in such quantities as to warrant mining undertakings. Marble, granite, porphyry, gypsum, and slate are quarried, and beautiful crystals are found in the mountains, while platinum occurs in the Drac valley. The manufactures of the department are unimportant; they consist chiefly of cloths, beetroot-sugar, brandy, and silk.

Isère is divided into four arrondissements as follows:—

Arrondissements.	Cantons.	Communes.	Pop. 1851.
Grenoble	20	212	220,192
Vienne	10	134	159,514
La-Tour-du-Pin	8	122	136,593
St Marcellin	7	84	87,198
	45	552	603,497

Grenoble, the capital of the department, had in 1851 26,852 inhabitants.

Iserlohn ‖ Ishmael.

ISERLOHN, a walled town of Prussian Westphalia, government of Arensberg, on the Baar, a small affluent of the Ruhr, 17 miles W. of Arensberg. This is one of the most extensive manufacturing towns in Westphalia. In the surrounding country there are iron forges, paper-mills, bleach-works, and other factories. The manufactures comprise steam-engines and machinery, cutlery, zinc and brass ware, leather, silk, calicoes, and broad cloth. Pop., including a suburb beyond the walls, 12,645.

ISERNIA (the ancient *Æsernia*), a town of Naples, province of Molise, on a spur of the Apennines, 23 miles W. of Campobasso. It is one of the most ancient towns of the kingdom, having been in the Roman times a stronghold of the Samnites. The massive remains of its polygonal walls still exist as the foundation of the modern ones in nearly their entire circuit. An aqueduct hewn in the solid rock, and numerous remains of the ancient town, are still to be seen. It is the see of a bishop, and the chief town of a district. The cathedral and a great part of the town were destroyed by an earthquake in 1805. Pop. about 8000.

ISH, in *Scotch Law*, signifies *expiration*. Thus we say "the *ish* of a lease." It signifies also *to go out;* thus we say, "free *ish* and entry" from and to any place.

ISHMAEL was Abraham's eldest son, born to him by Hagar. He made the desert into which he had been cast his abode, and by attaching himself to, and acquiring influence over, the native tribes, rose to great authority and influence. Although their lots were cast apart, it does not appear that any serious alienation existed between Ishmael and Isaac; for we read that they both joined in the sepulchral rites of their father Abraham (Gen. xxv. 9). This fact has not been noticed as it deserves. It is full of suggestive matter. As funerals in the East take place almost immediately after death, it is evident that Ishmael must have been called from the desert to the death-bed of his father; which implies that relations of kindness and respect had been kept up, although the brevity of the sacred narrative prevents any special notice of this circumstance. Ishmael had, probably, long before received an endowment from his father's property, similar to that which had been bestowed upon the sons of Keturah (Gen. xxv. 6). Nothing more is recorded of him than that he died at the age of 137 years, and was the father of twelve sons, who gave their names to as many tribes (Gen. xvii. 20; xxv. 13). He had also two daughters, one of whom became the wife of Esau.

Ishmael has no claim to the honour which is usually assigned to him, of being the founder of the Arabian nation. That nation existed before he was born. He merely joined it, and adopted its habits of life and character; and the tribes which sprung from him formed eventually an important section of the tribes of which it was composed. The celebrated prophecy which describes the habits of life which he, and in him his descendants, would follow, is therefore to be regarded not as describing habits which he would first establish, but such as he would adopt:—"Behold, thou art with child, and shalt bear a son, and shalt call his name Ishmael (*God hears*), because the Lord hath heard thine affliction. And he shall be a wild man: his hand shall be against every man, and every man's hand against him, and

Ishnik ‖ Isinglass.

he shall dwell in the presence of all his brethren" (Gen. xvi. 11, 12). This means, in short, that he and his descendants should lead the life of the Bedouins of the Arabian deserts; and how graphically this description portrays their habits, may be seen in the article ARABIA, and in the works of Niebuhr, Burckhardt, Lane, &c.; and, more particularly, in the Arabian romance of Antar, which presents the most perfect picture of real Bedouin manners now in existence. The last clause, "He shall dwell in the presence of all his brethren," is pointedly alluded to in the brief notice of his death, which states that "he died in the presence of all his brethren" (Gen. xxv. 18). Of this expression, various explanations have been given, but the plainest is the most probable. It had seemingly some such force as this: The heritage of Canaan is, indeed, destined for another son of Abraham; but still the lot of Ishmael, and of those that spring from him, shall never be cast far apart from that of his brethren. This view is confirmed by the circumstance, that the Israelites did, in fact, occupy the country bordering on that in which the various tribes descended from Abraham or Terah had settled—the Ishmaelites, Edomites, Midianites, Moabites, Ammonites, &c. Most interpreters find in this passage, a promise that the descendants of Ishmael should never be subdued. But we are unable to discover this in the text; and, moreover, such has not been the fact, whether we regard the Ishmaelites apart from the other Arabians, or consider the promise made to Ishmael as applicable to the whole Arabian family. See ARABIA.

ISHNIK, or ISNIK. See NICÆA.

ISIDORUS. Of several persons of this name the most notable are St Isidore of Pelusium and St Isidore of Sevilla. The former, who died about the year 450, was a native of Alexandria, and spent the greater part of his life in a monastery near Pelusium, of which he is supposed to have been abbot. He was an ardent disciple and supporter of Chrysostom. The memory of his learning and piety is preserved in his *Letters*, of which upwards of 2000 are extant. They are chiefly expository, containing much sound instruction, and are deserving of notice for the purity of their style. They are in five books, collected into one volume fol., Gr. and Lat., Paris, 1638.

Isidore of Sevilla, surnamed *Hispalensis* from the country of his birth, lived between 570 and 636. About A.D. 600 he succeeded his brother Leander in the archbishopric of Sevilla, and during a long and active administration of office made his name venerable as the main pillar of the Catholic Church in Spain, the restorer and maintainer of clerical discipline, the most learned and the most eloquent doctor of his age. Of his voluminous works the most remarkable is his *Origines seu Etymologiarum libri xx.*, an encyclopædic collection of treatises on all the arts and sciences at that time embraced within the range of human study. The best edition of his collected works is that of Arevali, 7 vols. 4to, Rome, 1797–1803.

A celebrated collection of forged canons or decretals, intended to prove the paramount authority of the Romish See over all other tribunals, was the work of Isidore Mercator or Peccator, a monk of the eighth century.

ISINGLASS, a variety of gelatine, sometimes called *ichthyocolla*, or fish-glue (from ἰχθύς, *a fish*, and κόλλα, *glue*), prepared from the air-bag, swimming-bladder, or sound of various fishes. The Russian and Siberian isinglass is most esteemed; it is chiefly obtained from sturgeons, a family of cartilaginous fishes of the genus *Acipenser*. The swimming-bladder is cut up, washed, and then exposed to the air, with the inner silvery membrane upwards. When dry, this membrane is removed by beating and rubbing; the sound is then prepared in various ways. For forming what is called *leaf* isinglass it is merely dried; for *long* and *short staple*, it is twisted between three pegs into the shape of a horse-shoe, harp, or lyre; for *book* isinglass, it is folded like the sheets of a book; for *ribbon* isinglass, it is rolled out. The swimming-bladder of *A. sturio* of the Caspian Sea furnishes leaf isinglass of three qualities, known as *fine-firsts*, *firsts*, and *seconds*. *A. guldenstadtii* of the Caspian and Black Seas and their tributary rivers, furnishes *caviare* from its roe or ovary, whilst the swimming-bladder yields *staple* and *leaf* isinglass. The varieties of staple are *Patriarch Astrakhan*, and *Astrakhan firsts*, *seconds*, and *thirds*. The varieties of *leaf* are also *firsts*, *seconds* and *thirds*,—the firsts forming the finest leaf known in commerce. *A. rufinus* and *A. stellatus* also yield isinglass. There is a kind known as *Samovey leaf*, from Tanganrod, but this is inferior; there is also the *sisane leaf*, said to be obtained from a small fish, and *kroshi isinglass*, which is made into small membranous disks. Isinglass is also procured from *Siluris glanis*. For *purse*, *pipe*, and *lump* isinglass, the swimming-bladder is dried unopened, and the variety known as *Siberian purse*, of moderately good quality, is greatly in demand.

Isinglass.

Brazilian isinglass is obtained from Para and Maranham, but the fishes which produce it have not been named. For the variety known as *pipe-Brazil*, the swimming-bladders are dried unopened, and made into pipes 10 or 12 inches long, and from 2 to 2½ inches broad, and are sometimes distended with air. *Lump* isinglass is formed by placing two swimming-bladders side by side, and for *honey-comb* isinglass, the largest lump isinglass is split open. There are also varieties of isinglass from New York, from Hudson's Bay, and from the East Indies. In Moldavia a variety is prepared from the skin, stomach, intestines, and swimming-bladder of the sturgeon. These are cut small, steeped in cold water, and simmered. The jelly thus produced is spread out into thin layers, and dried into a kind of parchment, which, on being softened with water, is rolled into cylinders, or extended into plates, and forms an inferior isinglass. Cod sounds are also used for a similar purpose. The *patent gelatine* prepared from glue-pieces or cuttings of hides, &c., after the manner of glue, is also used as a substitute for isinglass. A solid gelatine in thin plates and strings, is prepared from bones, and is chiefly of French manufacture.

Isinglass is prepared for sale by being picked and cut. This was formerly done by hand, but is now effected by steam machinery; the thin filaments thus produced should be whitish in colour, dry, semitransparent, nearly tasteless, and quite devoid of smell. Isinglass differs from glue, in being tough, fibrous, and elastic, instead of brittle. On boiling, it should completely dissolve, and on cooling, should form a white jelly, soluble in weak acids, but separable from them by alkalies. With milk and sugar it is used as a diet for invalids, and it is also used in the preparation of blancmange, jellies, and creams, and for enriching soups, and sauces. For the reasons given under GELATINE, isinglass is no longer considered to be highly nutritive; it is even less digestible than the flesh or muscular part of animals. The great consumer of isinglass is the brewer, who uses it as a fining material, for which purpose lump isinglass is chiefly used. This is deeper in colour, and inferior in solubility to the better varieties. On mixing it with the liquor to be fined, it partly combines with some of those matters which render the liquor cloudy, and entangles in its meshes those which are mechanically suspended, the whole then rising to the surface can be removed, and the liquor be left clear. Wine, coffee, and other liquids are also clarified by isinglass, but sole-skins and hartshorn shavings are often used as substitutes for it. Isinglass forms the adhesive material in court-plaister, for which purpose a solution of isinglass, mixed with tincture of benzoin, is brushed over black sarsenet. Isinglass dissolved in spirits of wine or common gin, and gently simmered by placing

Isis ‖ Ismail.

the bottle in a vessel of boiling water for about an hour, forms *diamond cement*, or *white fish-glue*; gum ammoniac is sometimes added. Panes of isinglass, instead of glue, are used in France instead of horn, for lanterns, and also for lamp-shades, &c. (C. T.)

ISIS. See EGYPT.

ISKARDOH, the capital of Bultistan, is situate in a valley 19 miles long and 7 broad, and embosomed in stupendous ranges of mountains. The castle of the former sovereigns stands on a small natural platform about 300 feet above the bed of the Indus and its great tributary the Shigur, the two rivers forming a junction at the foot of the rock on which the castle is built. Ahmed Shah, the late native sovereign of Bultistan, had ruled his kingdom with a moderation little known among Asiatic despots. He made some unsuccessful efforts to become a protected vassal of the Indian Government as he dreaded the power and rapacity of the Sikhs. His fears proved true; Iskardoh having been seized by Gholab Singh, the present ruler of Cashmere. Iskardoh is in Lat. 35.12, Long. 75.35.

ISLAM, or ISLAMISM. See MOHAMMEDANISM.

ISLAY, or ISLA, an island on the west coast of Scotland, the most southern of the Hebrides, lying between N. Lat. 55. 30. and 55. 58., and W. Long. 6. 2. and 6. 35., 17 miles W. of Cantyre, and 2 miles S. of the island of Jura. It is 27 miles in length from N. to S., and 22 miles broad, and contains an area of about 174 square miles. Unlike the other islands of the same group, its surface is generally regular, with moderate undulations. The soil, which is a mixture of clay, sand, and peat, is highly absorbent, a quality that renders it very productive under the great amount of rain which falls on the island. The rocks belong to the schistoze formation, and contain some veins of lead. Islay has long been famous for the distillation of whisky, which is generally accounted the best in Scotland. In 1851 the number of proof gallons distilled on the island amounted to 458,089; in 1852, to 311,836; in 1853, to 336,715; in 1854, to 401,071; in 1855, to 386,822; or, on an average, an 18th part of the quantity distilled throughout Scotland. The principal crops of the island are barley, oats, bere, rye, and wheat. Islay is divided into four parishes, and in 1851 contained 2100 inhabited houses, with a population of 12,334 in 1851, showing a decrease since 1831 of 2658. The largest village is Bowmore, on Lochindaal, with a population of 1202 persons. See HEBRIDES.

ISLA DE PINOS, or ISLE OF PINES, one of the Spanish West India Islands, lying 16 miles off the S. coast of Cuba. It is 42 miles in length from N. to S., by 32 in breadth, and has an area of 709 square miles. It is richly wooded, and is noted for its healthy climate and fertile soil. Pop. 1400.

ISLE, L', a town of France, department of Vaucluse, arrondissement of Avignon, and 12 miles E. of the town of that name. It stands on a small island formed by the Sorgues, and contains about 6000 inhabitants, chiefly employed in the manufacture of silk and woollens.

ISLE OF PINES, an islet in the South Pacific, lying S. of New Caledonia in S. Lat. 22. 38., E. Long. 167. 25. It is about 42 miles in circumference, and is covered with luxuriant vegetation. In 1853 the French took possession of it along with New Caledonia.

ISMAIL, a town of Moldo-Wallachia, on the north bank of the Kilia mouth of the Danube, 65 miles distant from the Black Sea, and 52 from the town of Galatz. Prior to 1790 it was in the hands of the Turks, but in that year was taken by the Russians, in whose possession it remained till 1856, when it was ceded to the Moldo-Wallachian provinces, under the sovereignty of the Porte. The fortifications were blown up by the Russians in 1856 before evacuating. Its inhabitants are chiefly dependent on the trade of the Danube, which is here navigable for steam and sailing vessels. The products of Moldavia—grain, hides, and tallow—are exported from Ismail in large quantities. With the exception of some old Armenian churches there is nothing in the buildings of Ismail to strike the eye of the observer. Pop. (1849) 26,243.

Ismid ‖ Isocrates.

ISMID, IZMID, or IZNIKMID, a seaport town of Asia Minor, at the head of the Gulf of Ismid (an inlet of the sea of Marmora), and 50 miles E.S.E. from Constantinople. It stands on the slope of a hill rising from the bay, and contains about 900 houses. Its trade is said to be considerable. Ismid occupies the site of the ancient *Nicomedia*, a celebrated city of Bithynia, built in B.C. 264, by Nicomedes I., who made it his capital. It soon became one of the most splendid cities in the kingdom; and under the Romans was a favourite residence of several of the later emperors, among others of Diocletian and Constantine the Great. It is memorable in history as the scene of Hannibal's death, and as the birthplace of Arrian, the historian of Alexander the Great.

ISOCRATES, a celebrated Athenian orator, and the fourth in the order of the Alexandrian canon, was born at Athens B.C. 436. He was the son of Theodorus, a musical instrument maker in that city. As his father was a man of large means Isocrates had the benefit of the best training then to be had in his native city, and Tisias, Gorgias, Prodicus, and Theramenes were among his teachers. A constitutional shyness and timidity which he tried in vain to overcome led him to abandon all hope of attaining eminence as a public speaker. But though he could not speak himself, none knew better than he the laws of oratory, or the best training for students of that art. In Chios, where he first established himself as a teacher of rhetoric, he did not succeed very well; but when he removed to Athens he was eagerly sought after, and counted among his scholars such men as Theopompus, Ephorus, Xenophon, Isæus, and Demosthenes. Cicero somewhere observes that the house of Isocrates was a gymnasium, a workshop of words, open to the whole of Greece, and that from his school, as from the horse of Troy, had gone forth a troop of heroes. It became a fashion at Athens to attend his course, and the number of his pupils at last rose to 100, from each of whom he received 1000 drachmæ. His terms were often complained of as extravagant; but when at the height of his fame he said that he would gladly pay 10,000 drachmæ to any one who could give him a good voice and confidence to speak in public. At the age of 94 he wrote in the exordium of his *Panathenaicus*, "So utterly destitute am I of the two qualities most valued in an orator at Athens—voice and manner—that I believe no one of my time is in these respects so ill-provided as I." Certain it is that he was never known to speak in public but once. The orations which he wrote were either delivered by others or sent for private perusal to the persons to whom they were addressed, and in this way he amassed large means. Nicocles, king of Cyprus, gave him twenty talents for the oration Πρὸς Νικοκλέα. His persistent refusal to take any direct part in public affairs raised against him a host of enemies. To put an end to the slander that threw suspicion upon his motives, he determined in B.C. 352 to accept the trierarchy—the most important and expensive of the extraordinary public services that could be undertaken by a private citizen. Isocrates fulfilled his self-imposed task with a splendid liberality that silenced his enemies, and made him for a time extremely popular. Another accusation charged him with maintaining too friendly and intimate a correspondence with kings, and letters of his are still extant to Philip and Alexander of Macedon. But his political views were too large and wide for any of the factions that then distracted Athens in common with the other states of southern Greece; and he never would identify himself with the politics of any party. His great desire was to see the Greeks (under that name he included all

Isocrates.

those who spoke the Greek tongue) banded together in a powerful league against their common foe of Persia.

Though a strong advocate of a peaceful policy he urged this war as the only means he could think of that would likely put an end to the wretched little wars in which the Greeks were wasting each other's strength, and which made the whole country an easy prey and a tempting bait to any rapacious neighbour. No better proof of his genuine patriotism can be adduced than his *Panegyricus*, which it is said that he spent ten years of his life in polishing and retouching. In this harangue (written while Athens was still suffering from the disasters of the Peloponnesian War) he expatiates in glowing terms on the glory and greatness of his native city, her exploits in war, her sufferings in the cause of Greece, and her splendid achievements in literature and the arts. With equal eloquence he enlarges on her services to civilization by her colonies in every corner of the Mediterranean, her management of them, and her development of the commercial resources of every country to which her splendid fleets could penetrate. A powerful appeal to Spartans and Athenians to lay aside their mutual enmity, and combine their forces against their common enemy of Persia, shows at once the genuineness of his patriotism and his enlarged political views. Though he was all his life a friend of peace, yet he was at the same time too much a friend of virtue to purchase it at the cost of honour. His conduct, in the case of his old friend and teacher Theramenes, suffices to refute the charge of personal cowardice sometimes brought against him. When Theramenes was condemned to death by the Thirty Tyrants, Isocrates was bold enough to risk his life in upholding and sympathizing with him. He had reached the great age of 98, when the battle of Chæronea was fought, B.C. 338. The victory of the Macedonians extinguished for ever the liberties of Greece; and Isocrates, unwilling to survive the downfal of his country, died by his own act a few days after.

The general esteem in which Isocrates was held by the ancient critics is attested by the number of commentaries which were written upon his works. These, with the history of his school by Hermippus, have all long since perished. Of the sixty-eight orations, which in ancient times passed under the name of Isocrates, twenty-eight were acknowledged as genuine, and of these twenty-eight only twenty-one have come down to us. The titles and a few fragments of twenty-seven others ascribed to his pen have been preserved. Besides these orations, ten letters, bearing chiefly on the political questions of the day, are extant under his name; but some of them are undoubtedly spurious. Of the extant orations eight belong to the forensic class, and contain much valuable information on the civil law of Athens and the forms of legal procedure. Others of them belong to the hortatory or declamatory style; and all alike display the characteristic excellencies and defects of their author. In estimating these orations it must never be forgotten that they were not intended to be valued by their effect upon a miscellaneous audience, but upon the intelligent reader in his closet. He bestows great care on the arrangement and distribution of his subject. His language is always finically Attic. In the choice of his words he was hardly less fastidious than Charles Fox, who would use in his History no word that had not the stamp of Dryden's sanction. His periods are all rounded with consummate care. Every clause is scrupulously balanced with the other members of the sentence, and disposed so as to flow on in harmonious cadence with the whole. Indeed, Cicero expressly says that Isocrates was the first to study rhythm in the writing of prose. His words thus roll on melodiously, till their very melody cloys by its sweet monotony, and the reader begins to long for something more free and forcible, and less obviously artistic. Dionysius neatly decides between Lysias and Isocrates in a single line, when he says that "the first pleases naturally, while the latter aims at pleasing." Yet this critic, severe as he is upon the finely modulated phrases and regular antithesis of Isocrates, does ample justice to the high moral tone and noble spirit of piety and virtue that breathe through all his works.

Isomerism ‖ Ispahan.

Few of the writers of Greece have been so often or so well edited by modern scholars as Isocrates. He appears, of course, in all the collections of the Attic Ten, and in a vast number of special editions. The best text is that of Bekker. The English edition of Battie, 1749, and the French edition of the Abbé Auger, 1782, are neither of them so good as they ought to have been from the MSS. which these scholars had at command. Coraës' edition, Paris, 1807; that of W. Lange, Halle, 1803; and that of Baiter and Saüppe, Zurich, 1839, are all good. G. S. Dobson published an excellent edition in London in 1828, with a Latin translation and copious notes. Isocrates has been translated into English by Sadleir; Dinsdale, Lond. 1752; and Gillies, Lond. 1778. The French translation of the Abbé Auger, the only one in that language, is regarded as a total failure. Excellent criticisms on the life and writings of Isocrates will be found in some of the works already named, and also in Westermann's *History of Greek Oratory;* Leloup's *Commentatio de Isocrate,* Bonn, 1823; Pfund's *De Isocratis vitâ et Scriptis;* and Bréquigny's *Vies des Anciens Orateurs Grecs.*

ISOMERISM, from ἴσος, *equal,* and μέρος, *part.* Bodies which contain the same elements in the same ratio, and yet have distinct physical and chemical properties, are said to be *isomeric.* Isomeric bodies are divided into *polymeric,* in which the elements being the same the mode of condensation is different; and *metameric,* which have the same equivalent numbers, but are supposed to be differently constituted. See Chemistry.

ISOMORPHISM, from ἴσος, *equal,* and μόρφη, *shape* or *form.* A vast number of subtances are distinguished by crystalline forms, which have been arranged into six classes or systems founded upon the relation of their axes of symmetry to each other, the study of which belongs to the science of *Crystallography.* (See Mineralogical Science.) Certain elementary substances, which are analogous to each other in chemical properties, have the power of assuming a similar crystalline form, and may be substituted for each other in a compound without producing any change in its crystalline form. Such bodies are said to be *isomorphous.* Thus, magnesia, oxide of copper, protoxide of iron, and oxide of nickel, are isomorphous: when they enter into combination with the same acid, and with similar proportions of water of crystallization, they furnish crystals which are identical in form, and if of the same colour cannot be distinguished by the eye. Common alum is a sulphate of alumina and potash; but the alumina may be displaced by peroxide of iron, the potash by ammonia, or by soda, and yet the shape of the crystal remain the same. Mixtures of isomorphous salts cannot be separated by the method of crystallization, unless of very different degrees of solubility.

ISOTHERMAL LINES. See Climate.

ISPAHAN or Isfahan, formerly the capital of the Persian empire, now of the province of Irak-Adjemi, on the north side of the Zendarood, N. Lat. 32. 42., E. Long. 51. 46., about 220 miles S. of Tehran, and 230 miles N. of Schiraz. It is the centre point from which all the important roads of the country radiate. The present city is in a very dilapidated condition. The streets are empty, palaces in ruins, the gardens once so famous for their luxurious beauty, strewn with stones and lime from the neighbouring ruins, and the bazaars deserted, though formerly the resort of merchants from all quarters of the East. Along with its suburb Julfa, Ispahan covers an extensive area, and its circumference is 30 miles. The suburb occupies the opposite side of the river from the town. The present in-

Israel. habitants confine themselves to certain districts where the streets are more commodious and accessible, the rest of the town being quite tenantless. The suburb Julfa is occupied by Armenians, and forms the residence of the European embassies when the Court is at Ispahan. It is connected with the city proper by three ruinous bridges, only one of which can be used. This bridge is composed of thirty-three arches, above each of which are three smaller ones, and has, besides a causeway for horsemen and cattle, a covered footpath for passengers. The principal features of Ispahan are the mosques, palaces, and gardens, that vie with each other in displaying tokens of departed greatness. In the centre of the town is the Maïdan, or Square of Shah Abbas, said to be 2000 feet long by 700 feet in breadth, each of its sides being occupied by arcades of double ranges of arches. In the N.W. side of the square is the gate of entrance to the Shah Abbas Bazaar, on which the celebrated clock of Ispahan formerly stood. This bazaar, built by the Shah whose name it bears, is described by travellers as one of great extent, but is now occupied by only a few tradesmen. Opposite its gate, on the south-eastern side of the Maïdan, stands the mosque of Shah Meshed, the most richly adorned of any in Ispahan, and having a gate of great magnificence covered with gold and silver ornaments. Christians are not admitted to the interior. The Looft Ullah Mosque and Ali Gate front each other on the S.E. and S.W. sides of the square, and both are remarkable specimens of Persian architecture. But the building which strikes the eye of the stranger most in this city is the palace of forty columns, or Chehel Sitoon. Its interior is covered with gilding, mirrors, and paintings. Some of the pictures represent scenes which occurred two or three hundred years ago, and are said to be well executed. The Shah holds his audiences here when in Ispahan. Besides these buildings there are several smaller mosques, colleges, and a considerable number of caravanserais and public baths. The interest attached to this city is, however, chiefly derived from the historical descriptions of its former wealth and grandeur. It was under the caliphs of Bagdad that Ispahan began to increase in wealth, population, and trade, and rose to be capital of Irak. The invasion of Timor, in 1387, gave a blow to its prosperity; and the pile of 70,000 heads which he erected proves the populousness of the city as well as the barbarity of its captor. Early in the seventeenth century it began to rise again into notice. Abbas Shah, of the Sefi dynasty, removed the seat of government from Kazwin to Ispahan, and used every means to advance its prosperity, and increase trade. He carried off the inhabitants of Julfa, a town on Arras River, in Armenia, and allotted them the suburb of Ispahan, now called Julfa. These were famous for their industrious habits and their knowledge of the arts. Under this monarch the city rose to great eminence as a place of commerce and wealth, and is said to have contained a population of more than a million souls, but after his death it again declined, and at the end of the eighteenth century the seat of government was transferred to Teheran, the present capital of Persia. Ispahan is again beginning to acquire importance, and to attain somewhat of that commercial position which, from her natural advantages, she is entitled to occupy. The inhabitants are reputed the most intelligent in the empire. At present the chief manufactures are silk and gold brocade, and the general trade embraces all those articles belonging to the East, such as silk, tea, coffee, &c., that are brought through Ispahan on their road westwards. The population is variously estimated from 50,000 to 120,000. See also PERSIA.

ISRAEL ("a prince with God"), the name given to Jacob at Peniel (Gen. xxxii. 28–30). After denoting first the patriarch Jacob, and from him the whole nation of the Jews, the name was applied to the ten tribes, after their revolt, in contradistinction to Judah. Since the Babylonish Captivity, the name of *Jews*, from the tribe of Judah, has been commonly applied to the nation. See JEWS.

D'Israeli. ISRAELI, ISAAC D', the author of *The Curiosities of Literature*, and many other works connected with literary history, was the son of a Venetian merchant of Jewish race settled in England, and was born at Enfield, near London, in 1766. His early education at the place of his birth was shaped with a view to fit him for the merchant's desk; but, while at school, he evinced a precocious, and, as his parents thought, a dangerous fondness for literary, and especially poetic pursuits. To cure him of these tastes they sent him to Amsterdam, where a correspondent of his father's was charged to place him in some school of repute. At the age of eighteen he returned to England with a great knowledge of Bayle, Voltaire, and the French philosophes, and a MS. poem of his own against "Commerce." Meeting with no sympathy in his favourite pursuits at home, he sought it abroad. Samuel Johnson had long been the English dictator on all questions of poetry and criticism, and the story is that the young D'Israeli sent his poem to him for judgment about the same time that Samuel Rogers sought an opinion on the first fruits of his genius. Both alike were disappointed. The reign of the great critic was then drawing to a close. While they were still in suspense as to their fate, they heard that Johnson was dead. The satire against Commerce never saw the light; but its author, still believing himself a poet, continued to pour forth his soul in song, and beside many short pieces in verse (contributed chiefly to the *Gentleman's Magazine*), published also, but without his name, some romantic tales in prose. The latter do not seem to have ever had much success, if we except the satirical piece called *Flim-Flams;* and his *Defence of Poetry*, his most ambitious effort in rhyme, was speedily suppressed by himself. The fortune which awaited him on reaching manhood enabled him to shape his future life according to the plan long before laid and cherished by himself. He resolved to devote himself to the career of literature, and to take the literary character itself for his theme. Some of the fruits of his wide and miscellaneous reading appeared in 1791, when he gave to the world the first volume of his *Curiosities of Literature;* a second followed a few years later; and a third appeared in 1817. A second series appeared in 1823. In the intervals of his deeper studies he contributed occasional papers to the *Quarterly Review*. The most memorable of these was his review of *Spence's Anecdotes* in 1820. This essay gave rise to the famous Pope controversy, in which Campbell, Byron, Bowles, Roscoe, and others less eminent, broke lances. The character of Pope had long occupied D'Israeli's thoughts, and he had gathered a great mass of materials for a life of the poet. But after hesitating for a while between this task, and the weightier one of contributing to the history of our vernacular literature, he decided, as must ever be regretted, in favour of the latter. In 1795 he had published one of the most delightful of his works, his *Essay on the Literary Character*, and had followed it up in the ensuing year with his *Literary Miscellanies*. Between 1812 and 1816 appeared the *Calamities of Authors*, the *Quarrels of Authors*, and the *Character of King James I.* The last-named work was described by himself as "an affair of literary conscience." Naturally shy and timid in private life, D'Israeli proved his moral courage as a writer by vindicating the first of the Stuart dynasty. Whatever weight be allowed to this defence of James, it was from no love of paradox that it was undertaken by its author. He earnestly believed every line that he wrote on the subject, and that his judgment was borne out by the original records on which his work was based. A similar motive actuated him in his next elaborate work on the history of the seventeenth century —his *Commentaries on the Life and Reign of Charles I.*,

D'Israeli.

1828–1831. This work excited far more interest than its predecessor. "Men were attracted," says his son, "to a writer who traced the origin of the anti-monarchical principle in modern Europe; treated of the arts of insurgency; gave them at the same time a critical history of the Puritans, and a treatise on the genius of the Papacy; scrutinized the conduct of triumphant patriots, and vindicated a decapitated monarch. The success of this work was eminent; and its author appeared for the first and only time of his life in public, when, amid the cheers of undergraduates, and the applause of graver men, the solitary student received an honorary degree from the university of Oxford, a fitting homage, in the language of the great university, 'optimi regis optimo vindici.'" Increasing years and infirmities were not able to damp the ardour of his literary enthusiasm; and it was for many years believed that a complete history of our literature might be looked for from his pen. His historical labours interfered with this design, and it was only partly fulfilled in his *Amenities of Literature*. This was his last work, and it saw the light in 1841, two years after its author had been struck with blindness. The devotion of his daughter enabled him to finish it, and carry it through the press. D'Israeli spent the last thirty years of his life in studious ease at Bradenham House, Buckinghamshire, where he died in the January of 1848, in the eighty-third year of his age.

In works like D'Israeli's, which range over the whole field of modern literature, and present flowers culled from every tree, it would be too much to look for absolute correctness in many small matters of detail. But, though the critics have detected errors (few of them of any importance), yet, on the whole, D'Israeli's works deserve high praise on the score of accuracy as well as honesty. Without prejudices and without passions, almost, it might be said, without a country, he had no motive either to distort the facts of history, or by adroitly managing its lights and shadows, to gild the evil, and obscure the good. Having no theories or traditionary opinions to defend, he sought truth for itself, and reproduced it, set and polished perhaps, but intrinsically the same as he found it. The literary vein upon which he fell had been, till his day, almost unworked in England, though the French had for ages known its value, and had gathered from it some rare and precious ore. He may therefore fairly be called the father of that very important and interesting branch of English literature of which his own *Curiosities* may serve as a type. It may be doubted if, in the walk which he marked out for himself, he has yet been approached—he certainly has not been left behind. It would be absurd to place him, as is sometimes done, on the same niche with Montaigne; yet it is true that one reads the works of both with a similar kind of interest. His delightful gossippings are made the vehicle of curious and valuable learning. His criticism, though not always very philosophical, is generally set off by some choice felicity of phrase, while many of his isolated remarks are singularly acute and happy. Sometimes, as in his story of *Chidiock Titchbourne*, he strikes upon a chord of deep and subtle pathos. Many of his miscellaneous papers present pictures of past times, more graphic and memorable than the formal disquisitions of the most learned antiquarians. The reader enjoys the fruit, without having planted the tree, or anxiously watched the stages of its growth. In the charm and freshness of these pieces one forgets that they are merely the fragments, which it was the author's plan to have welded into the unity of a perfect whole. Had he been able to carry out this design he would have been entitled to rank with Warton; but he wanted the fine critical sagacity and compass of mind which the poet-historian brought to bear on his *History of English Poetry*.

In private life D'Israeli was one of the best of men. By one who had the best means of judging he is described as having "passed through life without an evil act, almost without an evil thought." His excessive nervousness made him shy, timid, and sometimes irritable; but it was not in his nature to harbour thoughts either of guile or malice.

Issoire ‖ Isthmia.

ISSOIRE (the ancient *Issiordurum*), a town of France, capital of a cognominal arrondissement, in the department of Puy-de-Dôme, on the Couse, near its confluence with the Allier, and 18 miles S.S.E. of Clermont. The only point of public interest in the town is the Church of St Paul, a curious specimen of the Romanesque style. It has a considerable trade in articles of copper manufacture, as also in hemp and wine. Pop. (1851) 5735.

ISSOUDUN, a town of France, capital of a cognominal arrondissement in the department of Indre, and situated partly on the declivity and partly at the foot of a hill, on the right bank of the Théols, 17 miles N.E. of Châteauroux, and 148 miles S. of Paris, with both of which it is connected by railway. The river is here crossed by three bridges, connecting the town with as many suburbs on the opposite bank. Issoudun was formerly a place of considerable strength, and has been subjected to repeated sieges. The fire of 1651, by which upwards of 1000 houses were destroyed, gave occasion for great improvements in the town, and to this circumstance it owes its superiority to the other towns in the centre of France. The *Tour-Blanche*, an erection of the twelfth century, the walls of which are 14 feet thick and 95 feet in height, and the ancient town-gate and belfry, now used as a prison, are objects of interest. The chief manufactures are woollen cloth, cotton goods, hosiery, leather, and parchment; and these, with corn, wine, wool, cattle, and timber, constitute the chief articles of trade. Pop. (1851) 13,215.

ISSUS, in *Ancient Geography*, a city of Cilicia in Asia Minor, close to the frontier of Syria, on or near the head of the Sinus Issicus, now the Gulf of Scanderoon or Iskenderun. It was in the neighbourhood of this city that Alexander annihilated the Persian army under Darius, B.C. 333. Here, too, was fought, in A.D. 194, the bloody battle between Septimus Severus and Pescennius Niger, in virtue of which the former became sole master of the Roman empire. The exact site of Issus has not yet been discovered. It has been often sought for by modern travellers, and much has been written about it, to little purpose. The disappearance of all remains can only be accounted for on the idea that they have been engulfed by the sea. About 7 miles S.E. from the Syrian frontier, Col. Chesney found some considerable ruins, consisting of the remains of a temple, part of the Acropolis, and an extensive aqueduct, which he believed to belong to the ancient Issus. It is more likely, however, that these mark the site of Nicopolis, a city built by Alexander to commemorate his victory over the Persians.

ISTALIF, a town of Afghanistan, province of Cabool, and 22 miles N.W. of the town of that name. It is picturesquely situated amid groves and orchards, at the base of the Hindoo Coosh, which here rises from 15,000 to 20,000 feet above the level of the sea. Till it was taken and partly destroyed by the British in 1842, its population was about 15,000. The inhabitants, much reduced in number since that year, are chiefly employed in the spinning, weaving, and dying of cottons.

ISTHMIA, one of the four great national festivals of the Greeks. It was instituted in honour of Neptune, and took its name from the isthmus (*i.e.*, of Corinth) where it was celebrated. At the narrowest part of that isthmus was a race-course and theatre, where the games were held. The conduct of the games was entrusted to the Corinthians, who enjoyed that privilege till the overthrow of their city by Mummius, B.C. 146. In that year it was devolved upon the people of Sicyon, with whom it remained till the rebuilding of Corinth by the order of Julius Cæsar, when it

Istria or Histria || Italy.

again reverted to the Corinthians. The Isthmia were originally celebrated at irregular intervals; but in B.C. 584, when they had come to be regarded as a national festival, they became periodical, and were held every third year, *i.e.*, twice in each Olympiad. They continued to be so celebrated till the establishment of Christianity as the religion of the empire. Their gradual decay and final extinction date from that event.

The games themselves, which marked the recurrence of the festival, included the usual athletic sports in all their varieties of wrestling, boxing, gymnastics, and foot and chariot races, besides the higher contests of musical and poetical skill. After the establishment of the Roman power in Greece, gladiatorial shows and wild beast fights were added to the other attractions. The prizes in the Isthmia consisted of simple garlands of pine leaves. Ivy was at one time substituted; but the pine soon regained its old ascendency. These simple rewards were as keenly contested as the costly prizes of the English race-course; and the successful aspirant for them was held in the highest honour for the remainder of his life, and became entitled to many valuable privileges and immunities. The best poets of Greece found in these victories a theme worthy of the highest efforts of their muse. The triumphal odes of Pindar are the noblest monuments of this kind of composition that have descended to us. See GAMES, GYMNASIUM, &c.

ISTRIA or HISTRIA, in *Ancient Geography*, a peninsula at the northern extremity of the Adriatic, jutting out between the Sinus Tergestinus (the Gulf of Tergeste or Trieste) and the Sinus Flanaticus or Gulf of Quarnero. It took its name from Ister, the Greek word for the Danube, in consequence of an old popular idea that a branch of that river fell into the Adriatic near its head. The peninsula is about 50 miles in length, with an average breadth of between 30 and 40 miles, and an area of about 1900 square miles. It is nearly triangular in form, and has for its apex the Pr. Polaticum, now the Punta di Promontore. A range of bare rocky mountains shooting off from the Julian Alps, traverses its whole length, and sends off lower and smaller ranges to the sea. The highest point of the central ridge is called the Monte Maggiore, and is about 4500 feet above the sea. The coast is rugged and rocky, but, except on its eastern side, neither bold nor picturesque. The numerous inlets and arms of the sea which indent it on every side form excellent harbours; that of Pola, in particular, was as famous in ancient, as it is in modern times. The rocks and shoals along the coast render these forts difficult of access, an additional advantage in the eyes of the ancient Istrians, who, like all the tribes of the Illyrian coast, were noted pirates. The soil of the peninsula, though not very fertile, is well adapted for olives, vines, and other fruit trees. The oil was held in high esteem by the Romans, and still maintains its high character. The mountains afford pasture for considerable herds of cattle, and, besides growing excellent timber, especially oaks, are valuable for their quarries of marble and freestone. The fisheries of the coast give employment to many hands both in taking the fish and in making the salt employed in curing them. Italy.

The ancient Istrians were of the same stock as their Illyrian neighbours, and like them became known to the Romans as pirates. They were first subdued by the Roman arms about the beginning of the second Punic War; in the following century it was found necessary to reconquer their country. The final annihilation of their independence was effected by C. Claudius in B.C. 177. Augustus incorporated their territory as a part of Italy, and it remained subject to Rome till the 6th century, when it fell into the hands of the Goths. The Goths were in their turn driven out by the emperors of the East, who retained Istria, till in the 10th and 11th centuries, it became subject successively to the dukes of Carinthia and Dalmatia. In the 13th century the western part of the peninsula, as far as the River Arsa, was seized by the Venetians, and retained by them till the overthrow of their republic in 1797. The eastern part of it finally fell into the hands of the Austrians, who united it to Carinthia. Western Istria, sharing the fate of the other possessions of Venice, was, by the treaty of Campo-Formio, likewise made over to Austria. The treaty of Presburg made the French masters of all the Venetian provinces till the downfall of Napoleon in 1813. From that date till 1849, Istria formed part of the government of Trieste. A new territorial arrangement of the Austrian possessions was made in 1849, by which Istria was incorporated with the Küstenland. (See AUSTRIA, ILLYRIA, and KUSTENLAND.)

ITALY.

Name.

THE name *Italia* was originally applied to the extreme end of the peninsula, south of a line drawn from the Gulf of Squillace, *Sinus Scylaceus*, to that of Sta. Eufemia, *Sinus Terinæus*. By the time of Thucydides, in the 5th century B.C., the appellation had already extended to Metapontum on the E., and the Posidonian Gulf on the W. coast, thus including the whole of modern Calabria, and great part of the provinces of Basilicata and Salerno. The further extension of the name was contemporary with the progress of the Roman power, and at the time of Pyrrhus it included apparently the whole peninsula, except Liguria and Cisalpine Gaul. In the 7th century of Rome, though both Liguria and Cisalpine Gaul were still, in official usage, distinct from *Italia*, yet the latter name, as we gather from many passages in the classics, was already employed, in common acceptation, to designate the whole country from the Alps to the Sicilian Straits. The official acceptation was dropped as soon as Augustus, in his division of Italy, incorporated Liguria, Cisalpine Gaul, Venetia, and Istria.

The origin of the name has been referred to various sources, all equally uncertain. Greek and Roman tradition deduced it from the eponymous hero Italus, a supposed Œnotrian or Pelasgic chief; whilst Timæus, followed by Varro and Gellius, derived it from *Italos*, which in old Greek signified an *ox*, from the quantity of cattle bred in the country. *Græcia enim antiqua, ut scribit Timæus, tauros vocabat* Ἰταλούς, *a quorum multitudine et pulchritudine et fœtu vitulorum, Italiam dixerunt.*[1] The word *Vitulus* (calf) and *Italus* were, according to Festus, synonymous; and on the *denarii*, struck by the Sabellian nations during the Social War, B.C. 90–88, there occurs the word *Vitelu* for Italy.

In early times Italy was also called *Saturnia* from the Latin god Saturnus, *Œnotria* from an ancient chief Œnotrus, and *Ausonia* from the Ausones, the *Aurunci* of the Romans, who occupied the centre of the peninsula. All these names, however, seem to have belonged to particular districts, and to have been applied to the whole country only by the Latin and later Greek poets; indeed *Œnotria* would appear from Antiochus to have been synonymous with *Italia* in its original acceptation. The Greek poets applied to it sometimes the name *Hesperia*, on account of

[1] VARRO, *De Re Rustica*, ii. 5.

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its being to the westward of their country. The Germans called it *Waelshland*, because the parts nearest to them were inhabited by the Galles or Walles; and in their present language the name of Waelshland is still retained by the common people.

Divisions.

The loftiest range of mountains in Europe on the N.E., N., and N.W., and the sea on every other side, form the natural boundaries of Italy. The alpine chain, extending in a semicircular form from the Julian Alps at the head of the Adriatic to the Maritime Alps on the Gulf of Genoa, divides it on the N.E. from Illyria and the Tyrol, on the N. and N.W. from Switzerland, and on the W. from France, where the River Var (*Varus*) forms its boundary. From this alpine range, which may be called its basis, Italy projects S.E. in a peninsular form, and nearly in the shape of a boot, far into the Mediterranean Sea, which takes the different names of—Adriatic, *Mare Superum*, on the E. coast—Ionian, *Mare Ionium*, on the S.E. coast, from the Cape of Sta. Maria di Leuca to the Straits of Messina—and of Tyrrhenian, *Mare Inferum* vel *Tyrrhenum*, on the W. coast. According to these physical barriers, Trieste and the province of Istria on the E., and Nice on the W., would be excluded from Italy; but ever since Augustus extended its limits to the Var on the W., and the Gulf of Quarnero (*Sinus Flanaticus*) on the E., they have been reckoned as part of Italy. In the present political division of the Austrian empire, however, neither Istria nor Trieste are included in the Lombardo-Venetian kingdom, the limits of which are at the Isonzo, N.E. of Aquileia. Along the N. and N.W. frontier the limits of Italy have at different times undergone various, though insignificant changes; for the Alps, though presenting an unbroken line on a distant view, are so deeply indented with valleys as to make a natural boundary possible only by following the watershed, a course never or seldom adopted in political arrangements. But even the watershed would not mark the limits of different nationalities, as valleys which, by this criterion, should not belong to Italy, are inhabited by an Italian race; and German or French is spoken in districts which should be included in Italy.

The Italian peninsula is situated between the parallels of N. Lat. 46. 30. and 37. 54., and E. Long. 6. 38. and 18. 32.; if the islands are included, the southernmost parallel of Lat. is 35. 40. Its length in a direct line from the foot of the Alps near Aosta to the Capo di Sta. Maria di Leuca (*Iapygium Promontorium*) is about 600 miles, and to the Capo dell' Armi (*Leucopetra*) a little more than 660. Its breadth varies greatly. From the mouth of the Var to the head of the Adriatic, near the Isonzo, it is 300 miles; and if the line be carried to the head of the Gulf of Quarnero, near Fiume, it is more than 350. It narrows rapidly as it descends S.; and from Viareggio to Cervia is only 95 miles. Further S. it expands a little; and from Piombino to Ancona the breadth is 138 miles, and 150 from Capo di Licosa to Brindisi. From Diamante to the mouth of the Crati, in Calabria, it is 29 miles, and only 18 between the Gulfs of Sta. Eufemia and Squillace. It is surrounded by many islands, the principal of which are—on the E. coast the group of the Tremiti, N. of Monte Gargano, and S. Pietro and S. Paolo in the Gulf of Taranto; on the S., Sicily, the largest of all, the Lipari group, Pantelleria, Malta, and Gozo, 58 miles from Sicily; on the W., Capri, Procida, and Ischia, at the two extremities of the Gulf of Naples; the Ponza group opposite Gaëta, Giglio near Monte Argentaro, the two large islands of Sardinia and Corsica; and between the latter one and the coast of Tuscany are Pianosa, Elba, and Capraia. The most important of these are noticed under their respective heads in this work.

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The sea coasts of the peninsula, on the Tyrrhenian side, are, for the most part, protected by lofty acclivities, but on the Adriatic and the Ionian they are generally flat. The most remarkable capes or promontories of the peninsula are:—Delle Melle, Manara, Piombino, Argentaro, Circello, Miseno, Campanella, Licosa, Vaticano, Delle Armi, on the W. shore; Spartivento, Rizzuto, Nau or Colonne, Alice, Leuca, Gargano, on the S.E. and E. shore.

The extent and population of Italy, including its islands, are shown by the following Table, which is to be considered as merely approximative. In some of the states, the returns of population are not much attended to; and, with regard to their area, there is great discrepancy between the various authorities:—

Name of the States.	Episcopal sees.	Extent in square miles.	Jews.	Population.	Capital Cities.
Kingdom of the Two Sicilies—					
Naples	83	24,962	2,500	6,845,355	Naples.
Sicily	14	9,556		2,285,580	Palermo.
Kingdom of Sardinia—					
Piedmont and Riviera	26	15,397	4,250	3,946,450	Turin.
Island of Sardinia	11	8,228	...	552,665	Cagliari.
Lombardo-Venetian kingdom	20	13,208	7,000	5,503,473	Milan.
Papal States	68	12,120	12,800	3,065,000	Rome.
Grand Duchy of Tuscany (including Lucca)	21	6,784	7,180	1,817,500	Florence.
Duchy of Modena	4	1,629	2,680	606,300	Modena.
Duchy of Parma	4	1,712	630	508,800	Parma.
Republic of S. Marino	...	18	...	7,800	S. Marino.
	251	93,614	37,040	25,148,923	...
Corsica, belonging to France	1	2,850	...	236,251	Aiaccio.
Malta and Gozo, belonging to England	1	114	...	128,361	Valletta.
	253	96,578	...	25,503,535	

The most densely inhabited state is that of Lucca, which contains 525 individuals for every square mile; next to it come the Lombard provinces. The most thinly inhabited parts are the Campagna of Rome and the Island of Sardinia. Italy has more populous towns than any other state of Europe of the same extent. Naples has more than 400,000 inhabitants; Milan, Turin, Rome, and Palermo each more than 150,000; Florence, Venice, and Genoa more than 100,000; Leghorn, Messina, Verona, and Bologna more than 60,000; Parma, Padua, and Catania more than 40,000; Mantua, Bergamo, Brescia, Ferrara, Modena, Piacenza, Ancona, and Bari, more than 30,000, &c.

The division of Italy into Northern, Central, and Southern, is neither political nor strictly geographical, but is adopted sometimes as a convenient designation of some parts of the country. According to the general acceptation in the peninsula, Northern Italy is understood to include Piedmont and the Riviera, Lombardy, the Venetian, Parma, Modena,

and the States of the Church, as far as an imaginary line from the Gulf of Spezia to Ravenna; Central Italy includes Tuscany and the rest of the States of the Church; and Southern Italy the kingdom of Naples. The division in more common use among natives is into Upper and Lower Italy, the former applying to the portion N. of the Apennines and to the Riviera, the latter to all the rest of the peninsula.

Physical geography.

The face of the country is much diversified by mountains, of which those forming its N. and N.W. boundary have been described in this work under the article ALPS. A second range of mountains, running through its whole length, determines its configuration and its physical character. From the earliest historical times they were called *Apennines*,—a name supposed of Celtic origin, from its containing the root *Pen*, which in Celtic dialects signifies height or head.

The Apennines may be regarded as a great offshoot of the Alps, from which they branch off near the Gulf of Genoa; but as there is no regular break in the chain, much difference of opinion has prevailed as to the point of their real commencement. Polybius extends the Apennines nearly as far as Marseilles; Strabo, on the contrary, extends the Maritime Alps to Vado, and states that the Apennines begin near Genoa. The latter opinion has been adopted by the best modern geographers, who fix the junction of the Maritime Alps and the Apennines in the valley of the Bormida, W. of Savona, where the range, which does not exceed the height of 1300 feet, presents the nearest approach to a break.

Their main range follows at first the sea-coast in a N.E. direction, till it forms the mass of Bocchetta, at the head of the Gulf of Genoa, where it makes a bend, and, increasing in breadth and height, proceeds eastward to Pontremoli; N. of the latter place the range makes another bend, and strides across the peninsula in a broad, unbroken mass E.S.E. till it approaches the Adriatic, so as to send down its lower slopes towards Rimini. In this part of their course, which forms the S. barrier of the great plain of Upper Italy, the highest peaks of the Apennines are Monte Cimone, to the N. of the Baths of Lucca, 6975 feet in height, and Monte Falterona. From Monte Nerone, 5011 feet, where the Metauro (*Metaurus*) rises, and Monte Catria, 5586 feet, S. of Urbino, the range proceeds S.E., not far from, and almost parallel with, the coast of the Adriatic, to which its lower skirts descend. Increasing in bulk, it then swells into the masses of Monte Sibilla, N.E. of Norcia, 7200 feet, where are the sources of the Nera; and of Monte Terminillo or di Lionessa, 6998 feet. Here the Apennines diverge into two main ranges, of which the eastern one, the loftiest, keeps along the Adriatic, and forms Monte Corno, or the Gran Sasso d' Italia, their highest peak, 10,207 feet; Monte Morrone, 6862 feet, which rises abruptly behind Solmona (*Sulmo*); and Monte Amaro, the highest summit of the Maiella, 8956 feet. This branch has been sometimes considered as an offshoot, for it is almost entirely drained by rivers falling into the Adriatic. But it is evident that it belongs to the principal chain, and that before the Aterno had opened its way through the narrow gorge of Intermonti, the Valley of Solmona must have formed an inland basin similar to, though lower in level than Lake Fucinus. The other range, sweeping round the head of the Aterno, and separating its valley from that of the Salto and Velino, swells into Monte Velino, 8180 feet, standing nearly in the centre of the peninsula; and then, after inclosing the basin of Lake Fucinus, forms the high summit of Monte Greco, 7875 feet. The two ranges reunite in the Piano di Cinquemiglia, the coldest and most wintry spot in Italy. It is a high table-land, 4298 feet, inclosed by much higher mountains, and divides the upper basin of the Sangro from the valley of Solmona. The chain proceeds from the group of Monte Greco, round the head of the Sangro, in a S.E. direction, and, keeping in the centre of the peninsula, attains, at La Meta, an elevation of 7480 feet. Proceeding southwards, it incloses the source of the Volturno, and forms the group of the Matese, 6745 feet, on the N.E. of the Campanian Plain. It is in their course from the group of Monte Sibilla that the Apennines, attaining their greatest elevation, exhibit the nearest approach to alpine scenery. As they descend further south, they gradually diminish in height, though still rising occasionally to great elevation.

From the Matese, the main range follows a S.E. direction in the centre of the peninsula, in an irregular and confused mass, to the group of mountains between Bisaccia and S. Angelo de Lombardi, in Lat. 41. At this point it takes a sudden bend W. to Monte Terminio, 5680 feet, at the head of the Ofanto, and there, after dividing the valleys of the Sele, the Ofanto, the Calore and the Sabbato, turns E. and proceeds to form the group of mountains N. of Potenza, which divide the basin of the Ofanto from that of the Bradano, and with their branches spread over most of the surface of the province of Basilicata. From that group the main range takes a S. course, approaches the Tyrrhenian Sea near the shore of the Gulf of Policastro (*Laus Sinus*), and in entering Calabria, forms the high table-land of Campotenese, on the E. of which, Monte Dolcedorme, the summit of the Pollino, rises to 6875 feet. The range afterwards keeps along the shore of the Tyrrhenian Sea to Monte Cocuzzo, 5620 feet, W. of Potenza, where it turns E., divides the basins of the Crati and the Savuto (*Ocinarus*), and after spreading over a considerable surface of table-land, called *Sila*, sinks rapidly as it extends southwards, and offers almost a complete break between the two gulfs of Sta. Eufemia and Squillace. Here the neck of land, 18 miles broad, is so low as to have suggested, at two different periods, the idea of a canal across it; to Dyonisius the elder, in the fifth century B.C., and in the last century to Charles III., king of Naples. South of the Rivers Lamato and Corace (*Crotalus*), (the former emptying itself into the Tyrrhenian, and the latter into the Ionian Sea), the range of the Apennines rises again, and extends along the end of the peninsula, the original *Italia*, nearer the E. coast, till it forms the mass of the Aspromonte, 4512 feet, the slopes of which are washed by the Ionian and Sicilian Seas. The Straits of Messina can scarcely be considered as the end of the chain. The narrowness, the indentations, and the geological formation of the two coasts are such as to favour the inference that before the sea found its way through the range, the Apennines followed their course through Sicily in a W. direction from Cape Peloro (*Pelorum*), to Cape Boeo (*Lilybæum*), the extreme W. point of the island.

Having so far traced the main range by the watershed of the Apennines, we shall proceed to notice the most important of the numerous offshoots. On the N.E. declivity of the range, from its commencement to the high table-land of the Piano di Cinquemiglia, there are numerous but low and short spurs. The ranges of hills, especially those that descend into the plain of Lombardy, branch off uniformly at right angles from the central chain, and differ but little in length from one another. South of the Piano di Cinquemiglia several lofty offshoots descend towards the Adriatic, dividing the basins of the Sangro, the Trigno, and the Biferno, and forming the N.W. boundary of the Apulian Plain, which, on the S.E., is inclosed by a low ridge of tertiary hills, known by the local name of *Le Murgie*. The latter hills branch from the group of mountains near Lagopesole, S. of Monte Vulture, and after sending a small shoot towards Venosa (*Venusia*) and Minervino, proceed in an E. direction, and gradually diminish in height as they approach the head of the Gulf of Taranto; then cross the province of Otranto in its length (where they at-

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tain to but a very insignificant elevation), and end in the Capo di Sta. Maria di Leuca.

It is on the S. side of the Apennines that we have to look for their most remarkable offshoots. As soon as they begin to recede from the coast of Genoa, and take, beyond Pontremoli, an E.S.E. direction, they send down a rugged ridge, which separates the valleys of the Magra (*Macra*), and the Serchio (*Auser*), and forms the group near Massa and Carrara (known for their marble quarries), of which Pizzo d'Uccello is 5800 feet high.

The greater part of Tuscany consists of a series of valleys formed by minor offshoots of the Apennines descending towards the Tyrrhenian Sea. As soon as the main range has reached the frontier of the Abruzzi, it projects westward a lofty and important branch, which, under different names, forms, in part, the boundary between the Papal and the Neapolitan states, and separates the basin of the Garigliano from that of the Teverone, and from the Pontine Marshes. Spreading over the country of the ancient Sabines and Volscians, it sweeps round the volcanic group of the Alban Hills, forms the N.W. boundary of the Campanian Plain, overhangs Terracina, and ends in the Gulf of Gaëta, leaving between the two latter places a hollow in which lies the small lake of Fondi (*Lacus Amyclanus*). From the group of the Matese another lofty offshoot, taking a S. direction, incloses on the E. the Campanian Plain, and forms the mountain group S. of Avellino, where it divides into two branches. One of these taking an E. course rejoins the main range towards Monte Terminio; the other bending S.S.W. forms the *Montes Lactarii* (the highest of which, Monte St Angelo, overhanging Castellamare, is 4722 feet), and after dividing the Gulf of Naples from the Gulf of Salerno, ends in the Punta della Campanella (*Prom. Minervæ*), opposite the island of Capri. Beyond Salerno another offshoot of the main range sweeps round the plain of Pæstum, and after forming the hilly district of the Cilento, ends in the promontory of Licosa, on the Tyrrhenian Sea.

For the greater part of their course towards the N., the Apennines, like the Alps, exhibit rather a uniform ridge, of no great breadth, with transverse valleys descending on each side towards the sea; but in their S. course, from the N. frontier of the Abruzzi to Calabria, they display features peculiar to themselves. They spread to a considerable breadth, divide into numerous irregular groups and ranges, through which there are narrow passages, and which, by maintaining a general parallelism, inclose highly fertile though elevated valleys, and then reuniting, form the high table-lands of the Piano di Cinquemiglia, Campo Tenese, and Sila. The most remarkable passes and valleys of this kind are,—the high valley of Leonessa, shut in on every side by mountains; the valley of Rieti (*rosea rura Velini*), whence the defile of Antrodoco (*Interocrea*), through which the River Velino emerges, leads to the upper valley of the Aterno; the pass of Tagliacozzo, leading from the valley of the Teverone to the basin of Lake Fucinus, through which the ancient *Via Valeria* passed; the narrow gorge of Intermonti, cut by the Aterno through the lower shoots of Monte Corno and the Maiella; the valley of Boiano, the *Boviana claustra* of Silius Italicus, on the N.E. of the Matese; the pass of Arpaia, supposed to be the Caudine Forks of the Romans, which opens a communication between the Campanian Plain and the valley of Benevento; the Val di Bovino, a long defile leading from the upper valleys of Principato Ultra to the Apulian Plain; and the valley of Diano, through which the high road to Calabria is carried.

None of the summits of the Apennines are covered with perpetual snow; which, however, remains all the year round in the chasms and hollows of Monte Corno, the Maiella, Monte Greco, and Monte Pollino. The lower slopes of the range are well wooded, but the lofty peaks or ridges are generally bare rocks. Their geology and mineralogy, with the exception of a few districts, have not been sufficiently explored. There is no doubt that the greatest bulk of the range is of limestone, but other rocks appear oftener and to a greater extent than is generally supposed. Monte Corno and other peaks in the Abruzzi are of compact quartz, which abounds also in Calabria. Serpentine crops out in large masses near Sestri on the Riviera, on the flanks of Monte Pollino, and of the Terminio, &c. Extensive beds of lignite, and it is supposed of coal, exist in the Abruzzi, near Lettomanoppello; on the N.E. slopes of the Maiella; in the mountains of Giffuni and Monte Corvino, E. of Salerno; and on the S. slopes of the Sila in Calabria. Granite, porphyry, and gneiss, cover large tracts of the south portion of the range, and the great mass of the Aspromonte, at the toe of the boot, consists almost entirely of primitive rocks.

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A few detached mountains are found in Italy, which, though geologically similar to, yet geographically do not belong to the chain of the Apennines, from which the largest of them is at a considerable distance. The most important of these, arranged according to their size, are—Monte Gargano (*Garganus*), an isolated mass, at the E. end of the Apulian Plain, projecting considerably into the Adriatic; Monte Argentaro (*Mons Argentarius*), a lofty promontory rising in the Tyrrhene Sea, opposite the small island of Giglio, from the lagoon of Orbitello, which separates it from the mainland; Monte Circello (*Mons Circeius*), which stands like a gigantic beacon at the S. extremity of the Pontine Marshes; last in size, but greatest in interest, Monte Sto. Oreste (*Mons Soracte*), a mass of secondary limestone, rising like an island 2000 feet from the midst of the volcanic tufa of the Campagna, about 25 miles, as the crow flies, from Rome.

The Italian peninsula presents four distinct volcanic districts. Three of the volcanoes are entirely extinct, while the fourth is still in great activity. These districts are,—

1*st*, The Euganean Hills, a small group extending for about 10 miles from the neighbourhood of Padua to Este, and separated from the lower offshoots of the Alps by the wide plain of the Padovano. Monte Venda, their highest peak, is 1806 feet.

2*d*, The Roman district, the largest of the four, extending from the hills of Albano to the frontier of Tuscany, and from the lower slopes of the Apennines on the E. to the Tyrrhene Sea on the W. It may be divided into three groups,—the Monti Albani, the highest of which, Monte Cavi, 3160 feet, is the ancient *Mons Albanus*, on the summit of which stood the temple of *Jupiter Latialis*, where the assemblies of the cities forming the Latin confederation were held; the Monti Cimini, which extend from the valley of the Tiber to the neighbourhood of Civita-Vecchia, and attain, at their culminating point, an elevation of more than 3000 feet; of Radicofani and Monte Amiata, the latter of which is 5794 feet high. The lakes of Bolsena (*Vulsiniensis*), of Bracciano (*Sabatinus*), of Vico (*Ciminus*), of Albano (*Albanus*), of Nemi (*Nemorensis*), and other smaller ones, belong to this district; and between its S.W. extremity and Monte Circello are the Pontine Marshes (*Palus Pontina*), a broad strip of alluvial soil infested by malaria.

3*d*, The volcanic region of Terra di Lavoro (*Campania Felix*), which is separated by the Volscian Mountains from the Roman district. It may be also divided into three groups,—of Roccamonfina, at the N.N.W. end of the Campanian Plain, where the highest cone, called Montagna di Santa Croce, is 3200 feet,—of the Phlegræan Fields, embracing all the country round Baiæ and Pozzuoli, and the adjoining islands. Monte Barbaro (*Gaurus*), N.E. of the site of Cumæ; Monte S. Nicola (*Epomeus*), 2610 feet, in

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Ischia; and Camaldoli, 1488 feet, W. of Naples, are the highest cones. The lakes Averno (*Avernus*), Lucrino (*Lucrinus*), Fusaro (*Palus Acherusia*), and Agnano, are within this group, which has shown activity in historical times. A stream of lava issued in 1198 from the crater of the Solfatara, which still continues to exhale steam and noxious gases; the Lava dell' Arso came out of the N.E. flank of Monte Epomeo in 1302; and Monte Nuovo, N.W. of Pozzuoli, and 440 feet high, was thrown up in three days in September 1538. Since its first historical eruption in A.D. 79, Vesuvius or Somma, which forms the third group, has been in constant activity, its last eruption having taken place in May 1855. The Punta del Nasone, the highest point of Somma, is 3747 feet, and the Punta del Palo, the highest point of the brim of the crater of Vesuvius, was, in 1847, 3949 feet high.

4th, The Apulian volcanic formation consists of the great mass of Monte Vulture, which rises at the W. end of the plains of Apulia, on the frontier of Basilicata (*Lucania*), and is surrounded by the Apennines on its S.W. and N.W. sides. Its highest peak, the Pizzuto di Melfi, attains an elevation of 4357 feet: within the widest crater there are the two small lakes of Monticchio and S. Michele.

In connection with the volcanic districts, we may mention *Le Mofete*, or Pools of Amsanctus (*Amsancti Valles*), lying in a wooded valley S.E. of Frigento, in the centre of the Neapolitan province of Principato Ultra, and described by Virgil, *Æneid*, vii. 563–71. The largest of the two is not more than 160 feet in circumference, and 7 feet deep. These pools emit noxious gases (carbonic acid and sulphuretted hydrogen), which, when wafted from the pools by the wind, endanger animal life in the open air. Birds are occasionally killed, whilst crossing the valley, by the mephitic vapours.

The volcanic districts of the Italian islands of Sicily, Sardinia, Lipari, Ponza, &c., will be found noticed under their respective articles. See also ÆTNA, VESUVIUS, VULTURE.

The range of the Apennines, by the shifting which we have noticed of their direction from sea to sea in their course through the peninsula, form six principal basins, besides several smaller ones, which we shall briefly notice.

1. The basin of the Po and the Adige, extending from the Alps to the Apennines, and comprising nearly the whole of Upper Italy, is the largest uninterrupted extent of highly fertile alluvial land in Europe. On its N. frontier, at the foot of the Alps, is a series of lakes, which, being never frozen in winter, feed numerous streams, and serve the purpose of internal navigation.

The Lago Maggiore or di Locarno (*Verbanus*), the most westerly of these lakes, is nearly 50 miles long, and varies in breadth from 5 to 8 miles. It reaches a depth of 2624 feet. It contains the *Borromean Islands*, already described in this work. The Lago di Lugano is about 24 miles in length, and from 2½ to 6 in breadth. It is of great depth, and its surface is 870 feet above the level of the sea. The Lago di Como (*Larius*) is of great depth, and surrounded by high abrupt mountains, which constitute the romantic beauty of its borders. It is 27 miles long, or 33, if the small Lago di Riva at its N. end be included, and in no part exceeds 3½ miles in breadth. The Lago d'Iseo (*Sebinus*), 18 miles long and 5 broad, is 630 feet above the level of the sea, and in some parts has a depth of 985 feet. In its centre there is an island 1½ mile long. The Lago d'Idro is only 7 miles long. The Lago di Garda (*Benacus*), the largest of all the lakes of Italy, is nearly 40 miles in length and 10 miles in its greatest breadth. Its surface is 255 feet above the level of the sea, and its greatest ascertained depth is 941 feet.

This part of Italy abounds in rivers. The principal of these is the Po (*Padus*), the largest river in Italy. It originates in the Monte Viso (*Vesulus*), one of the highest summits of the Western Alps, 12,000 feet high, S.W. of Turin, and after a course in an E. direction of more than 380 miles, including its windings, enters the Adriatic by many mouths, which form a kind of delta somewhat similar to that of the Nile. It receives numerous tributaries, the most important of which are,—on its northern side the Dora Baltea (*Duria Major*), the Ticino (*Ticinus*), the Adda (*Addua*), the Mincio (*Mincius*); all flowing from the S. slopes of the Alps; and, on its southern bank, the Tanaro (*Tanarus*), the Scrivia, the Trebia, the Panaro (*Scultenna*), the Reno (*Rhenus*), flowing from the N. slopes of the Apennines. A more detailed description of this important river, and of the dykes or embankments by which it is inclosed, will be found under the head Po in this work. The next considerable river of Upper Italy is the Adige (*Athesis*). It rises in the Rhaetian Alps, in the German Tyrol, where it is called *Etsch*, in a small lake near the modern village of Reschen, and after receiving the Eisach and other small tributaries, it flows past Trento, emerges into the plain of Italy at Verona, and after a course of 200 miles enters the Adriatic a few miles N. of the Po.

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The lakes of Upper Italy are of unspeakable advantage both as regards the internal communications and the cultivation of the country. As the slope of the land from these lakes to the Po is regular and gentle, nature has thereby furnished the means of distributing the water over an extensive portion of the land, and in that due proportion which the nature of the soil, or the description of the crop, may require. By an ingenious system of canals, which dates at least from the twelfth century, streams of water are made to pass rapidly over the fields that require it, and what is not absorbed by the earth is received into canals, and at lower elevations again passed in a similar manner over other fields, till the surplus fluid at length reaches the Po. A full description of the origin and of the various modes of disposing water to the greatest advantage peculiar to this part of Italy, has been already given in this work in the articles IRRIGATION and HYDRODYNAMICS. A detailed notice of the basins of the Po and the Adige, of its lakes, its divisions, its agriculture, &c., will be found also in this work in the articles given under the separate heads of LOMBARDY, and SARDINIA.

2. The sweep of the Apennines between the parallels of N. Lat. 44. and 42. 30., leaves on their W. side an extensive tract of country, constituting the whole of Tuscany and considerable part of the Roman States, and forming the basins of the Arno (*Arnus*) and the Tiber. These two principal rivers of Central Italy rise at a short distance from each other; the Arno in Mount Falterona, and the Tiber in Mount Coronaro; and at first both take a S. course till the Arno approaches within a few miles of Arezzo, where the difference of level of the district intervening between the two basins is such, that, by an artificial canal through the Val di Chiana, the Arno might be brought to flow into the bed of the Chiana, and to join the Tiber below Orvieto. From near Arezzo the range of hills that extend towards Siena drive the Arno into a N.W. direction, till it is joined by the Sieve, when it makes a sudden turn W., flows through Florence, and, after a course of 140 miles, enters the sea by an artificial canal 6 miles below Pisa. The Tiber, on the contrary, continues its course due S. to the foot of the hill on which Todi stands, whence it follows a S.W. course till it is joined by the Chiana, when it flows S.E. till within about 20 miles from Rome. It takes then a S.W. direction, and, after a course of 198 miles, falls into the sea at Ostia. It receives many tributaries, of which the most important are the Chiana (*Clanis*), on the right side; and on the left the Nera (*Nar*), and the Teverone (*Anio*). The Tiber is turbid (*flavus*), rapid, and deep. The basins of the Arno and the Tiber are separated by the volcanic groups of the Monti Cimmini and the Monti Amiata, and by the ridge of tertiary

Italy. hills near Siena, in which the Ombrone (*Umbro*) and other smaller streams have their source. The Lake of Perugia (*Thrasimenus*) belongs to the basin of the Tiber. It is 26 miles in circumference, and has three small islands. Its bed has been gradually raised by vast quantities of alluvial deposit carried into it by the rain, and its greatest depth at present is only 21 feet.

3. The Campanian Plain, the most fertile district in Italy, inclosed on three sides by the Apennines, and on the fourth, the S.W., by the sea, forms the basin of the Garigliano (*Liris*) and the Volturno (*Vulturnus*), the latter of which rises at the foot of the mountains of Rionero, near the village of Castellone, and after a tortuous course (from which it is supposed to have derived its name) flows round Capua, and enters the sea 15 miles W. of that city. Its principal tributary is the Calore (*Calor*), which has already been joined by the Sabbato (*Sabatus*), below Benevento. These two rivers rise at no great distance from each other in the group of Monte Terminio, where also are the sources of the Ofanto and the Sele, and drain an extensive tract of country inclosed by the Apennines. The Garigliano, which, as far as Ceprano, still retains its classic name of Liri, rises below the village of Cappadocia, 5 miles S. of Tagliacozzo, in the Abruzzi, runs S.E. through the valley of Roveto; on issuing from which, at Sora, it bends S. to Ceprano, where it turns again S.E. towards Pignataro, and thence due S. to the sea only 12 miles N. of the mouth of the Volturno; the beds of the two rivers being separated by an offshoot of the Apennines, and by the volcanic group of Roccamonfina. Among the tributaries of the Liris is the small classic Fibreno (*Fibrenus*), which rises at once with a considerable volume of water near the village of Posta, at the foot of a group of mountains S. of Lake Fucinus, of which the Fibreno is supposed to be one of the subterranean channels. This lake, which we have already noticed as being inclosed in an upper valley of the Apennines, is the largest in S. Italy; it is 35 miles in circumference, and has an area of 36,315 acres, and, though fed by several streams, has no visible outlet. Its greatest depth is 52 feet, and its surface is 2176 feet above the level of the sea. It is known to have been entirely frozen over in 1167, 1229, 1595, 1683, and 1726. As its shores are subject to great inundations, the Emperor Claudius constructed a tunnel about three miles and a half long to convey its surplus waters into the Liris. This tunnel was allowed to fall into disrepair during the middle ages.

4. The plain which, sloping gently over a breadth of thirty miles from the E. side of the Apennines to the sea, extends more than eighty miles in length from the Biferno (*Tifernus*), to Barletta, a few miles S. of the mouth of the Ofanto, is known by the local name of *Tavoliere di Puglia*, or *Puglia Piana*, and is intersected by several streams, of which the Ofanto is the only important one. At the E. end of this plain, where it approaches the isolated group of Mount Gargano, are the small salt lakes of Lesina (*Lacus Pantanus*), Varano, Salpi (*Salapina Palus*), and Pantano Salso, the latter of which receives the Cervaro (*Cerbalus*), and the Candelaro. The Ofanto (*Aufidus*), the principal river of S. Italy, rises from the group of the Terminio, about 25 miles from the Gulf of Salerno, flows E. through the rugged mountain country, which is the frontier of the provinces of Salerno, Avellino, and Basilicata, flows round the basis of Mount Vulture on the N. side, and crossing the Apulian Plain, enters the Adriatic midway between the Lago Salpi and the town of Barletta. It has much of the character of a mountain torrent, being swollen rapidly by heavy rains in winter, while in summer the volume of its water is very small. The soil of the Tavoliere is of a calcareous nature, and well adapted for the growth of wheat. In winter it forms the excellent pasturing ground on which graze the countless flocks that descend at that season from the high valleys of the Abruzzi.

5. The basin of the Sele (*Silarus*), includes the plain which extends about 28 miles in length from the neighbourhood of Salerno, to the S. of Pæstum, and 12 miles in its broadest part. The Sele rises at once in a large volume at a place called Caposele, near the source of the Ofanto, and takes a S. direction till it receives the Negro (*Tanager*), which drains the valley of Diano; it then turns S.W., and enters the Gulf of Salerno, 4 miles N. of the site of Pæstum. Italy.

6. The Apennines, in their course S. through Basilicata, after sending E. the offshoot of Le Murgie, form a sloping plain, which, with scarcely any interruption, extends nearly 100 miles along the shore of the Ionian Sea from Tarentum to Capo del Trionto, and varies from 24 miles to only 2 miles in breadth. It is traversed by numerous streams of classical associations; the Bradano (*Bradanus*), the largest, which rises in the mountains near Rionero, S. of Venosa, and following a S.E. course, enters the sea N. of the site of ancient Metapontum; the Basiento (*Casuentus*), the Salandrella, the Agri (*Aciris*), the Sinno (*Siris*), the Calandro (*Acalandrus*), and the Crati (*Crathis*), next in size to the Bradano, which rises S. of Cosenza in the table-land of Sila, flows at first in a due N. direction, and afterwards turns abruptly E., and 5 miles before entering the sea, is joined by the Coscile (*Sybaris*). This district, which, from the frequency of floods, and the want of drainage, is now infested with malaria and very scantily inhabited, was in former times famous for its fertility, and was the seat of the large and opulent Grecian cities of Metapontum, Heraclea, Sybaris, and Thurii.

Between the plain of Lombardy and the Apulian Plain, there are a great many streams flowing almost due E. into the Adriatic. The largest of them are,—the Tronto (*Truentus*), the boundary between the Papal and the Neapolitan states; it rises in the mountain group of Amatrice; the Pescara, which, from its source W. of Monte Corno to Popoli, retains the ancient name of Aterno (*Aternus*). From the upper part of its course through a deep valley, where its bed has an elevation of 2000 feet, it descends through a narrow gorge into the valley of Solmona, whence it issues by the pass of Intermonti, and flowing through the plain below Chieti, enters the sea with a considerable volume of water at the fortress of Pescara. The Sangro (*Sarus*) rises near Gioia under the mountains S.E. of Lake Fucinus, runs in a very elevated upper valley, from which it escapes through a very deep and narrow gorge below Barrea, winds its course round the hill on which Castel di Sangro is built, runs through the valley that divides the south offshoots of the Maiella from the mountains of Agnone, and reaches the plain of Lanciano, where it enters the Adriatic.

All the rivers of Italy are subject to sudden and very heavy floods, and with the exception of the Po, the Adige, and the Tiber, have their volume of water greatly reduced in summer. The insignificant amount of tide in the Mediterranean renders most of them useless for navigation.

Climate. In a country extending through 10 degrees of latitude there must be great differences of climate, and consequently of vegetation and agriculture, from position alone. Besides that, however, the climate of Italy is modified to such a degree by the ranges of the Alps and Apennines, and by the air of the sea along its coasts, as to render useless any division into regions according to the classification of Saussure. In the plains of Lombardy and Piedmont, and the other territories to the N. of the Apennines, which are inclosed by mountains on every side but the E., Fahrenheit's thermometer in winter descends to 10 degrees; snow lies sometimes a fortnight on the ground, the lagoons at the mouths of the rivers are frozen, and slight night frosts appear early in November, and some years as late as April. Delicate plants do not thrive except in sheltered situations, but the mulberry trees flourish, rice is grown, and the pastures are rich. South of the Apennines, that part of Tuscany

Italy. and the States of the Church which is near their main range is subject to great cold, but westwards, and along the Riviera, the temperature grows milder, snow seldom lies long on the fields, and the climate is suitable to the growth of the olive and the orange. But it is when we reach the central range of the Apennines that we find the coldest districts of Italy. In all the upland valleys of the Abruzzi and of Sannio, snow begins to fall early in November, and heavy storms occur often as late as May; whole communities are shut out for months from any intercourse with their neighbours, and some villages are so long buried in snow that regular passages are made between the different houses for the sake of communication among the inhabitants. The district extending from the S.E. of Lake Fucinus to the Piano di Cinquemiglia, and inclosing the upper basin of the Sangro and the small lake of Scanno, is the coldest and most bleak part of Italy south of the Alps. Heavy falls of snow in June are not uncommon, and it is only for a short time towards the end of July that the nights are totally exempt from light frosts. Yet, less than 40 miles E. of this district, and even more to the N., we find the olive, the fig-tree, and the orange, thriving luxuriantly on the shores of the Adriatic from Ortona to Vasto. In the same way, whilst in the plains and hills round Naples snow is rarely seen, and never remains long, and the thermometer seldom descends to the freezing point, 20 miles E. from it in the fertile valley of Avellino, of no great elevation, but encircled by high mountains, light frosts are not uncommon as late as June; and 18 miles further E., in the elevated region of S. Angelo de' Lombardi and Bisaccia, the inhabitants are always warmly clad, and vines grow with difficulty and only in sheltered places. But nowhere are these contrasts so striking as in Calabria. The shores, especially on the Tyrrhenian Sea, present almost a continued grove of olive, orange, lemon, and citron trees, which attain a size unknown in the N. of Italy. The sugar-cane flourishes, the cotton-plant ripens to perfection, the date-trees are seen in the gardens, the rocks are clothed with the prickly-pear or Indian-fig, the inclosures of the fields are formed by aloes and sometimes pomegranates, the liquorice-root grows wild, and the mastich, the rosemary, the myrtle, and many varieties of oleander and cistus, form the underwood of the natural forests of arbutus and evergreen oak. If we turn inland but five or six miles from the shore, and often even less, the scene changes. High districts covered with oaks and chestnuts succeed to this almost tropical vegetation; a little higher up and we reach the elevated table-lands of the Pollino and the Sila, covered with firs and pines, and affording rich pastures even in the midst of summer, when heavy dews and light frosts succeed each other in July and August, and snow begins to appear at the end of September or early in October.

Along the shores of the Adriatic, which are exposed to the N.E. winds, blowing coldly from over the Albanian Mountains, delicate plants do not thrive so well in general as under the same latitude along the shores of the Tyrrhenian Sea.

It may have been gathered from the preceding sketch of the physical conformation and the climate of Italy, that it becomes difficult to take a general view of the state of its agriculture.

The cultivation of Savoy or Lombardy differs from that of Calabria as much as that of Massachusetts does from that of Carolina. In this work, therefore, the details of rural economy will be found under the heads of the several dominions into which Italy is divided; and in this place will only be noticed those results of agriculture which yield food, drink, or clothing to its inhabitants, or which form the basis of manufacturing industry, or the rudiments of foreign commerce. The cerealia form, as elsewhere in Europe, the chief aliment of the inhabitants; in Italy, however, the lower classes, who are the most numerous, subsist much on maize and beans, which requires little preparation to render it fit for food. In some of the southern parts wheat is made use of by the same class, both in the form of bread and in that of macaroni, which is manipulated with great facility. Wheat and maize are, on the average of years, about equal to the consumption, but little can be spared for exportation; and in many of the ports are depôts of foreign wheat kept to meet the variations of seasons, or to be used as articles of commerce with other countries. Italy.

As Italy produces abundance of wine, and consequently needs neither beer nor corn-spirits, no barley is needed for these drinks, and scarcely any is cultivated. Oats are but little grown, but abundance of beans of various kinds is produced. Rye, the common bread-corn of the far greater portion of Europe, is only raised in a few spots in the very northernmost parts of Italy, where it is made into bread for the poor; whilst those of the higher classes there, as well as throughout the whole peninsula in the cities, make use of wheaten bread. Rice grows in many parts, in fact wherever there is a sufficiency of water to insure a good produce, at such a distance from towns as not to be injurious to the health of the inhabitants. It is a part of almost every meal in families in easy circumstances, but is scarcely used by the families who are in circumstances that require the practice of great parsimony. A great variety of lupines are used as food, especially in the soups. In some parts of the mountainous regions, chestnuts are a substitute for corn as long as they last. Fruits are plentifully used, particularly figs, grapes, and melons, as food; whilst the cheapness of onions, garlic, tomatos or love-apples, and capsicums, render them valuable as condiments. The potato, which in the other parts of Europe has been so much extended of late years, has been but partially introduced into Italy; and, where it is cultivated, it occupies a very small proportion of the soil. Lettuces, asparagus, endive, artichokes, and several kinds of turnips and of carrots, are everywhere grown.

Animal food is far from being extensively used. The oxen yield in some parts excellent, in other very indifferent meat. The mutton is neither good nor abundant, but has been much improved of late years. Swine furnish a plentiful supply during the winter months; they are also prepared as bacon or hams, and above all as sausages, the fame of which latter has reached unto England under the name of the city of Bologna, where they were early and extensively prepared. The large dairy farms in Lombardy, in which the cheese known by the name of Parmesan is made, and the oak and chestnut forests of Calabria furnish the most and best swine's flesh.

The fisheries contribute largely to the supply of food in Italy, though, from the number of fasts still countenanced by the Catholic Church, not sufficient for the consumption; and the deficiency is procured by commerce with the English, French, and Americans, who convey to the sea-ports the salted cod-fish from the banks of Newfoundland. Their own fisheries on the coast give much occupation; the most considerable are those for the tunny, a very large fish, and for the anchovy, a very small one. These are conducted upon a large scale by joint-stock companies. The lakes and the rivers also yield some, though not a great proportion, of that kind of food which ecclesiastical restrictions render indispensable.

The sugar-cane is not cultivated in the south of Italy, as it is found, that in point of strength, as well as of cost, the sugar made from it does not succeed in a competition with that substance when imported from the West Indies.

The products of agriculture are sufficient for the clothing of all its inhabitants; for though wool is neither good

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nor plentiful, yet hemp and flax are grown everywhere, are manufactured at home, and, from the nature of the climate, linen can be substituted for woollen dress during most of the months of the year. Some raw wool is, however, imported to supply the manufactures, and some cloths both from England and France, together with (in Lombardy) those from the other Austrian provinces, especially from Bohemia. Some cotton is grown on the southern divisions of Italy, but not sufficient to furnish materials for their very insignificant manufactures of that article.

The chief product of Italian agriculture is the silk. It is produced in every part, and much of it is converted into articles of dress or of furniture, where it is collected; but the chief production of it is in Sardinia, Naples, and Lombardy, whence the looms of England, Prussia, Austria, Russia, and Germany, are supplied. The value of this commodity exceeds that of all the other productions of Italy which are exported to foreign countries. The manufacture has of late years made great progress, which it is still steadily maintaining. The great increase which has taken place in the propagation of the mulberry tree has, within the last thirty years, increased the quantity of raw silk to an extent that had never before been dreamed of.

Another very important Italian product, which is used partly as food, partly employed in home manufactures, and extensively exported as an article of foreign commerce, is the oil of the olive tree. It is used as a substitute for butter in the S., is much appropriated to the manufacture of many kinds of soap, and is exported to England for the use of our various fabrics, chiefly those of wool, and as a luxury at our tables. The planting and watching costs but little labour or expense, and in a few years the income more than recompenses the labour. The best olive oil is produced near Genoa, in Lucca, in Tuscany, and in Calabria; but it is plentiful throughout the whole of Italy, except in Lombardy and in Piedmont.

The wines of Italy are not very highly valued in other countries, and almost the whole that is produced is consumed at home. Those of the N. are for the most part disagreeably acid, and scarcely any of them are or can be preserved beyond one year. The vines are not so much grown in vineyards, as in the hedge-rows; a system which doubtless injures the quality of the wine. In the southern parts, however, where the vines are grown in low vineyards as in France, the wines are of a more fiery quality, and though prepared with little care, they only require to be better known to be esteemed by foreigners.

The minerals of Italy are of small value; and though mines of gold, silver, and copper were once wrought, the veins have been long exhausted. Some alum is found in the Papal dominions and the Neapolitan territory, some vitriol and antimony in Parma, and sulphur in the island of Sicily. In many places there are excellent marble quarries, the best near Verona and Carrara. Alabaster is found in many of the mountains. The salt manufactured on the sea-shore, and from saline springs, is more than is required for the home consumption, and a large quantity might be exported.

The commerce, trade, and manufacturing industry of Italy, differ in the different states. The statistics of these will be found under the heads of the respective states.

History.

The history of Italy before the rise of the Roman power is involved in obscurity, or clouded with indistinctness. Notwithstanding the learning and the ingenuity of modern antiquaries in collecting and reconciling the very scanty and often contradictory statements of ancient authors, very little deserving the name of history is known of the ethnography and the political divisions of the country at that early period. The names of the early inhabitants, however, as far as they can be ascertained, will be found in this work under the articles on the modern Italian states.

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The horizon begins to clear as Rome extends her conquests. In the northern part the Gauls were rude and fierce, and they the longest resisted the encroaching power; whilst lower down, on the Arno and the Tiber, there was a number of tribes, such as the Etruscans, the Samnites, and the Latins, who, in a kind of confederacy, though sometimes at variance with one another, long sought, and ultimately in vain, to defend their freedom against the rising and aspiring city. In the southern parts were Grecian colonies, with but little union, and frequently engaged in hostilities amongst themselves. When and by what means all these tribes became finally subjected to Rome, belongs to the history of that empire. The history of the conquered is swallowed up in that of the conquerors.

The fate of Italy was that of Rome till the dissolution of that colossal power. When the seat of empire was removed to Constantinople, Italy, though accounted a portion of the Western Empire, was treated as a dependent province, and continued with only the semblance of power, till a soldier of fortune founded the kingdom of Italy. A.D. 476 to 568.

Odoacer, who by his intrigues had raised himself to the command of the German mercenaries in the imperial service, gathered hordes of Heruli and other followers of Attila, besieged and captured Pavia, Ravenna, and Rome, and proclaiming himself king of Italy (Aug. 23, 476), put an end to the Western Empire. The conqueror consigned Romulus Augustulus, the last emperor of the West, to the Castrum Lucullanum, near Naples, where he was allowed to end his days in obscurity and confinement. Odoacer used as much prudence and humanity as could have been looked for in a rude conqueror; but his kingdom was of short duration. Theodoric, king of the Ostrogoths, at the instigation of the Emperor Zeno, who reigned in Byzantium, invaded Italy, and after defeating Odoacer at Aquileia (March 27, 489), and again near Verona, and on the Adda, besieged him in Ravenna. In 493 Ravenna surrendered, and Theodoric, who murdered Odoacer as they sat together at table, erected a sovereignty, which, besides the whole of Italy and Sicily, extended northwards to the Rhine and the Danube, and eastwards to the frontiers of Dacia and Macedonia. The only part not subjected was some islands in the lagoons of the Adriatic Sea, inhabited by those fugitives who had first found a refuge there from the ravages of Attila, after the fall of Aquileia (A.D. 452), and had there secured freedom, and, by the capability of defending themselves, laid the foundation of what subsequently became the republic of Venice. Under the government of Theodoric, the Goths multiplied rapidly, and Italy for a time enjoyed all the advantages of peace. By his external policy Theodoric had acquired the confidence of the other Gothic tribes, even in the remote regions that border on the Baltic Sea, and had introduced strong forms of government into Rhætia, Noricum, Dalmatia, and Pannonia. Though the jealousy of the emperor at Byzantium induced him to invade the territory commanded by Theodoric, and to employ both a large fleet and a powerful army, his attempts were repelled, and he retired from the contest.

Theodoric was not less successful against King Clovis, the leader of the Franks, who were checked in the midst of a career of victories in Burgundy.

Ravenna was the seat of the government of this prince, though he occasionally resided at Verona. He once visited Rome, where he was received with rapture by the populace, and with the highest marks of respect by the senators. Cassiodorus and Boethius, the last writers who can pretend to a place in the Latin literature, were among the ministers of Theodoric. His endeavours to amalgamate his Italian and Gothic subjects were much obstructed by the religious controversy between the orthodox and the Arians. Whilst adhering to the latter sect, he tolerated at first, and even honoured, many of the other profession; but in the later

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years of his reign, when the Emperor Justin began to persecute the Arians, Theodoric retaliated upon the orthodox; and in the disorders that followed, Boethius ended his days in prison, and his father-in-law, Simmachus, was executed.

Theodoric died in the palace he had built at Ravenna in 526, after having by his will divided his dominions between two grandsons, bequeathing Italy to Athalaric, then a boy of twelve years of age. The youthful sovereign was left under the pupilage of his mother Amalasontha, from which he was early withdrawn by the flatterers who surrounded him. His mother then entered into a negotiation with the Emperor Justinian, tending to secure a safe retreat to herself at Dyrrachium, in Epirus; but the death of Athalaric at the age of sixteen, from premature consumption, caused her to assume the power of the state. She was smothered in a bath on a small island in the lake of Bolsena by order of Theodatus, a husband she had chosen to be a sharer of the throne.

The imperial court was eager to take advantage of the unsettled state of Italy to reduce it again under subjection. Belisarius, the most renowned of the generals, was despatched, but with an inconsiderable force. He regained Southern Italy as far as Naples without any defensive steps being taken by Theodatus, who at last resigned his crown to Vitigis, who was elected by a solemn assembly of the Goths. The war began now to rage with great fury. Vitigis appeared before Rome, which had received Belisarius, and summoned it to surrender. After a siege of a year (March, 537–38), in which both besiegers and besieged fought with desperate fury, Vitigis, being threatened in the rear by the lieutenant of Belisarius, set fire to his camp, and proceeded by forced marches to invest Rimini. Belisarius would now have been able to subjugate the enemy but for the dissensions which broke out amongst the officers in command of the several divisions of the army of Justinian in 538. The chief command was then conferred on Narses, a eunuch, whose conduct at that period, whatever military merit he afterwards displayed, tended greatly to the injury of his sovereign's party. Vitigis recovered several strongholds, marched to Milan, and because it had admitted a Greek garrison, put to death all its inhabitants.

Narses was soon recalled, and Belisarius being reinstated in the supreme command, captured Ravenna, where Vitigis had in vain sought safety, and returned with numerous captives to Constantinople to receive the applause of the people and a splendid triumph. His departure revived the spirits of the remaining Goths, and the feeble efforts of the successive generals of Justinian were insufficient to crush the war. The handful of the barbarians chose Totila for their king, in the year 541; his progress was rapid, and almost without interruption. He captured Naples and besieged Rome, which, after an unsuccessful attempt to relieve it by Belisarius, who had been recalled from the wars of Persia, was compelled by famine to surrender in the year 546. After a useless occupation of Rome when it had been abandoned by Totila, Belisarius was recalled to Constantinople, and the command once more conferred upon Narses, who was furnished with troops, stores, and money, with a profusion widely different from the parsimony exercised towards his predecessor. He advanced with his forces by the head of the Adriatic Sea, and encountered and totally defeated the Goths under Totila, who himself was killed in the conflict. After his death, those who had escaped elected Tejas as their king; but he too was soon subdued by Narses, and with him terminated, in 553, the Gothic supremacy in Italy.

After these events, Italy became a province of the Eastern empire, of which Ravenna formed the capital, and in which the representatives of the emperor, the exarchs, fixed their residence. Narses, the first of them, was removed by Justin, the successor of Justinian, and in revenge for his dismissal and the insulting language of the Empress Sophia, he despatched a messenger to Alboin, king of the Longobards, inviting him into Italy. The Longobards are supposed to have been of Scandinavian origin, and to have gained a settlement between the Oder and the Elbe, in the reign of Augustus. They gradually descended towards the south and approached the Danube, which they passed to reduce, in pursuance of a treaty with Justinian, the cities of Noricum and the fortresses of Pannonia. Italy.

A D. 568 to 774.

They were thus established on the frontiers of the Roman empire, and had for neighbours two other tribes, the Avars and the Gepidæ, who were sometimes hostile towards each other, though commonly at peace, demanding and receiving what they deemed tribute, but which the imperialists denominated presents. The Avars and the Longobards, at the instigation or with the connivance of the Emperor Justin, jointly attacked the Gepidæ. The bravest of them fell in battle; their king Cunimund was slain, and his daughter Rosamund became the captive of Alboin, the chief of the Lombards, and by marriage shared that throne which had before been occupied by the daughter of Clovis, the king of the Franks.

The ambition of Alboin was excited rather than satisfied by the conquest of the Gepidæ, and the submission of the Avars to his authority. Fifteen years before, his subjects, as the confederates of Narses, had visited Italy; the mountains, the rivers, and the highways, were familiar to their memory. The report of their success, and the sight of the spoil, kindled in the rising generation the flame of emulation and of enterprise. Their hopes were encouraged by the spirit and eloquence of their leader. No sooner had Alboin erected his standard, than the native strength of the Longobards was multiplied by the adventurous youth of Germany and Scythia, and by the peasantry of Noricum and Pannonia, who had resumed the manners of barbarians.

The whole nation of the Longobards, accompanied by their allies, and attended by their wives, their children, and their cattle, began their march through the Carnic Alps in April 568. Leaving a strong garrison to guard the passes of the mountains at Forum Julii, the modern Cividale, which was erected into a dukedom under his nephew Gisulphus, Alboin passed without encountering any opposition, through the Venetian country, and the city of Aquileia opened its gates, most of the inhabitants having abandoned their homes at the approach of the invaders. Padua and some other cities were passed by, either because they did not intercept his progress, or because they were too strongly garrisoned. Vicenza, Verona, Trent, Brescia, &c., were easily occupied, and each city was garrisoned and entrusted to one of his officers with the title of Duke; and five months after his departure from Pannonia, the conqueror invested Milan, then the capital of Liguria, which was captured after a short siege, the principal people, with their bishop, Honoratus, having fled to Genoa. In Milan the ceremony of the inauguration was solemnly performed. Alboin was lifted on a shield in the midst of his troops, received the emblems of royalty then in use, and was proclaimed king of Italy.

From Milan Alboin sent out expeditions, which reduced Piacenza, Parma, and Modena, and the other inland cities in Æmilia and Tuscany. Pavia offered an obstinate resistance, but, after a siege of three years, it surrendered; and being strongly fortified, it was fixed as his place of residence, and long continued to be the capital of the Longobard kingdom. Whilst Alboin was taking the steps necessary to defend the dominions he had acquired, and to reconcile his new subjects to his rule, he was murdered in his palace at Verona, 28th June 573, at the instigation of his wife, who had been mortally insulted by the request of Alboin to drink out of the skull of her father, Cunimund, which he used as a goblet. The queen, with her paramour,

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made an attempt to obtain the command of the Longobards; but not succeeding in their purpose, they fled to the Roman garrison at Ravenna, where both perished most miserably. Clephis, a relation of Alboin, having been raised to the throne, extended the Longobard power to the gates of Rome; but he conducted himself with such cruelty, that he was killed by his own people, after a reign of eighteen months. His actions produced a dislike to monarchical power, and for ten years no king was chosen. The dukes who had been created among the chiefs of the Longobards acted in their respective territories as independent but allied sovereigns. Under this kind of government their power continued to extend, and that of the emperor gradually retreated before it. The want of a central authority was, however, soon discovered; and in 584 Autharis, the son of Clephis, was chosen as king, and, by his valour and prudence, established the throne securely. It is not necessary to enter into a minute history of the several kings of the Longobards. A kind of aristocratic monarchy was created, composed of thirty principalities, the chiefs of which were distinguished by the titles of dukes, counts, or barons, which, with the revenues of the land, were held as fiefs under the kings, and became gradually hereditary.

The islands of the Adriatic were formed into a republic, and the inhabitants, by electing, in 697, their first doge or duke, formed an independent and central government. The exarch appointed by the government at Constantinople held authority at the city of Ravenna, and had under his power Romagna, the Pentapolis, or five maritime cities of Rimini, Pesaro, Fano, Senigaglia, and Ancona, and almost the whole sea-shores of Lower Italy, where Amalfi, Naples, and Gaëta had their own dukes. The island of Sicily, and the capital, Rome, in which a patrician ruled in the name of the emperor, formed also parts of the imperial dominions.

Constantly pressed upon by the Longobards, the power and influence of Constantinople gradually declined; and its fall was hastened by the Emperor Leo, called the Isaurian, whose zeal in the destruction of images embittered the clergy of the orthodox church in Italy. The inhabitants of cities forcibly expelled the imperial authorities, and elected a senate, with consuls, as in the time of the Roman republic. In Rome itself a certain power was acknowledged in the bishop, which, on account of the sanctity of his character, was of a paternal nature; at first it was exercised in ecclesiastical affairs, but by degrees extended to civil matters, and in process of time arrived at temporal sovereignty. The popes, who were anxious to defend their territory against the Longobards, when the Byzantine court had neglected or abandoned them, applied for assistance to the Franks.

The original Longobard invaders, composed as they were of various tribes, comprised different religions, some of them still adhering to the ancient heathenism, whilst others had embraced the Christian religion, but with the heretical tenets of Arianism. These tribes had gradually been led to embrace the profession of the Roman Catholic Church. Luitprand, who ascended the throne in 712, was the last of that nation to abandon his heresies, which he did in the presence of Pope Gregory II., at Rome in 729; upon which the pontiff made a public renunciation of his allegiance to the imperial court, and withdrew all claim of obedience from it. The popes were, however, indisposed to form an alliance with Luitprand, whose vicinity to the capital of their diocese they viewed with suspicion. When the emperor was making preparations to invade Italy, in order to enforce his decrees for the destruction of images, Gregory III. addressed himself to Charles Martel, who then governed the Franks, and was the best commander, and the most powerful prince of Western Europe.

Gregory despatched an embassy to his residence, with numerous presents of holy relics. It was received with respectful distinction, and a treaty was speedily concluded, by which Charles engaged to march with an army into Italy in defence of Rome and of the church, in case any attack should be made by the emperor or the king of the Longobards. The Romans, on their part, were to acknowledge Charles as their protector, and to confer upon him the dignity of the consulship.

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Leo the Isaurian was succeeded by his son Constantine, surnamed Copronymus, who carried his rage against images to a greater extent than his predecessor, and forbade the worship of the saints and of the Virgin Mary. This occasioned new disturbances in Italy, and made the Romans more zealous than before to separate themselves from their dependence on Constantinople. Zachary, who had succeeded to the chair of St Peter, urged on Luitprand the restoration of the four cities, and also the district of Sabina, which had been seized upon thirty years before; and, in compliance with the representation, they were thus added to the sacred patrimony. Luitprand died in 744, after a reign of thirty-two years. His son Rachis, who succeeded him, was anxious to extend his dominions, and invaded the territory ceded to the holy see by his father, when Pope Zachary visited him, and, by his representation of the punishment hereafter to be inflicted on those who violated the rights of the church, so operated upon his mind, that he not only restored the towns and territory he had seized, but took the habit of a monk, and entered into the monastery of Monte Cassino, where he passed the remainder of his days, honoured as a saint by the other monks of the fraternity.

Astolphus succeeded his brother on the Longobard throne in 751. The exarchate of Ravenna and the duchy of Rome excited his love for conquest. The city, the capital of the first, was surrendered with little difficulty. He advanced towards Rome, and, arriving at Narni, sent an embassy to the pope, announcing his determination to enter that city, to seize the wealth of the Romans, and to impose a tax of a golden *solidus* on every one who would not swear him allegiance. Stephen, who then filled the papal chair, attempted by negotiation to avert the threatened storm; but failing to appease Astolphus, in imitation of his predecessor, he had recourse to the assistance of France. Pepin, the son of Charles Martel, now filled the throne of that kingdom, and professed unlimited obedience to the holy see. Stephen, by the consent, or at least connivance, of Astolphus, whose forces were encamped round the city of Rome, made a journey to France, and Pepin immediately, accompanied by the pope, passed the Alps with a large army, and advanced into Italy. Astolphus could not raise a sufficient force to repulse his assailants, and, after some slight reverses, retired to Pavia. In that city he was besieged, and compelled to sue for peace. This was granted, upon the condition that he should give up, not to the emperor, but to the pope, the several cities he had captured in the exarchate and the dukedom, and deliver hostages for the performance of the conditions agreed on. Pepin with his forces returned to France; and the pope proceeded to the south, in the expectation of being placed in possession of the cities and territories which Astolphus had stipulated to deliver up to the holy see. The Longobard king, however, as soon as the storm had passed over, broke into the dukedom and besieged Rome. The pope again had recourse to Pepin, who readily advanced. Astolphus, after an unavailing siege of three months, abandoned Rome, and once more took refuge in the strong fortifications of Pavia. During this second siege, which Pepin speedily commenced, an embassy from the Emperor Constantine Copronymus arrived at his camp, to remonstrate against the donation of the exarchate to the pope; and offered to repay the expenses of the war to France, if the territories were delivered over to the power of the emperor. Pepin replied

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to the envoys, that "as he had a right to those territories by the sword, and had thought proper to bestow them on the pope, nothing should induce him to alter his resolution." By a vigorous prosecution of the war, Pepin obtained a peace; and for the pope the city of Comacchio, in addition to what had been before ceded to him. From this period, 756, the pontiffs assumed the language as well as the power of sovereigns, no longer using for the dates of their rescripts the year of the reign of the emperor, but that of their own pontificates.

Astolphus, soon after executing the treaty concluded at Pavia, met an untimely death, the manner of which, however, has been variously described. During the succeeding twenty years the Longobards languished in a state of weakness and decay, but interrupted by a disputed succession, which ended in the elevation of Desiderius to the vacant throne. A double marriage was arranged between two daughters of this Longobard king and Carloman and Charles (usually called Charlemagne), the sons of Pepin. Charles soon divorced his wife, under the pretence of barrenness; and Carloman died, leaving two sons, who with their mother fled for refuge to Desiderius, when Charlemagne took possession of their father's estates. Thus family jealousy was one amongst many grounds of quarrel. Desiderius was induced to attack the dominions granted to the pope; and, at the invitation of the pontiff, Charlemagne advanced with a large army. Desiderius took refuge in Pavia; and after the capture of Verona, and a visit to Rome, Charlemagne drew up his forces, a part of which had blockaded it, around that city. The defence was brave and protracted; but by famine, and by the plague, which raged within the walls, the city was at length compelled to surrender. Desiderius was made prisoner, and sent with his family to France. All the other cities submitted to Charlemagne in 774.

Thus ended the kingdom of the Longobards, after it had existed two hundred and six years. Though the kings were at first rude and barbarous, yet, when they had embraced the Christian religion, they ruled with equity and mildness.

The policy of Charlemagne to his newly-acquired kingdom appears to have been wise and liberal. He sanctioned the laws by which the districts had been governed, whether Roman or Longobard; but to the latter he made a few additions. The emperor was left in quiet possession of the whole of Apulia, and of the other places in Italy that he held. He allowed to the Dukes of Spoleto, Friuli, and Benevento, the same power and authority as they had exercised under the Longobard kings; and the smaller dukes were continued in their dignities, but were compelled to take annually the oaths of allegiance to him; and, unless they violated it, the dignity was made hereditary in their families. Having thus settled the affairs of Italy, he returned to France, having in 781 appointed his son Pepin his viceroy.

A.D. 774 to 961.

A seditious controversy in Rome respecting the election of a pope, induced Leo III., who had been raised to that dignity, to pass the Alps and apply for protection to Charlemagne, against the Roman populace. The conqueror of Italy, in consequence of this, repaired to Rome, where, on Christmas day 800, during the celebration of divine rites, Leo placed a valuable crown on his head, and the church resounded with the acclamations of the people, "Long life and victory to Charles, the most pious Augustus, crowned by God, the great and pacific emperor of the Romans." The title thus conferred by the pope on the conqueror has been retained by his German successors, till it was abandoned in the present century, out of compliment to revolutionary France.

During the life of Charlemagne, whilst his son Pepin was acting as viceroy, Venice, which had grown up to be a consolidated and warlike power, disavowed the title conferred by the pope, and commenced hostilities against his Italian dominions. The Saracens, a new power, availed themselves of the circumstances, and attacked the islands of Corsica and Sardinia, where they obtained much plunder, and made captive many of the inhabitants. Pepin equipped an army and a fleet to reduce Venice to submission; but having failed in the attempt, and lost most of his vessels among the shoals and rocks of the islands, he died shortly afterwards at Milan through sheer chagrin. A natural son of Pepin, named Bernard, was nominated by Charlemagne as his viceroy in Italy.

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Charlemagne died the 28th January 814, and was succeeded by his son Louis. Louis and Bernard met at Aix-la-Chapelle, and arranged the mode of ruling the extensive dominions of their departed ancestor. The ambition of Bernard, however, led him to attack his uncle, and to dispute his succession; but he was defeated, captured, and condemned to the loss of sight, under which operation he expired, in the fifth year of his reign.

Italy remained as a portion of the Frankish monarchy till the treaty of Verdun in 843, when it was delivered over, with the imperial title, and with the addition of the country of Lorraine, to Lotharius I. the eldest son of Louis. He bequeathed his dominion to Louis II. in 850, who appears to have been one of the best of the princes of the Carlovingian race. The election of a pope, Benedict III., his rejection by Louis, and the ultimate submission of the monarch to its legality, were sources of vexation, though not of actual hostility. In the latter years of his reign, the Saracens, who had occupied Sicily since the year 828, invaded the south of Italy, ravaged Apulia and Calabria, and took possession of several strong places in which they established themselves. A defeat they sustained near Capua checked for a while their progress; but three years afterwards they resumed their attacks, and carried their depredations as far as Rome, which was saved by the courage and energy of Pope Leo IV. in 849. The death of Louis II. in 875 seemed the signal for discord, from the various claimants in the imperial family to the Italian dominions. Charles the Bald of France first took possession; but dying in 877, Carloman, king of Bavaria, seized the inheritance; and he was followed in 880 by his brother Charles the Fat, king of Suabia, who, for the last time, united under one sovereign the whole of the Frankish monarchy. During seven years Italy was the theatre of the lawless violence, in which the nobles required an Italian prince, and the pope was anxious to have a foreigner placed on the throne; whilst the Saracens, availing themselves of the disturbances, extorted money from the pope as the price of peace, and still continued their depredations. Berengar, duke of Friuli, and Guido, duke of Spoleto, with the Marquis of Ivrea, were rivals for the throne; but Guido was, in 894, crowned as emperor and king, and his son Lambert nominated as his successor in these dignities. Arnulf, the German king of the Carlovingian race, urged and succeeded in his pretensions, and was crowned in 896; but, like those who succeeded him, he was unable to exercise any considerable power except whilst he continued to reside among his subjects.

After the death of Lambert, in 898, and of Arnulf in 899, Louis, king of Lower Burgundy, appeared as the rival of Berengar I., but without effect; and the same fate befell another claimant, Rudolph of Upper Burgundy; in spite of the pretensions of both, the possession of the throne was at length, in 915, in the hands of Berengar, who was solemnly crowned. The power in the hands of the feudal vassals of the throne was so much weakened by the recent dissensions, that it became almost impossible to repress the plundering inroads which the Saracens were continually making on his dominions. This monarch was murdered in 924, when Rudolph of Upper Burgundy was induced to

Italy. transfer his pretensions to the throne to Hugo, count of Provence. Hugo endeavoured, by the exercise of the most bloody tyranny, to gain the unsteady dominion of Italy; but his nephew, Berengar, marquis of Ivrea, having escaped some snares that were laid for him, fled for refuge to Otho the Great in Germany, collected there a number of fugitives, turned towards Italy, and in 945 succeeded in compelling Hugo to abdicate the throne, and transfer it to his son, Lotharius, who was less the object of general aversion than himself, and who, upon his accession, appointed Berengar his first minister of state.

The death of Lotharius occurred in 950, and was supposed to have been the result of poison administered by Berengar, who was desirous to marry the beautiful wife of his royal master to his own son. To avoid this match, and to escape from the consequences of rejecting it, Adelheld fled for safety to the Castle of Canossa, against which her persecutor commenced a siege. She then applied for assistance to King Otho. He with great expedition passed the Alps, liberated the lady, defeated Berengar, captured Pavia, and having seated himself on the throne of Italy, espoused the fair Adelheld in 951. Berengar made himself useful to the new sovereign by his early submission, and by his delivering up the Friuli (the keys of Italy) to the brother of Otho; and thence his offers of service were accepted, and he was appointed to rule the country in the name of Otho. After ten years, complaints reached the throne from the great vassals in Italy, when Otho returned there, dismissed Berengar from his station, led him as a prisoner to Bamberg, in Germany, and having united Italy with his German dominions, was crowned with the iron crown at Milan in the year 961. Otho certainly granted the best lands as feuds to his German nobles; but he conferred great privileges on the cities of Italy, and on these their free constitutions were grounded. During the tenth century, the liberality of the Frankish kings, who had served their purpose, so corrupted the church, and so weakened the royal authority, that it effectively undermined it; whilst the clergy and the people elected the popes according to the dictation of the consuls and of the inferior patricians. Thus it happened that, in the first half of the tenth century, two women of great beauty and skill in intrigue disposed of the holy see. Theodora, in 914, raised her son by her lover Pope John X. to the chair of St Peter, which he filled under the name of John XI. The brother of the last, Alberich of Camerino, and his son, Octavian, were absolute masters of Rome; and the latter was consecrated pope in 956, at the age of twenty years. Otho, when crowned at Rome in 962, annulled the election, and appointed Leo VIII. in his stead; but the people, jealous of this exercise of power, elected Benedict V. The popes, instead of governing Rome, were thus themselves dependent on the leaders of the populace, who were at this time the real dispensers of the patronage.

The republics of Gaëta and Amalfi, and the dukedom of Naples, still maintained their independence against the Longobard dukedom of Benevento. They had a common enemy to contend with in the Saracens, who had by each party been invited to afford them assistance in their quarrels, but who had fixed themselves in Apulia, and there constructed powerful fortifications. The Emperor Louis II., and King Macedo, by their united forces, had so broken the power of the Mussulmans in 866 that the latter could no longer maintain themselves in Lower Italy; and thus enabled the Greeks to form establishments on the territory previously occupied by the Saracens. They founded a province called the Thema of Lombardy, which was ruled by a chief residing in Bari, and which maintained its independence during more than a hundred years.

A.D. 961 to 1073. Otho the Great was succeeded in 973 by his son, Otho II. Under his reign, Crescentius, then consul in Rome, on the pretence of restoring the ancient constitution, attempted to secure to himself the sole power of that city; whilst Otho, engaged in warfare against the allied forces of the Greeks and Saracens in Lower Italy, suffered the vicious popes, Boniface VII. and John XV., to exercise supreme authority. Otho III., who, when only three years old, in 983 had succeeded his father, elevated his cousin, Gregory V., to the papal throne; but Crescentius, with the assistance of the populace, drove him from the city, and filled his station with a Greek pope, John XVI. Otho entered Rome a second time; deposed John, and elevated to the papal chair his late tutor, Gerbert (Silvester II.) Crescentius and twelve others of his associates, who had thrown themselves into the Castle of St Angelo, were besieged, taken prisoners, and beheaded in 997; and the city was compelled by force of arms to take the oaths of allegiance. Italy.

The death of Otho III., in 1002, was deemed by the Italians a dissolution of their connection with the German emperors, and Hardouin, marquis of Ivrea, was crowned king of Italy in Pavia; upon which the jealousy of the Milanese, the habitual rivals and enemies of Pavia, induced the citizens of that place to declare Henry II. of Germany as king also. The immediate consequence was a civil war, in which each city and district took a greater or a less part, and all suffered most severely. Henry was indeed, in 1004, acknowledged by the assembly of nobles collected in Pavia; but, in the tumult which arose on the occasion, a great part of the city was destroyed by fire. Hardouin died in 1015, and Henry remained without any competitor. He died, without leaving any children, in 1024; and with him ended the Saxon dynasty. Conrad II., of the house of Weibelingen, and surnamed the Salic, who had been recommended by Henry on his deathbed as most worthy to succeed him, was elected by the states of the empire in Germany, and having descended to Italy, was crowned at Rome in 1027. A general assembly was held near Piacenza, at which smaller fiefs were declared to be hereditary, and attempts were made to obtain peace and security to all the states. These efforts were ineffectual, from the rage between the growing cities and their bishops, as well as the hatred between the clergy and the inferior inhabitants and the nobles. In Rome, where the family of Crescentius still directed the voices of the public, neither Henry, nor Conrad, nor the pope, could enforce obedience. When Henry III., the son of Conrad, came to Italy in 1046, he found no less than three popes in Rome. These he displaced, and selected Clement II., who was placed in the chair of St Peter, and regularly afterwards raised to the spiritual dignities German ecclesiastics. This reform, although apparently wise at the time, as giving dignity to the pontiffs, was afterwards found in practice to have tended to corrupt them.

During the long minority of Henry IV., after the death of his father, Hildebrand, a monk, afterwards Pope Gregory VII., took the lead in opposition to the temporal power. The increase of clerical power was much promoted by the transactions of the Normans. As early as the year 1016, some warriors from Normandy settled in Apulia and Calabria, and having early formed alliances with the Longobards, the republics, or the Greeks, as best served their purpose, against the Saracens, they became, through their warlike habits, a very powerful party. Leo IX. made several attempts to draw them away; but these all failed, and ended in his own captivity and submission. Nicholas II., on the other hand, formed alliances with the Norman leaders, and in 1059 endowed Robert Guiscard with the feudal rights of all the lands he had conquered in Lower Italy. Afterwards, the popes, in the contentions with the imperial power, trusted chiefly to the aid they could draw from their faithful confederates, the newly-created Dukes of Apulia and Calabria, and the Great Counts of Sicily, Normans also. Whilst in the south of Italy the small states thus became larger,

Italy. in the north the great states were broken up into several of small extent and power. The Longobard states founded their subsequent greatness, and Venice, Genoa, and Pisa had already become rich and powerful. The Pisans, who, in 980, were in alliance with Otho II., and performed great services against the Greeks, and against the Saracens in Lower Italy, united with the Genoese, now a seafaring and warlike people, to attack the unbelievers in Sardinia, and twice, in 1017 and 1050, conquered those intruders, and finally divided the lands, in large districts, amongst the most eminent of the native inhabitants.

A.D. 1073 to 1260. Gregory VII., who was elected pope in the year 1073, used all the exertions and influence of his station to extend the power of the church. He laid claims to authority over Spain as a fief of the church, and required of that kingdom all the conquests which had been made from the Moors. Sardinia was demanded of the conquerors, and France was under his authority. He made attempts to exercise his power in Hungary, and even in Russia; and extorted from England the tax known by the name of Peter's pence, which long continued to be paid. In Italy, where knowledge had begun to dawn, there were many opposed to the vast extension of the papal power; but they were outnumbered by others, who feared more the government of a German prince. In most of the other parts of Europe the regular priests had so much influence, that the pretensions of the pontiff were submitted to with little or no reluctance. It was not so, however, in Germany. The policy of Gregory had enjoined on the priests the observance of celibacy, and the German clergy were reluctant to put away their wives. They opposed the pope's decrees, and joined with the emperor in resisting them. The German bishops in council pronounced the deposition of the pope; and the pontiff issued his excommunications against them and their emperor. A war thus broke out between Henry of Suabia and Pope Gregory, though Clement III. had been created pope by the Germans. Gregory with his army was defeated, and he retired to the Castle of St Angelo, where he was long besieged. On his release by Robert Guiscard he removed to Salerno, where he died in the year 1085. Two popes were chosen in succession by the cardinals, viz., Victor III. and Urban II.; whilst the antipope Clement, with his conclave, sometimes in Rome, at other times driven from it, never ceased to fulminate his excommunications. Urban maintained the contest with Clement, and in fact triumphed over him. His success was owing in a great measure to the part he took in favour of the Crusades, which about that period began to excite the attention and rouse the passions of all Europe to achieve the conquest of the Holy Land. The enthusiasm of the period enabled Urban to drive Clement from the city of Rome, and to take possession of the chair of St Peter, in which dignity he terminated his life in the year 1099. Paschal II. was fixed by the cardinals at Rome in the papal chair; and though the party of Clement on his death elected another antipope, it did not weaken the secure hold on the dignity to which Paschal had been elevated. The son of Henry IV. was encouraged by the pope to rebel against him, as one who, being excommunicated, could not convey to his successor any right. The father was made prisoner by the son, and Henry V. was then crowned emperor and king.

Henry V., though, until he obtained the throne, the devoted defender of the papal claims, after his accession became their antagonist, and thus gained the support of his German nobles. After suppressing commotions in other parts of his dominions, he crossed the Alps with an army of eighty thousand men; passed through Italy to Rome without serious opposition; and there massacred many of the citizens, shut up the pope, the cardinals, and the nobility in prison, and held them confined till he had compelled Paschal II. to renounce the right of investiture in 1111, and to crown him as emperor. Henry had scarcely departed and reached his patrimonial dominions when he found a general flame kindled around him. The Lateran council disavowed all that the pope had done, upon the notorious ground that it had been extorted by force. The French clergy had acquiesced in the excommunication, and those of Germany rejected the bull of investiture; whilst a rebellion, excited by Duke Lothario, broke out in Saxony. By the aid of the Duke of Stauffen-Suabia, Henry was enabled to lull the domestic threatening storm, and again with an army marched to Italy, and seized upon Rome, whilst the pope fled to Apulia. At last, in the year 1122, by the Worms compact, the respective rights of the emperor and the pope were clearly defined, both with regard to the imperial investiture and to the selection of bishops and their oath of allegiance. Shortly afterwards Henry died at Utrecht in May 1125. Italy.

During the reigns of these German princes many of the cities of Italy had risen to considerable wealth, power, and splendour, and, from the emperors being often absent with their armies in the other parts of their dominions, had assumed to themselves almost all the rights of sovereignty. These cities forced the others of less extent near to them into an alliance, by which they obtained the aid of their population whenever they had occasion to have recourse to arms. The two cities of Milan and Pavia, in the north of Italy, were the chief of rival associations. Disputes between Milan and Cremona gave occasion to the first hostilities between the former of those cities and Pavia, in 1129, to which a contest between two rivals for the crown of Italy, Lothario II. and Conrad of Hohenstauffen, gave a different direction, and created two parties, the Guelphs, the adherents of the popes, and the Ghibelines, the supporters of the German emperors. These two parties, which long divided Italy, derive their origin from a family which in the eleventh century held extensive possessions in the north of Italy, amongst the mountains between St Gothard and the Brenner, and bore the name of Welf. They descended into the plains of Germany, and obtaining settlements in some of its finest provinces in the south of that country, were thus enabled in process of time to become the founders of both the royal and ducal houses of Guelph; the first seated on the throne of Great Britain, and the second enjoying the duchy of Brunswick.

This family quarrelled among themselves, one branch bearing the name of Welf, changed by the Italians into Guelph, and the other Weiblingen, changed into Ghibeline; and they had, before their intermeddling in the Italian wars, fought a bloody battle at Winsberg in 1140. The state of Italy favoured the creation of parties, to which the chiefs of the two branches of this German family attached themselves, and continued their animosity during more than one hundred years.

In Rome were violent schisms between the partisans of rival popes; and this again gave rise to that spirit of independence which that city had constantly nourished. It was especially excited by the preaching of Arnold of Brescia, an eloquent monk, the pupil of Abelard, who declaimed with great energy against the luxury of the clergy and the temporal power of the popes, and in favour of that liberty which Rome had in ancient times enjoyed. Though banished in the year 1146, he returned again from Zurich, where he had taken refuge, and, under the English Pope Adrian IV. was taken and burnt alive in 1155. In the meantime the two great cities had strengthened themselves. Milan had in her alliance the cities of Tortona, Crema, Bergamo, Brescia, Piacenza, and Parma. Pavia was at the head of Cremona and Novara. Verona, Padua, Vicenza, Treviso, and Mantua, who were nearly equal in power, maintained each its independence. Turin was at the head of the towns of Piedmont, and disputed the authority of the

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Counts of Savoy. The great feudatories were the Marquis of Montserrat and the Prince of Asti. To the south of the Po the city of Bologna had acquired great power, and exercised influence over Modena and Reggio on one side, and Ferrara, Ravenna, Faenza, Forli, and Rimini on the other. Florence had risen to superiority in Tuscany by the destruction of Fiesole, and had as allies the cities of Pistoja, Arezzo, San Miniato, Volterra, Lucca, Cortona, Perugia, and Siena.

Such was the state of affairs in Italy when the diet of the empire of Germany, assembled at Frankfort in the year 1152, bestowed the crown of that kingdom on Frederick duke of Bavaria, of the house of Hohenstauffen, better known by the name of Barbarossa, the nephew of Conrad, his predecessor in that dignity. The new emperor is recorded by the authorities of his time to have been brave, just, and not addicted to cruelty, yet his reign was a most disastrous one for Italy. The cities were zealous to defend the rights of self-government which they had obtained, and, though filled with factions, resolved to maintain them. They were surrounded with strong walls, impregnable against the arts of attack then practised; and they were well peopled with men, patient, brave, and abstemious. The open country and the smaller towns, from which the numerous fortified cities drew their sustenance, suffered severely whenever an army traversed that country; and, to produce a greater pressure on the cities, the rude soldiery of that time not only destroyed the provisions they could not consume, but cut down the growing crops before they were fit to be harvested, or set them on fire, with the houses and the barns of the cultivators. Barbarossa viewed the whole of Italy as his subjects, and treated those who opposed him as rebels and traitors; and as the Ghibelines, who were the weaker party, adhered to him, his chief operations were directed against the Guelphs, of whom Milan was the main support and centre of union.

Six times did the emperor cross the Alps with a numerous German army to reduce the country to obedience, and each time his attempts were frustrated. In 1154, in conjunction with the people of Pavia, he defeated the Milanese army, but could not take the city; yet he destroyed Tortona, and was then crowned in Pavia with the iron crown of Lombardy, and at Rome with the golden crown of the empire, though the ceremony was performed in the suburb, admission within the walls of the latter city being refused. After plundering Spoleto, sickness and desertion so thinned his ranks, that he led back the remnant of his troops, and repassed the Alps by way of Trent and the Tyrol. The most savage destruction was perpetrated in the retreat; but the cities were unassailed, and rejoiced in their freedom, though they did little injury to the retiring army. In the interval that followed, a civil war was carried on by the two parties, at the head of which were Milan and Pavia; but in this the latter, the weaker of the two confederates, suffered the most, whilst by the former the citizens of Tortona were received with sympathy, their houses rebuilt, and their fortifications restored.

Barbarossa entered Italy again in 1158, with the vassals who crowded to him from all parts of Germany. At Brescia the terror of his name induced that city to renounce the alliance with Milan, which refused to receive the emperor. By the aid of the militia of Cremona and Pavia he was enabled to besiege Milan; but his engines being insufficient to beat down the walls, he resolved to starve it into surrender, and intercepted all provisions and destroyed the growing crops. In this situation of distress Blandrate, an independent noble, known as a protector of Lombardy, with some others of the same rank, assumed the office of mediator, and obtained favourable terms. The city agreed to pay a tribute, and to restore the rights of the emperor, on condition that they should elect their consuls, and not be bound to open their gates to the emperor. Tortona and Crema were both included in this pacification, which was signed on the 7th of September 1158. A few weeks afterwards, a diet of the kingdom of Italy having been convoked at Roncaglia, fixed much wider bounds to the regal rights than the Milanese would admit, upon which they again took up arms and prepared to defend themselves. Another diet was called, which met at Bologna in the spring of 1159, and by whose decision Milan was declared to be under the ban of the empire. As that city was too strong to be captured, the first attempt of the emperor was directed against the allied city of Crema, which was compelled to surrender, after a siege of six months, in January 1160.

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The German troops were exhausted by the severe duty of the siege, and their term of service having expired, many of them withdrew; but Frederick, with the Italian Ghibeline cities of Pavia, Cremona, and Novara, carried on the war by devastating the country of the Guelphs, and excluding all supplies from Milan. In June 1161, a new army reached the theatre of war in Italy, when the emperor resolved to reduce what he called his rebellious city. The defence of Milan was hopeless, but firmly maintained, when a fire, which destroyed the chief magazine of provisions, induced the inhabitants to surrender at discretion in March 1162. Frederick ordered the militia of the Ghibeline cities to raze the walls, and so to destroy the buildings, that not one stone should be left on another. The poorer inhabitants were placed in villages at some distance from the place; and many sought hospitality in other cities, where their perseverance was recorded with applause, and where they spread the love of freedom and hatred of tyranny. The spirit of independence so rapidly increased that it was soon communicated to the Ghibeline cities; and the effect of it was to produce a confederacy of a most extended nature. Frederick had entered Italy in 1163, attended only by his splendid train of nobles, but without an army, under the impression that he could at pleasure call out the militia of the Ghibeline cities. He directed his steps towards Rome, where, on account of a contest for the papal chair, occasioned by the death of Adrian IV., he thought his presence necessary. Whilst in the south, a union was formed in the Veronese, which he deemed injurious to his prerogatives; and he hastened to call out the militia of the Ghibeline cities of Pavia, Cremona, Lodi, and Como, to lead them against Verona; but they were indisposed to the service, upon which he returned to Germany to collect an army, on whose exertions he might depend.

In October 1166 Frederick descended from the Grisons with his newly collected army. His military operations were ineffectual; and whilst he advanced to Rome and to Ancona, the confederation of the cities of the Guelphs and the Ghibelines, begun at Pontida in April 1167, was cemented on the 1st December of the same year, and assumed the name of the Lombard League. Frederick had been repulsed at Ancona, whilst he had been victorious at Rome; but his victory proved useless. His army was attacked by disease, which swept away great numbers; and with the remnant he could scarcely protect himself from the increasing influence of the League, whose authority had already restored Milan, and built the new city of Alessandria, at the confluence of the rivers Tanaro and Bormida. In March 1168, the emperor, with but a very few troops, was enabled to effect his retreat from his Italian subjects, by the road of Mount Cenis, and soon prepared a new German force, which was to be employed in coercing them.

In the efforts to lead the Germans again into Italy, he was baffled by their reluctance, and remained, as far as regarded Italy, in a state of repose during five years. He sent, indeed, his warlike chancellor, Christian, archbishop of Mentz, to raise his party in Tuscany, the only district

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in which there existed any portion of attachment to the Ghibeline cause.

In October 1174, Frederick again entered Italy at the head of a powerful army, but was detained four months by the siege of the newly-built town of Alessandria; and the sickness among his troops, occasioned by the severity of the winter, so weakened him, that having abandoned the siege in April 1175, he was too weak to attack the forces of the League, and thus induced to enter on a negotiation. Much time was spent, but no plan of conciliation was adopted; and Frederick again sent into Germany for an army, which arrived in the spring of 1176 at Como, whither he was enabled secretly to join them; but he could get very little aid from the few cities of the Ghibeline party. He advanced to the neighbourhood of Milan, and on the 29th May 1176 at Legnano, attacked the forces of the League. Though at first he met with success, yet the issue of the battle was so decisively against him, that his camp was pillaged, his army dispersed, and himself compelled to flee for his life. Finally he escaped to Pavia, to contradict the report of his death, which had prevailed during several days. Negotiations followed this defeat. The pope and the Venetians acted as mediators, and in 1177 a truce for six years was concluded. During its continuance the political power of the League was strengthened and consolidated; whilst, on the other hand the emperor had learned the lesson, untaught to his predecessors, of submitting to restrictions imposed by subjects on their sovereign. The truce was followed by the treaty of Constance, 25th June 1183, which secured the privileges of the cities, and recognised the prerogatives of the monarch, with certain necessary restrictions.

Barbarossa partook of the religious enthusiasm which infected all Europe, and, after the peace of Constance, repaired to the Holy Land, where, in 1190, he was drowned in crossing the Calycadnus, an inconsiderable stream in Armenia.

Though the peace of 1183 gave political freedom to the cities, yet, as it was not followed by any confederation, each thought only of strengthening its own defences, and of intriguing for power and supremacy. A party spirit was thus kindled, which spread and continued during the whole period that the emperors of Germany of the house of Hohenstauffen continued to exercise the shadow of sovereignty. The cities were soon divided again into Guelphs and Ghibelines. Where the Guelphs had the government, a large minority constantly opposed them; and the same was the case where the opposite faction had the upper hand. Noble families were engaged in feuds with each other, which endured through generations, and were constantly occasioning open murders or private assassinations. An instance of the prevalent feudal proceedings may not be without its use in showing the effects of such a state of society. A noble Guelph, named Buondelmonte, of the upper vale of the Arno, had demanded the hand of a lady of the Ghibeline house of Amidei at Florence. His proposals were accepted, and preparations were made for the marriage. But a lady of another family, the Donati, stopped the lover as he passed her door; and bringing him into the apartment where her females were at work, raised the veil of her daughter, whose beauty was most captivating. "Here," said she, "is the wife I had reserved for thee. Like thee, she is a Guelph; whilst thou takest one from the enemies of thy church and race." Buondelmonte, dazzled and enamoured, instantly accepted the proffered hand. The Amidei considered this inconstancy as a deep affront; and all the noble families of Florence of the Ghibeline faction, about twenty-four in number, met, and agreed that he should atone with his life for this offence. Buondelmonte was attacked on the morning of Easter Sunday, as he passed the bridge on horseback, and was there killed. Forty-two families of the Guelphic faction then met, and swore to avenge the insult, and much bloodshed followed. Every day some new murder or some open battle alarmed the citizens of Florence, during the space of thirty-three years. These two parties stood opposed to each other within the walls of the same city; and although sometimes in appearance reconciled, yet every little accident renewed their animosity, and they again had recourse to deadly warfare.

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The nobility of Italy, who possessed extensive feudal estates in the neighbourhood of the cities, were bound by their tenures to take part with the emperor in the hostilities he had carried on against them. They soon became deeply involved in debt; and their creditors were for the most part the inhabitants of the cities, to whom the estates were hypothecated. They were a high-spirited race, had by practice acquired great skill in arms, and were acuter and abler political intriguers than the magistrates of the cities. Some of the nobles who had castles sufficiently strong, lands sufficiently extensive, and vassals sufficiently numerous to defend themselves, became attached to the Ghibeline party. Those of them whose castles were weak from their situation, or near to cities too populous to be ruled by them, had been admitted to become citizens of such places, had assisted them in war, had obtained a considerable share in their government, and were for the most part compelled by their interest to become adherents of the Guelphic faction. The plains of Italy were thus deprived of all the independent nobility, who had become citizens of some of the free republics; but every chain of mountains was thickly set with castles, held by those who, whilst they maintained their own independence, professed to owe and to acknowledge allegiance to the emperors. As war was their sole occupation, they were often gladly received by the republics, which stood much in need of able captains. It seems that the independent nobles who became connected with the cities as commanders of the forces were not always, though most commonly, of the same faction; for the Ghibeline family of Visconti, which held most extensive fiefs, associated itself with the Guelphic republic of Milan. These nobles, however, when connected with the cities, soon acquired extensive influence, and became finally founders of families who obtained hereditary, and, some of them, sovereign power. Of these the house of Este, allied to the Guelphs of Saxony and of Bavaria, who had strong castles on the Euganean Hills, joined the republic of Ferrara. The family of Ezzel or Eccelino, whose fiefs and castles were at the foot of the Tyrolean range, and who were devoted to the Ghibeline party, formed connections with the republics of Verona and Vicenza. On the northern side of the Apennines, the fortresses of several Ghibeline nobles excited and maintained revolutions in Piacenza, Parma, Reggio, and Modena; whilst on the southern side of those hills were the castles of other Ghibeline nobles, in turns citizens or enemies of the republics of Arezzo, Florence, Pistoja, and Lucca.

The state of society here briefly sketched continued during the whole of the reign of the family of Hohenstauffen; yet in the latter years of that period the art of painting first made its appearance in Italy, and the first dawn of the revival of literature became visible in the horizon, by the improvement made in the language, by the discovery of magnifying glasses and of the magnet, by the establishment of the University of Bologna, and by the appearance of many writers of genius and learning, to whom the literature and civilization of all Europe became deeply indebted.

During the nominal reign of the German family, no one of the individuals who succeeded to the title after the death of Barbarossa is deserving of notice, excepting his grandson, Frederick II., who attained the dignity before he had arrived at the age of eighteen. During his reign, Innocent III. attained the pontifical chair; a man of vast talent, rare force of character, great learning, and an irreproach-

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able life. Though the instigator of the crusades against the Albigenses in France, his acts originated in the view he took of the moral effect of the increase of the ecclesiastical power, and of its concentration in the head of the church. He made efforts in Rome to establish civil liberty, by forming a representative senate, to whom all power but the judicial was intrusted; but he issued his commands to all the princes of Europe in stronger tones than those of Gregory VII., which, if obeyed, would have deprived them of all political liberty.

Frederick, who, at his coronation, had promised to undertake a crusade to the Holy Land, embarked for Palestine in 1228, and succeeded in making a treaty with the Sultan, in 1229, by which he obtained Jerusalem, and agreed that access to the Holy Sepulchre should be free both to Mohammedans and Christians. Gregory IX., who had succeeded Innocent, dissatisfied with the arrangements, excommunicated him. Having returned to Italy in 1237, he defeated at Cortenuovo his opponents, who lost 10,000 men: and his subsequent activity gained all Upper Italy to his party, except the four cities of Milan, Brescia, Piacenza, and Bologna. But Gregory IX. induced the maritime republics of Venice and Genoa to rescue the Guelphs from destruction. This gave a turn to affairs, though Pisa still held fast to the emperor and the Ghibelines. A general council, summoned by the pope, ratified his excommunication, and his party forsook him by degrees. The mendicant orders everywhere excited conspiracies against him; he became suspicious of every one around him, and was at length obliged to concede everything to the pope. Through the mediation of St Louis of France, he proposed, as the condition of his readmission to the church, that he should go to the Holy Land and join the crusaders. Whilst waiting the effect of his proposals he died from dysentery in the castle of Fiorentino in Apulia, the 13th December 1250.

After the death of Frederick, the new pope, Innocent IV., who had sought refuge at Lyons, returned to Italy, but he was deceived in the expectation of general submission which he had formed. During his progress through Genoa, Milan, Ferrara, Bologna, and Perugia, he was in some places received with coldness, and in others with disdain. Meanwhile, in the absence of the head of the empire, great confusion ensued, and freedom was extinguished. The Eccelinos became for a time absolute masters of the north of Italy. The cities of Mantua and Ferrara fell into the power of D'Este, and Verona into that of Mastino della Scala. Pallavicino became lord of Cremona, and the Torriani of Milan, Brescia, Alessandria, and Tortona. The whole of Italy, with the exception of Tuscany and the maritime cities, quietly submitted to a military commander.

A.D. 1260 to 1512.

During the period in which the emperors of Germany of the Suabian or Hohenstauffen race were the kings of Italy, the maritime cities of Venice, Genoa, and Pisa had grown up to be powerful republican states, and were only by slight ties bound to the common sovereigns of Italy. The nobility who had been admitted to the rights of citizenship were the senators; and some member of their families was commonly chosen as a ruler, with the title of doge or duke. They were strict aristocracies, preserved in that form by laws which, whilst they gave security to their privileges, secured in like manner the rights and possessions of each individual. Under this state of security they naturally became wealthy, and their progress was accelerated by favourable circumstances. The Crusades, which animated the whole west of Europe, created a demand for shipping to convey troops and stores to and from the Holy Land; and thus a mercantile navy was called into existence, which could at any time be easily converted into a military navy. It was in this way that Venice was enabled to take, and for a time to retain, the city of Constantinople itself. The commerce of the East had also greatly contributed to increase the wealth, and consequently the power, of these free cities. The chiefs of the Crusades, who returned from these expeditions, brought with them from Asia a taste for its luxuries; and for these the maritime cities became the storehouses, supplying the countries in the western part of Europe.

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After the death of Pope Alexander IV. in 1261, his successor, Urban IV., among several princes who sought the government of Italy, selected Charles of Anjou, brother of St Louis of France, appointed him king of Naples, a senator of Rome, papal vicar of Tuscany, and finally king of Italy. This gave a new direction to the two parties, the Guelphs and the Ghibelines, which still distracted the country. One of them was considered as the friend, and the other as the enemy, of the French aspirant. Besides these parties, there were also the republics; and besides them, contests between the nobles and the people, in most of which the latter were, in the beginning at least, the conquerors. Charles invaded Naples, and defeated Manfred, the king, who fell in battle at Benevento, February 26, 1266, and thus gave the superiority to the Guelphs, which he further increased by placing a garrison in Florence, and excluding from the councils the whole of the nobles, and all others of the Ghibeline party. He was for a short time alarmed by an invasion from Germany under Conradin, the grandson of Frederick II., and the last of the house of Hohenstauffen, who claimed the throne of Naples. Conradin was only sixteen years of age when he arrived at Verona at the head of 10,000 cavalry, where he was joined by all the Ghibeline commanders who had distinguished themselves under his ancestor, and aided by the efforts of the Ghibeline cities, Pisa and Siena. The citizens of Rome were so disposed to favour him, that on his advance they opened their gates and promised assistance. But all this zeal in his favour was of no avail. He entered the Abbruzzi, and in the Campi Palentini, near Tagliacozzo, fought a desperate battle 26th August 1268. It terminated in the total defeat of the Germans. Conradin, with the chiefs, were made prisoners, and, after a mock trial, were condemned and beheaded at Naples on the 26th of October 1268. After these executions, an uninterrupted exhibition of similar spectacles filled the two Sicilies, and some other parts of Italy, with such horror and dismay, that Charles of Anjou reigned triumphantly, and soon acquired the mastery over the republican cities.

Gregory X., who ascended the papal throne in 1272, saw the impolicy of his predecessors, who had given themselves a French master. He endeavoured to raise the Ghibeline party so as to counterbalance the Guelphs; and engaged Pisa, Venice, and Genoa, to co-operate with him in choosing a chief. The election was made the following year, when Rodolph of Hapsburg, the founder of the house of Austria, was declared emperor. Martin IV., who was made pope in 1280, undid the work of his prececessor, and persecuted the Ghibelines with great fury; but in the mean time the popes had secured to the holy see the temporal power over the ecclesiastical territories. During this period hostilities took place between the maritime republics. The Genoese had assisted Michael Palæologus in his successful efforts to retake Constantinople from the Venetians, and had received for their reward the island of Chios. In 1284, the Genoese had nearly annihilated the fleet of the Pisans in a sea fight near Meloria; and in another battle, near Curzola, they had gained the command of the sea by their defeat of the Venetians.

Charles was preparing an armament in all the ports of Naples and of Sicily, with the intention of contending in Greece for the Eastern Empire. This induced him to levy taxes of great amount with excessive rigour, and the judges endeavoured to prevent resistance by striking terror into

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all those who declined or even delayed the required payments. John of Procida, who had been the friend and confidant of Frederick and of Manfred, a native of Salerno, visited the cities of both Sicilies, to reanimate the zeal of the Ghibelines, and to rouse their hatred towards the French. He had also obtained promises from Greece and from Spain. It was not necessary, however, to have recourse to foreign aid, for a sudden and popular explosion took place in Palermo. It was excited by a French soldier, who behaved rudely to a betrothed lady, as she was on her way with her affianced husband to a church to receive the nuptial benediction. The indignation of her family was on the instant communicated to the populace. The bells of the churches were ringing for vespers; the people answered by the cry, "To arms! death to the French!" The French were furiously attacked in every quarter. Those who attempted to defend themselves were soon overpowered; others, who endeavoured to pass for Italians, were known by their pronunciation, and instantly put to death. In a few hours more than four thousand persons thus perished in Palermo, and every other town in Sicily followed the bloody example. Thus the Sicilian vespers overthrew the dominion of Charles and of the Guelphs, separated that island from the kingdom of Naples, and transferred the crown of the former to Peter of Aragon, the son-in-law of Manfred, who was considered as the heir of the house of Hohenstauffen. The massacre occurred on the 30th of March 1282.

In 1282 the democratic principle had been established in Florence by the attainder of the nobles as a body, and the Guelphic party had received great accessions of strength; but some disputes, which had originated in the neighbouring town of Pistoja, were extended to Florence, and in a short time divided the whole of Tuscany into two factions of Guelphs, called the *Bianchi* and the *Neri*, or the Whites and the Blacks. The mutual animosity and hostility of these factions lasted till 1302, when, by the intrigues of Boniface VIII., and the instrumentality of Charles de Valois, the Bianchi were plundered and expelled the country. Many of them thereupon joined the Ghibelines. In Lombardy the dying cause of freedom still continued to exist, and was at length rekindled; and the people, wearied out with the feuds of their nobles, between 1302 and 1306 drove them from the towns. At this period, by the management of Philip le Bel, a Frenchman, Clement V. was chosen pope, who removed the seat of the papal throne to Avignon, where it was maintained till 1377. This gave room for the display of the spirit of freedom in Rome, and in all the territory of the church. The authority, and almost the name of the emperor of Germany had been neglected in Italy during sixty years, whilst the minds of the people were wholly occupied with internal disputes. At length, in 1308, the diet of Germany advanced Henry of Luxembourg to the imperial dignity, after three other princes had enjoyed that honour. Henry VII. had little power to enforce obedience in Germany, and foresaw symptoms of opposition, which he wished to divert by flattering the vanity of conflicting parties, and uniting them in projects for extending his authority over the several parts of Italy. Henry crossed Mount Cenis, and appeared in Italy in 1310, accompanied by a few cavalry, not amounting to two thousand, composed chiefly of Belgians, Germans, and some Savoyards. At Turin he was received by many of the nobles of Lombardy and Piedmont, who at least professed obedience; and even the cities, in confusion and distress as they all were from their internal contentions, gave indications of a strong desire for tranquillity under their constitutional chiefs. Henry professed strict impartiality, and his conduct corresponded with his professions; but he was sadly in need of money. Supplies were furnished to him with great parsimony by all but the citizens of Pisa, who were extremely liberal, and increased his force with a guard of six hundred bowmen, who accompanied him to Rome, where he received the golden crown of the emperor from the pope's legate, without the walls, as the citizens refused admission to him and his troops, but had admitted a garrison of Neapolitans. The term for which his foreign troops had enlisted had expired on his coronation, and they mostly left his service; but the Ghibelines of Central Italy gathered round him, and formed a respectable force. He made some ineffectual efforts to conquer the democracy of Florence, who had taken a garrison of mercenaries into their pay. Reinforced by the Pisans, he then marched towards Rome to contend with Robert, king of Sicily, who maintained an ill-disciplined force in that city, and expected reinforcements from the Guelphs of Tuscany. On the road, not far from Siena, on the 24th August 1313, he died from poison administered to him in the sacrament of the Lord's Supper by a Dominican monk.

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On the death of Henry, disputes arose at the diet at Frankfort respecting the succession to the imperial crown, but they seemed to have had little effect on the condition of Italy. In a few years most of the republican cities in the middle of Italy had fallen under the government of some distinguished military family, whilst Tuscany alone maintained a share of liberty, by selecting Robert, king of Naples, as its protector. The Ghibeline city of Pisa found a master in Uguccione della Faggiuola in 1314; and, after his expulsion in 1316, in Castruccio Castracani. Padua fell to the house of the Carraras. Alessandria, Tortona, and Cremona were reduced to submission by the Visconti of Milan. Mantua fell to the share of Gonzaga in 1328. In Ferrara the family of the Este established their hereditary power; and Ravenna became the patrimony of the Polentas. In the other cities the same tyranny was established, and in each succeeding age with ever increasing evils. The petty tyrants adhered to Robert of Naples, whose greedy lust of power obtained the means of indulgence, when Clement V., designing thereby to hold the balance of parties in his own hands, appointed him vicar-general of Italy. Louis of Bavaria made his appearance in Italy in 1327, in order to put down both Anjou and the Guelphs. He was at first supported by the Ghibelines; whom, however, he soon completely estranged by his weakness and treachery. Meanwhile, the wickedness of Pope John XXII., who supported the Guelphs, had so cooled their zeal in his favour, that the two parties who had so long opposed each other, in the cause of common freedom, were now reconciled.

At this period (1330) John, king of Bohemia, the son of the Emperor Henry VII., made his appearance in Italy; and having been invited by the citizens of Brescia, and favoured by the pope, he was announced as the mediator and pacificator of the kingdom. But his purposes were frustrated by the opposition of Tuscany, where a dread of the government of a single person was generally entertained. His fickle disposition made him soon abandon his objects, and he quitted Italy in 1333.

After his departure, Mastino della Scala, who had been one of his supporters, and who was lord of the half of Lombardy, and of the territory of Lucca, began to threaten the independence of Italy. He was opposed by a league, at the head of which was Florence. But hostilities had hardly begun when they were brought to a close, and the freedom of Florence was thereby secured. The necessities of Mastino induced him to sell his city of Lucca to the Florentines, upon which the Pisans rose and took that city for themselves. After this transaction, the Florentines, disgusted with those who had caused the loss of Lucca, selected as their chief a military adventurer, who, in the Crusades, had obtained the title of the Duke of Athens; but, owing to his severity, they soon dismissed him. In Rome, torn by aristocratic factions, Cola di Rienzo was chosen tribune of the people, in order to restore the laws and

Italy. tranquillity; but after seven months he was obliged to give way before the power of the nobles, in 1347. After a banishment of seven years, in 1354 he returned with Cardinal Albornoz; but his rule was short, and he was killed in an insurrection instigated by the nobles. The Genoese, tired out with everlasting quarrels between the Guelphic families of Spinola and Doria, and the Ghibeline families of Grimaldi and Fieschi, drove them all out of their city, and elected their own first doge or duke. In Pisa the Ghibelines were divided into two violent parties, those of Bergolini and of Raspanti, when, after much contention, the latter succeeded in expelling the former, in 1348. At this period Italy suffered from a dreadful famine, which, in 1347, swept away, by absolute starvation, vast numbers of the inhabitants; and in the following year a pestilence of a deadly nature swept the peninsula. Such was the suffering produced by these visitations, that it was calculated that two-thirds of the whole population were destroyed. Another tremendous scourge followed, and was longer endured. After each peace, troops of disbanded soldiers were formed under chiefs, called *condottieri*, who carried on war on their own account, burning some towns, ransoming others, and plundering everywhere. They were mostly Germans, who had been called in by the Viscontis and Della Scalas. A Duke Werner, a Count Lado, and a Friar Monreale, led bands of these robbers, who devastated Italy from Montserrat to the extremity of Naples, between 1348 and 1354. Meantime another war had broken out between the maritime republics of Genoa and Venice. The Venetians formed alliances with the Greek emperor and with Peter of Aragon. Formidable fleets were collected, one commanded by the Genoese admiral, Paganino Doria, and the other by the Venetian, Nicolo Pisani. A battle was fought between them on the 13th of February 1352, which proved indecisive; but in a second, fought in the following August, the Genoese were defeated with great loss. In two years success changed sides; and after a defeat of the Venetians in November 1354, a truce was agreed to, which terminated in a peace in the month of May following.

The family of Visconti had risen to great power in the centre of Italy. John Visconti had influence in Genoa, intrigued in Venice, and threatened to destroy the independence of Tuscany. He died in 1354; and his power and pretensions, being divided between his three nephews, became weaker, and received a check when Charles IV. returned to Italy in 1355 to remodel the governments of Pisa and Siena, and so far overcame Tuscany, though only for a short period, as to compel even Florence to adopt the title of an imperial city. With but little real power he opposed the Visconti; but ended in obtaining money from them, as he did from most parts of Italy, in his progress through the country. In 1363, he liberated the city of Lucca from the dominion which the Pisans had obtained over it. Between the years 1365 and 1375, Pope Innocent VI. obtained absolute power over the cities of the papal dominions; but lost much of it again, from the discontent excited by the tyranny of the legate, and by the interference of Florence in favour of their freedom. Robert of Geneva, who was elected as pope, and took the name of Clement VII., established his court at Naples in 1378, under the protection of Queen Joanna. He was opposed by another pope, Urban VI. The church was thus divided between two popes and two colleges of cardinals, and the temporal power of the holy see was weakened. Several of the cities had been enfranchised by the Florentines; but those of Romagna, with some others, fell under the yoke of petty tyrants.

The continued thirst for dominion of the Visconti in the centre of Italy, where they had rendered themselves masters of Genoa and Bologna, excited a general combination against them, at the head of which was Florence; and the old parties of Guelphs and Ghibelines were forgotten in this new and threatening crisis. In Florence, the Guelphs were divided into two parties, the Ricci and the Albizzi. After much bloodshed, Michael de Lando, a man of humble origin, but brave and generous, restored tranquillity in 1378. The party of the Ricci, which had thus suffered a temporary check, was essentially aristocratic, and comprised among its members the family of Medici, whose names are then for the first time to be met with in Italian history. This party soon afterwards, in another tumult, banished Lando, and those who had supported his nomination, and then re-established the former aristocracy more firmly than before. Italy.

In the other republics the same progress was made. The leaders of the democracy, or their heirs, created themselves tribunes of the people, and became a fresh aristocracy, with the power of transmitting it to their families. At Genoa, a civil war was carried on for a long time between the two strongest parties. It ended in their conferring the sovereignty, in 1396, on Charles VI., king of France.

In Lombardy, Gian Galeazzo Visconti, who was on the throne of Milan, having rendered himself master of the smaller cities in that district, alarmed Siena, Pisa, Bologna, and other considerable places. Being restrained by the opposition of the Florentines from attacking them at that time, he carried out his design a few years later, and conquered most of them. Tuscany itself was endangered by his ambitious views, and was only saved by the appearance of the plague to which Gian Galeazzo with many thousand others fell a victim in 1402. This event gave a breathing time to that part of Italy; and, during the minority of the son of Gian, many of the places he had seized were retaken. Milan fell into a state of anarchy, and the Venetians availed themselves of it to conquer Padua and Verona, whilst, on the other side, the Florentines captured Pisa; and Gian Maria, a youth, was only supported on the tottering throne of Milan by the arms of his mercenaries. His tyranny and cruelty are painted in the blackest colours by all the writers of his age; and he at length fell a victim to the indignation of some of the nobles, by whom he was assassinated, in May 1412.

In 1409, a new but transitory danger threatened the republic of Florence, by the invasion of Ladislaus, king of Naples, which was no sooner repressed than the power of the Visconti became predominant. The Duke Philip Maria of that family, with the assistance of his celebrated general, Carmagnola, between 1414 and 1420, conquered all the states which had belonged to the family in Lombardy; and Genoa submitted to him in 1421. Venice and Florence then made a league in 1425, and Carmagnola conquered the whole of the territories on the river Adda, and secured them by the peace of Ferrara in 1428. The condottiero Braccio Montone contrived to make himself master of the city of Perugia, and of the whole of Umbria, and extended his power to Rome itself; whilst the Petrucci, in 1430, firmly established their power in Siena.

After the weakening of Milan by the Florentines and Venetians, and owing to the constant disturbances raised in Naples by the party of Anjou against Alfonso of Aragon, there was no longer any dangerously preponderating power in Italy. There existed, however, constant hostility between the armed military bands, in two divisions, according to their usual practice. One of these was led by Braccio Montone, and the other by Sforza Attendolo. Francis Sforza was enabled to make himself, after the death of Visconti, master of the whole territory of Milan, in 1450. The Venetians, greedy of extended territory, made an alliance with some of the smaller states; Sforza made a counter treaty with Florence, which, under the change of circumstances, providently changed its policy.

Italy. At this period the house of Medici, by its wealth and its prudence, began to attract notice and to gain importance in Florence. The power of Milan, where Sforza ruled; of Venice, which possessed the half of Lombardy; of Florence, which was wisely directed by Lorenzo de' Medici; and of Naples, which was not in a state to venture on offensive war; formed towards the end of the fifteenth century the political balance of Italy, and, in spite of manifold feuds, gave confidence to each state that its independence was secure.

In 1494, Charles VIII., king of France, advanced towards Italy, designing to conquer Naples; and Ludovico Sforza came forward, first to support, but afterwards to oppose him, whilst the pope, Alexander VI., in order to elevate his son Cæsar Borgia, courted the French alliance. The opposition to Charles was feeble, but the cruelties and the rapine which he caused or permitted filled Italy with disgust. Ludovico Sforza collected an army in the north, which induced Charles to leave one-half of his forces to retain the possession of Naples, which he had gained. He was impeded in his retreat, and lost in it the greater part of his army before he could enter his own kingdom. That portion of his force which he had left in Naples was obliged to capitulate at Atella in July 1496; so that after two years of a devastating war, the French did not gain the least footing. Louis XII., who had succeeded to Charles VIII. in April 1498, made pretensions to the government of Milan. He was opposed only by Ludovico Sforza, because Venice, which would have joined Ludovico, was engaged in an alarming war with the Turks; and Florence, from which the Medicis had been banished, was ruled by a party intent upon subjecting Pisa to their authority. Alexander VI., who had opposed Charles, formed an alliance with Louis, on condition that Cæsar Borgia should be made Duke of Valentinois in France, and of Romagna in Italy. Frederick king of Naples, though aware that he must be ultimately the victim of France, was too much occupied in restoring tranquillity at home to take any active measures to protect Italy.

Louis, favoured by the position of affairs, passed the Alps with a powerful army in August 1499. He took some small towns by assault, and put the garrisons and most of the inhabitants to the sword; a ferocious proceeding, which produced universal terror, so that Sforza could make no opposition, but dispersed the army he had collected, and withdrew with his family and treasures into Germany. There he found protection with the Emperor Maximilian. The cities of the north of Italy opened with trembling anxiety their gates to the troops of the French king, and he was installed as Duke of Milan in that capital, whilst Genoa, which had been an ally of Sforza, made terms with France. After this hasty subjugation, Louis returned to Lyons. The insolence of the French, their violation of all national institutions, their contempt of Italian manners, the accumulation of taxes, and the irregularity of their administration, rendered the yoke insupportable. Ludovico soon became acquainted with the ferment which prevailed, and the eager wishes of his subjects to see him again at their head. Presenting himself on the Swiss frontier, he hastily collected a small force. With this he entered Lombardy in February 1500, having only five hundred horse and eight thousand infantry. Como, Milan, Parma, and Pavia, opened their gates to receive him; and after a short siege Novara capitulated. But Louis was active, and his general, Tremouille, advanced to suppress this rebellion with an army in which were ten thousand Swiss. Hired troops of the cantons were in both armies. When they met, these troops had parleys between themselves, and the part in Ludovico's army agreed with those in the army of Tremouille to murder their Italian fellow-soldiers, and to leave the service in which they had entered. This was executed. Ludovico Sforza was delivered up and sent to France, where he died after ten years' imprisonment; and the Swiss returned home with the wages of perfidy and the curses of Lombardy, whilst the French continued masters of the country till 1512. Italy.

The French then attempted to gain Naples, and a most infamous treaty was concluded with Ferdinand the Catholic of Spain, who had engaged to defend it, by which that unfortunate country was subdued; and in the division of it, quarrels broke out between the French and Spaniards, in consequence of which, after the battle of the Garigliano, gained the 27th December 1503, by Gonzalvo, the general of the latter, the French were completely driven out, and the kingdom of Naples became an appanage of the Spanish crown.

By the death of Pope Alexander VI., and the accession of Julius II., the pretensions of Cæsar Borgia vanished, as the new pontiff was more zealous to strengthen the holy see than to advance the son of his predecessor. With this view he formed a treaty with the kings of France and Spain, called the League of Cambray, in 1508, the object of which was to check the engrossing measures of the Venetian republic. Failing in this object, his holiness, in 1509, entered into a treaty with the Venetians themselves, in which the king of Spain and the Swiss cantons were comprehended. His aim was to drive the French out of Italy; but he finally abandoned this project, from a fear that the council of French and German prelates assembled at Pisa would be induced to declare his election to the popedom invalid, and dismiss him from the dignity. In the mean time Maximilian of Germany and the king of France had concocted an alliance at Blois, by which it was agreed to divide between them the whole of the dominions of Venice on the continent; and in consequence of it, hostilities commenced in 1509. The cities surrendered to the French, the Germans, or the Spaniards, all of whom exercised the most abominable cruelties. The pope, in the midst of the conquests of the great powers, became alarmed, and attempted to free Italy from their ravages, by inflaming the emperor against the French, by forming a league with Venice, and by calling in the aid of the mercenary Swiss. The pope raised an army, commanded by the Duke of Urbino; and though it was defeated in 1511, he succeeded in forming a league, to which the prefix of Holy was given, on account of his being at the head of it, with the kings of Spain and of England, and which also comprehended the Swiss and the Venetians.

A powerful Spanish army from Naples, in 1512, advanced to assist the pope, commanded by Raymond de Cordova, who was glady received by the people. The French advanced under the command of Gaston de Foix, and a murderous battle was fought near Ravenna, on the 11th of April 1512. The French were victorious, but their victory was more than counterbalanced by the loss of their great general, who fell in the action. Maximilian suddenly betrayed his allies, recalled the German troops from the French service, and gave a passage through his territory to the Swiss to join the Venetian army. Ferdinand of Spain and Henry VIII. of England simultaneously attacked France, which was thus obliged to recall her troops from Italy, and abandon the country to the power of the Holy League. The liberties of Italy were then annihilated. Florence, with Tuscany, after being plundered by the Spaniards without pity or remorse, was delivered over to the banished but now restored Medicis. Giovanni de' Medici, afterwards Pope Leo X., with some other members of that family, reimbursed themselves for their long proscription, by the abundant wealth they employed their power to extort.

Charles V., already king of Spain, on the death of his grandfather Maximilian, was raised to the imperial throne in 1519. Charles, and Francis the king of France, had abundant subjects of contest; and Italy was doomed to be- A.D. 1512 to 1792.

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come the theatre of their quarrels. Francis, in 1523, sent an army under Bonnivet to invade Lombardy and take possession of Milan. The city had time to collect stores and complete its defences, owing to the supineness of the French general, and thus was preserved from capture till the emperor raised an army of sufficient strength to meet Bonnivet in the field.

In the next year the imperial army received such reinforcements that Bonnivet thought himself unable to resist it, and resolved to withdraw his troops. On the retreat he was wounded, and the command devolved on the Chevalier Bayard, who was killed in the battle. The remnant of the French now only thought of escaping to their own country, leaving Lombardy in the power of the imperialists. Charles was so elated by the success of his arms in Italy, that he resolved on invading the patrimonial dominions of Francis, and accordingly Pescara led his army into Provence, and began the siege of Marseilles; but the attempt proved unsuccessful, and Francis once more mustered courage to make an attempt to retrieve the reverses he had suffered in Italy. The French passed the Alps by Mount Cenis, and the rapidity of their movements enabled them to enter Milan, which was unprepared for the attack; but the imperial general secured and garrisoned the citadel, which in some measure commanded it. Francis then laid siege to Pavia, which was strongly fortified, and garrisoned by six thousand veterans. The siege occupied several months, and thus gave time for Charles to collect his troops. Francis was resolved to fight, though urged by his generals to avoid a battle. On the 24th of February 1525, the two armies engaged; the contest was obstinate, and the issue long doubtful; but after dreadful carnage, the imperialists were victorious, Francis himself was taken prisoner, and with him Henry king of Navarre, and a few only of the body guard escaped. The French in Milan retired, and in fourteen days after the battle, not a soldier of that nation remained in Italy.

After this attempt of the French on Italy, which, like all that preceded, had only shown that a temporary ascendancy could be obtained by that nation, but could never be retained, the preponderating influence was securely held by the Emperor Charles V. Most of the reigning houses disappeared, and their successors were appointed either avowedly or secretly by him. When the male line of the Marquis of Montserrat became extinct, Charles, in 1536, gave his dominions to Gonzaga of Mantua; and Maximilian II., in 1573, created it a dukedom. The Florentines made an attempt, after murdering the Duke Alexander in 1537, to regain their independence; but their efforts were unavailing, and Cosmo de Medici was raised to supreme power by the influence of Charles. Parma and Piacenza had been seized upon by Pope Julius II. for the holy see; but Paul III., in 1545, erected those states into a dukedom for his natural son Peter Alexander Farnese, whose son Octavio, in 1556, was invested by the emperor. Genoa, which, since 1499, had submitted to France, found a deliverer from that power in the person of Andrea Doria, who established a firm aristocracy, which overcame the conspiracy planned by Fieschi for its overthrow. Charles in 1553 had conveyed Milan, and also the kingdom of Naples, to his son Charles. At the peace of Château-Cambrésis in 1559, Philip II. and Henry II. of France renounced their pretensions to Piedmont, which was given to the legitimate heir, the brave Spanish general Emanuel Philip, duke of Savoy. In 1597 the legitimate line of the house of Este became extinct, upon which Cæsar d'Este, a natural son of the last prince, obtained Modena and Reggio by an enfeofment from the empire; and Ferrara was conveyed to him as a feudatory of the papal throne.

The end of the sixteenth century was a period of peace in Italy, and of such prosperity as could be expected after the discovery of the way to India by the Cape of Good Hope had destroyed the eastern traffic it had so long monopolized and found so lucrative. In the next century only some insignificant changes of territory took place. By the treaty of Lyons, 12th January 1601, the house of Savoy gave up some possessions it had in France, and received in return the estate of Saluzzo. By the peace of Chierasco in 1631, the cunning of Richelieu obtained Pignerol and Casale, which commanded the passes into Italy; but in 1637 he was obliged to give up the latter fortress. The peace of Italy was not disturbed by any of the operations of Louis XIV. of France. Its neutrality had been made one of the terms of the treaty of Turin in 1696.

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The war of succession in Spain, which broke out in 1700, produced considerable changes in Italy. The battle of Turin, won (September 7, 1706) by the Imperialists under the command of Prince Eugene of Savoy, caused the French to surrender to Austria (March 13, 1707) all the possessions and fortresses which they occupied in virtue of the Spanish rights in Lombardy; and thus Spain, after having held them for two centuries, lost them without even her consent having been asked. The duchy of Mantua shared the same fate. Ferdinand Gonzaga, the last duke, sunk in sensuality and sloth, and utterly indifferent to affairs of state, had allowed the French to occupy it during the war. It, too, was surrendered to the Imperialists, notwithstanding the protest of Ferdinand, who died of grief at Padua a few months after. By the treaty of Turin, October 7, 1703, Montserrat, which formed part of the duchy, was ceded by Austria to Savoy as the price of her co-operation. In 1707 the Imperialists took possession of Naples with scarcely any resistance from the Spanish viceroy. By the peace of Utrecht (April 1713) and the two treaties of Rastadt and Basle (March 6, September 7, 1714) the arrangements which had followed the battle of Turin were ratified, and the emperor was confirmed in his possession of Naples. The island of Sardinia, given up by Spain, was added to his conquests, and Sicily, chiefly through the agency of England, was also wrested from Spain, and given to the house of Savoy. After the death of Louis XIV., Spain, at that time governed by Cardinal Alberoni, endeavoured to retrieve her losses, and pounced upon Sardinia in 1717, and on Sicily in the following year. England, France, Holland, and Austria, immediately formed themselves into a league against her, known as the Quadruple Alliance. The war that begun was brought to a close by the peace of February 17, 1720. Naples was left in the possession of the house of Austria, which also received Sicily, exchanging it with the house of Savoy for the island of Sardinia. From this time the dukes of Savoy have taken the title of kings of Sardinia. The contingent succession to Tuscany, and to Parma and Piacenza, upon the extinction which was then anticipated of the Medici and Farnese families, was secured to Don Carlos, the younger son of Philip V. of Spain by Elizabetta Farnese, his second wife.

The war of the Polish succession, 1733–38, caused other important changes in the Italian peninsula. The Spanish Infant Don Carlos, to whom the duchies of Parma and Piacenza had already devolved (January 10, 1731), seized the kingdom of Naples, defeated the Austrians at Bitonto (May 25, 1734), and was crowned at Palermo (December 1734) as king of Naples and Sicily. Emmanuel of Savoy, now king of Sardinia, joined France and Spain, and with the aid of the former was enabled to take possession of the duchy of Milan. By the treaty of Vienna, of November 1735 (at first entered into only by Austria and France, but to which afterwards Spain and Sardinia found themselves obliged to give in their adhesion), it was stipulated that Don Carlos should deliver up Parma and Piacenza to the emperor, and in return be acknowledged king of Naples and Sicily; that the king of Sardinia should restore the duchy

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of Milan to Austria, retaining only Tortona and Novara; that Tuscany, at the death of the grand-duke Giangastone de Medici, who had no heir, should go to the house of Lorraine in compensation for their hereditary states, which, on their taking possession of Tuscany, were to go to Stanislaus, the father-in-law of Louis XV., in return for his renouncing the Polish crown, and after his death to France. Giangastone, in whom the line of the Medici became extinct, complained of these arrangements formed without his knowledge; but all he could obtain was an imperial diploma, issued with the consent of the Germanic diet on the 24th January 1737, which, to remove any chance of reversion to the empire, provided that at his death the sovereignty of Tuscany should be vested in Francis of Lorraine, and his male descendants in the order of primogeniture; in case of the extinction of that line, in Charles of Lorraine and his male descendants; and, failing the male branches altogether, it should be vested in their female descendants. Giangastone died the same year, and Francis of Lorraine, who had married Maria Theresa, eldest daughter of the Emperor Charles VI., afterwards empress of Austria, came to his newly acquired state in 1739. Massa and Carrara, in 1743, fell by hereditary succession to the duke of Modena.

The death of Charles VI. without male issue gave origin to the war of the Austrian succession. By a treaty agreed upon at Worms in 1743 by Austria, England, and Sardinia, the Finale was wrested from the republic of Genoa, a neutral power, which was thereupon driven, in self-defence, to join Spain and France. In the course of the war the Austrians were defeated at Velletri, near the Neapolitan frontier (10th August 1744), by Charles III., and were driven out of Milan by the Spaniards, who, in their turn, were expelled by Charles Emmanuel of Savoy. Genoa surrendered (7th September 1746) without opposition to the Austrians, who did such deeds of tyranny and extortion that the people rose *en masse* and drove them out of the town. The next year (1747) it withstood successfully a severe and protracted siege by Austrians and Piedmontese on land, and by an English squadron at sea. At length, by the treaty of Aix-la-Chapelle (30th April—18th October 1748), Charles III. was maintained in the possession of Naples and Sicily; the duchies of Parma, Piacenza, and Guastalla, were settled on his brother Don Philip; Milan was restored to the house of Austria; the districts of Vigevanasco and Bobbio, and some portions of Anghiera and Pavia, which Maria Theresa had ceded to the king of Sardinia for his services, were secured to him, and the Finale was restored to Genoa.

As soon as peace was definitely made, Genoa continued with greater energy the warfare which had been going on in the island of Corsica from 1736; but finding herself unable to cope alone with the islanders, especially through the genius and military skill of General Paoli, by a treaty concluded at Versailles (15th May 1768) she made over the island to Louis XV. A large French army, after a protracted and obstinate resistance, overcame the Corsicans, and Paoli, with more than 400 of the leading patriots, was compelled to make his escape from the persecution of the conqueror on the 13th June 1769.

From the treaty of Aix-la-Chapelle to the attack of the French upon Piedmont in 1792, Italy enjoyed 44 years of peace, during which the country made steady progress in the improvement of its social and political institutions. The Emperor Joseph II. encouraged the University of Pavia, abolished in part the feudal institutions, and checked the privileges of the clergy in Lombardy, which, under the mild and wise administration of his minister, Count Firmian, increased greatly in wealth and population. His brother Leopold, grand-duke of Tuscany, gave a new code of laws, introduced numerous improvements into every branch of the administration, and supported the bishop of Pistoja, Scipione de' Ricci, in his attempts at ecclesiastical reform. In Naples, Charles III., and, after his accession to the throne of Spain, his son Ferdinand, under the ministry of the Marquis Tanucci, adopted the same course of reforms. Feudal rights and jurisdictions were nearly all abolished, attempts were made towards a methodical arrangement of the numberless existing statutes, pragmatics, edicts, &c.; and the mortmain laws were enacted to check the increase of the excessive landed property of religious corporations. Numerous improvements were also made in the duchies of Parma and Piacenza by Don Philip, under the direction of his minister Dutillot. Even the Roman States had not been stationary. The reform in the secondary branches of the administration begun by Benedict XIV. (Lambertini, 1744–1758); neglected by Clement XIII. (Rezzonico, 1758–1769); were continued by Clement XIV. (Ganganelli, 1769–1774), who, yielding to the demands of the courts of France, Spain, Portugal, Naples, and Parma, suppressed the order of the Jesuits (21st July 1773); and by Pius VI. (Braschi, 1774–1799), who drained the Pontine Marshes.

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Such was the state of Italy when the French attacked Sardinia in September 1792. As the narrative of the events by which Italy fell under the dominion of Bonaparte has been already given under the head FRANCE, it is only necessary to refer the reader to that article. When possession of most of the peninsula had been gained in 1797, republicanism was in the ascendant at Paris, and the Cisalpine republic was formed. Lombardy was extended by adding to it a portion of the papal territory. Genoa formed another republic, called the Ligurian; and Venice, which had submitted without opposition, changed its own institutions on the model of the French republic, though it was soon afterwards transferred to Austria by the treaty of Campo-Formio. Naples also was, in 1799, formed into the Parthenopæan republic, but after a few months Cardinal Ruffo re-established the government of Ferdinand IV., the leading patriots having surrendered the castle on condition that they should be allowed to go to France. The capitulation was broken by Lord Nelson; and the liberals who had already embarked on ship-board, and who numbered many of the best and most learned men in Naples, were all executed. When Bonaparte became first consul, the Cisalpine republic was new-modelled after the pattern of France, and converted into the Italian republic. In 1805, when the military regime was completed in France, and Bonaparte had become its emperor, the same kind of monarchy was forced upon Italy, and he was crowned at Milan on the 26th of May, with the iron crown of Lombardy. In January 1806, a French army entered Naples and proclaimed king his brother Joseph, who, however, in 1808, exchanged it for the throne of Spain, and was succeeded by General Murat. For one of his sisters, who had married Paschal Bacciochi, Parma and Piombino were formed into a principality. Tuscany became a kingdom of Etruria, and was given to the Parma family; but in 1808 they were all converted into a province of France. Ferdinand of Naples, who in 1806 took refuge in Sicily, was enabled to maintain himself by the assistance of the English navy and army. Whilst Murat reigned as king in Naples, and Eugene Beauharnois as viceroy in Milan, they were both summoned, with all the forces they could collect, to join the grand army for the subjugation of Russia. After the retreat from Moscow, both returned to their dominions with the remnant of their forces. Eugene maintained the fidelity for which he had engaged; but Murat, offended with Bonaparte, formed an alliance with the confederated monarchs of Europe. After the abdication of the imperial throne, Eugene withdrew, and the states of Italy returned to the government of their former rulers, with the exception of Venice, which remained subject to Austria.

On the return of Bonaparte from Elba in 1815, Murat took up arms, advanced northwards, and entered Bologna. Driven thence, he was soon afterwards defeated near Tolentino, and his power completely destroyed. The capital was entered by the Austrian general Nugent, and Murat fled to France, while his wife and family found refuge in Austria. Ferdinand returned from Sicily to Naples, and maintained, with few changes, the Code Napoléon and the other institutions introduced by the French. Murat made a feeble attempt to recover his kingdom; and having collected a small body of troops in Corsica, landed with them at Pizzo, in Calabria, where he was made prisoner, tried by a military tribunal, and shot. By the final treaty of Vienna, the following arrangements regarding Italy were agreed to, which, with few changes, still remain. The king of Sardinia received back all his dominions, according to the boundaries existing in 1792, with some few changes in the frontier on the side of Geneva. To these were added the city of Genoa, and the territory attached to it in former times when it was a republic. The emperor of Austria united with his hereditary monarchy the newly-erected kingdom of Venetian Lombardy, in which were included the districts of the Valteline, Bormio, and Chiavenna parts of the Swiss canton of Grisons. Istria was not included in the Austrian kingdom of Illyria. The valley of the Po was fixed upon as the boundary between the Popedom and Parma. The house of Este was again declared sovereign over Modena, Reggio, Mirandola, Massa, and Carrara. The Empress Maria Louisa received the state of Parma as a sovereignty for her life, after which it was to fall to the Duchess of Lucca and her heirs, who were to give up a territory in Bohemia to the Duke of Reichstadt, the son of Napoleon and Maria Louisa. Prince Ferdinand of Austria received Tuscany and the district of Piombino, with the title of Grand Duke. He also obtained the sovereignty of the isle of Elba, on condition of reserving in that island the rights of Prince Buoncompagni Ludovisi. The Infanta Maria Louisa received Lucca as a sovereign dukedom, and with it a yearly pension of 500,000 francs, till the decease of the Empress Maria Louisa. The pope was fully reinstated in all his dominions, with the exception of a few small portions on the left bank of the Po; but Austria reserved the right of recruiting in Ferrara and Comacchio. Ferdinand of Naples was again acknowledged as king of both Sicilies, and the republic of San Marino and the Prince of Monaco were guaranteed in the enjoyment of their ancient rights.

Thus, at the end of twenty years of war, Italy lost the ancient liberties of some of its provinces, and saw the Austrian sway more firmly established and extended in others. But this was not the worst. Her rulers, who, before the French Revolution, had commenced civil and political reforms, came back with an obstinate aversion to any change. All that the country had gained was the abolition of the remnants of feudal rights and privileges, the division of feudal domains, and of the extensive lands wrested from the suppressed monasteries, and the introduction of the Code Napoléon into most of its states.

The restoration of the old governments, however, was not followed by the return of tranquillity, still less of contentment among the Italians. A new spirit was astir among them which was not likely to be allayed by the arrangements of the Congress of Vienna—the spirit of national independence. Awakened first by a few poets of the last twenty years of the eighteenth century, it had been fostered by the allied powers themselves, who found it their own interest to oppose it to the French rule. The archduke John of Austria, in 1809, Lord William Bentinck, in 1814, at Genoa, and General Nugent, in 1815, had all promised independence to the Italians, and excited them to rise in the name of their country's freedom, and defend their own rights and their own liberties. Even Murat, in his march to Upper Italy, in 1815, had appealed to the spirit of national independence, and gave out the freedom of Italy as the object of his expedition. It became then the favourite theme of the national literature, and the measures adopted by the Congress of Vienna contributed to strengthen it. By the extension of the Austrian power in the peninsula, all the Italian sovereigns became virtually so many liege lords of the empire; their policy was dictated by the cabinet of Vienna, and not one of them dared to act or think for himself. Thus King Ferdinand, who, on leaving Sicily in May 1815, had addressed to the Neapolitans a proclamation, in which he promised to be the depositary of such laws as should be decreed by a constitution, in June of the same year, by a secret treaty signed at Vienna, engaged himself not to introduce into his states any principles of government irreconcileable with those adopted by Austria in her Italian provinces; and accordingly, in 1816, he put, *de facto*, an end to the Sicilian constitution of 1812. The accumulated hatred of all the tyranny and petty persecutions that took place in any part of Italy after the restoration fell therefore upon Austria, which, right or wrong, was looked upon as their instigator and abettor. This feeling increased in proportion as at every effort made by the people to rid themselves of the tyranny under which they were groaning, the Austrians stepped in to support their sovereigns, and rivet their chains. A conviction then arose that there could scarcely be any real improvement in the state of the peninsula until national independence had been obtained. These observations will give a clue to the events that took place from 1815 to 1855. Their historical details, which varied in the different states, will be given under the head of each of those states; here we shall only sketch rapidly their course, in so far as they had a common object in view, and affected the interests of the whole peninsula.

The Italian sovereigns, on returning to their respective states, neither restored the ancient order of things, nor adapted their new policy to the fresh wants and altered conditions of society. In compliance with the dictations of the Holy Alliance, they undid not only what had been done under the French rule, but also their own previous reforms. By an agreement with the pope, the Jesuits were restored everywhere, many of the suppressed monasteries were re-established, and the mortmain laws of the eighteenth century were repealed. The taxes upon land were increased, and exports and imports checked by means of high duties. The system of passports was made much more stringent, and permission to leave one's native town, even for a few days, often denied. Elementary education was narrowed in its limits, and thrown entirely into the hands of the clergy; its highest branches were discountenanced and lowered by the expulsion from the universities of some of the ablest professors, supposed to entertain liberal views. Private lecturing or teaching was not allowed without a previous license from the ordinary and the police agent. The freedom of the press was fettered more than it had ever been before, and every work before being published was subjected to a rigorous scrutiny. Public functionaries were changed without any regard to justice, but merely because they had served under the former government. All who had distinguished themselves in the time of Napoleon, or who were of a liberal turn of mind, were openly persecuted, or held in disesteem, and their movements and words suspected, watched, and reported. In addition to all this, in the papal states ecclesiastics returned to fill all civil offices, and the Code Napoléon was withdrawn from those provinces which had formed part of the kingdom of Italy. Hence there arose general discontent among the people, and thousands of otherwise quiet persons, either in the hope of finding redress and protection, or only out

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of a feeling of revenge, joined the *Carbonari*. This was a secret political society which had been formed during the French rule for the purpose of emancipating the peninsula, and is supposed to have been at first encouraged by the Bourbons of Sicily against Murat. The Carbonari counted among their numbers many officers who, when the army at the restoration had suddenly changed its colours, were either expelled or not regularly promoted. This vast combination, supported by the general sympathies of the people, wanted but a small impulse to break out into open rebellion, and it was in vain that the government of Naples tried to oppose to the Carbonari another secret society, called the *Calderari*, who adhered to the royal party.

The Spanish military revolution of January 1, 1820, which proclaimed the constitution adopted by the Cortes in 1812, produced an excitement which spread rapidly throughout Italy. Its first effects were experienced at Naples. In July 1820, the army mutinied, and demanded the Spanish constitution. The king thereupon named as vicar-general his eldest son Francis, who assented to the demand in his father's name, and appointed a provisional junta. In presence of this body as well as of the chiefs of the army, both he and his father, on the 13th July, swore fidelity to the new order of things. An assembly was convened, which adopted the Spanish constitution, with some trifling modifications, decreed a large military force, and began reforms in several branches of the public administrations. General Florestano Pepe was sent with a body of troops to restore tranquillity in Palermo, where on the 15th July, at the news of the events of Naples, a popular outbreak had created great confusion. Pepe landed at Melazzo, marched towards Palermo, entered it by capitulation on the 6th October, and proclaimed the constitution.

Meanwhile the emperors of Austria and Russia and the Prince Royal of Prussia met in October at Troppau, where the ambassadors from France and England were also present, and decided on a military interference in the affairs of Naples. Austria at this time had marched an army of 80,000 men into her Italian provinces, and Great Britain and France had each stationed a naval squadron in the Bay of Naples, with instructions to watch over the safety of the king and the royal family.

The three sovereigns having invited Ferdinand to meet them at Laybach, the king announced his resolution of accepting the invitation, and received the assent of parliament, on his declaring that his going would have no other object than to avert a war and maintain the constitution in its integrity. The crown prince was appointed regent, and the king proceeded on the 13th December in an English ship of the line to Leghorn, and thence to Laybach. The congress decided not to allow the continuance of the new order of things at Naples, and entrusted the emperor of Austria with the power of suppressing what they called a revolt. This resolution was made known to the prince regent in Naples. He was also informed that an Austrian army was ready to enter the kingdom, and that if it was insufficient, a Russian army would follow. The regent and the parliament having determined to resist, and made preparations for defence, the representatives of the allied powers withdrew from Naples, a large Austrian army under General Frimont advanced, and after encountering and routing the Neapolitans on the frontier of the Abruzzi, entered Naples on the 23d of March 1821, and restored the old regime. Ferdinand returned soon afterwards to his kingdom to direct the state prosecutions.

While these events were taking place in Naples, another military insurrection, originating in the same causes, but differently directed, broke out early in March in Piedmont, and proclaimed the Spanish constitution. The king, who had assented to the resolutions of the Congress of Laybach, refused to yield, on the 13th abdicated the throne, and in the absence of his brother and heir, Charles Felix, who had set out for Modena to meet the king of Naples on his return from Laybach, appointed Prince Charles Albert Carignani as regent. Charles Felix, by a proclamation of the 16th, declared that the abdication of his brother was forced and illegal, and disavowing the changes that had taken place in Turin, appointed General Latour to take the command of the loyal troops stationed at Novara, and to suppress the insurrection. The liberal party determined to resist; but as soon as this resolution was adopted, the prince-regent on the night of the 21st fled to Novara, and there declared his readiness to submit to the royal pleasure. An army, hastily collected, was despatched from Turin to attack Latour, and on the other hand Count Bubna, the Austrian commander-in-chief in Lombardy, to whom Charles Felix had applied, on the 8th April crossed the Ticino and marched to his assistance. After a short but brisk skirmish near Novara on that day, the liberal army was defeated, General Latour entered Turin on the 10th, and Count Bubna took possession of the fortress of Alessandria on the 11th of April. Victor Emmanuel confirmed solemnly on the 19th his act of abdication; Charles Felix assumed the title of king, with a power as unrestricted as that of his brother had been; Charles Albert, who was refused admittance by the new king, after a short residence in Florence, went to make amends for his liberal tendencies by serving in the French army which restored despotic rule in Spain in 1823.

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These movements were followed by numerous state trials and executions in Naples and Piedmont, as well as in the rest of Italy. Among those arrested in Lombardy were Silvio Pellico, Count Gonfalonieri, Marroncelli, and other distinguished literary men, who, after being condemned to death, had their sentences commuted into imprisonment in the castle of Spielberg. In the kingdom of Naples, a call for a constitution by a few young men at Boscotrecase in 1827, was followed by a bloody retribution; many of the inhabitants were massacred; the rest were dispersed; the village itself was razed to the ground, and its site was effaced by the plough. In the Roman States, after the death of Pius VII. (August 1823), his successor Leo XII. (della Genga) adopted a coercive policy of still more grinding severity, while the strange excesses of Cardinal Pallotta, the espionage and bloodthirsty persecutions of Cardinal Rivarola, and the extraordinary commission of Monsignore Invernizzi spread dismay and affliction in every family.

After nine years of proscriptions and repression, the French revolution of July 1830 gave new hopes to the Italians, and was the proximate cause of fresh disturbances. The secret societies, which had never been entirely extirpated, increased in number and activity, and their leaders received and held out promises that if they came to an open rupture with their sovereigns, they might rely on effectual assistance from the newly established government in France.

No disturbances, however, took place in Lombardy and Piedmont, where the prosecutions had somewhat abated; nor in Tuscany, which was mildly governed; nor in the Two Sicilies, where the general amnesty by which Ferdinand II. initiated his kingdom in 1830 allayed discontent, and gave a hope of moderate reforms. In Modena the Duke Francis IV. had for some time promoted the conspiracy with arms and money, and was intimate with Ciro Menotti, a young man who led a first movement on the 3d February 1830. The troops were called out, and, after some fighting in the streets and from Menotti's house, he and his party surrendered. Two days later, on the arrival of the news of the events at Bologna, a more formidable revolt broke out; in consequence of which the duke deemed it expedient to withdraw to Mantua, taking with him his prisoners—of whom Menotti was afterwards shot—and a provisional government was established. Parma soon followed the example, and the duchess withdrew to Piacenza.

Italy. But the most important events happened in the Roman states, where the old and infirm Pius VIII. (elected 31st March 1823), being both unwilling and unfit to change the course followed by his predecessor, Leo XII., gave the people no hopes of better times, and drove them almost to madness. On the 4th of February an insurrection broke out at Bologna, which compelled the legate to resign his authority; and a provisional government abolished by a decree the temporal power of the pope. The insurrection spread out rapidly to Ancona, which capitulated to a handful of the insurgents. Meanwhile a division of a large Austrian army already collected in Lombardy advanced to Modena and Parma, and reinstated their respective rulers. The Italians, relying on the declaration made by France soon after the days of July, that she would not permit Austria to interfere in Italy, were buoyed up with the hope of French assistance; but when Louis Philippe had firmly established himself on the French throne, he explained away that declaration by stating that it did not bind him to take any steps to prevent such interference. A negotiation between Austria and France ended in an understanding that the former power might suppress the several Italian insurrections without permanently occupying the countries in which they prevailed. Accordingly, another division of the Austrian army advanced to Bologna, and having entered it without any resistance, marched towards Ancona, where the members of the provisional government (who belonged to some of the noblest and wealthiest families in the country) had taken refuge. Before the arrival of the Austrians, the insurgents, who in their flight had taken Cardinal Benvenuti and carried him with them as a hostage, surrendered to him the citadel on condition that indemnity should be given to all political offenders; but the pope refused to ratify the cardinal's stipulation. Pius died on November 30, 1830, and was succeeded by Gregory XVI. (Cappellari) 2d February 1831.

The events we have related caused Austria, Prussia, France, Russia, and England to present a joint memorandum (10th March) to the new pope, in which admission of the laity to administrative and judicial functions, and a general improvement in the laws and the administration, were strongly recommended. The only result, however, was a *motu proprio* (10th July 1831), by which the pope modified in part the municipal institutions. On the 15th July the Austrians withdrew, but no sooner had they crossed the frontiers than the liberal party took up arms again in the four legations. After a skirmish at Cesena, in which the insurgents were defeated, the papal troops entered Bologna, shot at random many people in the streets, and committed such horrors that when the Austrians arrived the inhabitants welcomed them with rejoicings. This fresh intervention of Austria having called the attention of the French government, a French fleet with an army on board appeared before Ancona in March 1832, seized the citadel, and drove away the papal troops. This led to some detailed negotiations which ended in a treaty of the 16th of April, by which it was settled that the French were to remain at Ancona at their own expense and without receiving any reinforcements, and were to depart as soon as the pope should have no longer occasion for the assistance of the Austrians.

From this period there was a lull of nearly 10 years in the Italian agitation, with the exception of the outbreaks, caused chiefly by the cholera, in 1837, at Syracuse and at Palermo, in Sicily. It was easily put down by the Neapolitan minister of police, Del Carretto, who shed blood unsparingly, and it gave an excuse to Ferdinand II. to put an end to the separate government that the island had enjoyed from the foundation of the monarchy in the 12th century. In 1838 the French withdrew from Ancona, and the Austrians from the Legations.

No attempt to reform having been made, and the police, in the Roman States and the Two Sicilies especially, becoming more stringent and inquisitorial every day, the discontent and agitation reappeared stronger than ever in 1844, and were kept alive and spread by the scientific Congress which met every year in one of the Italian cities. An attempt at revolt at Cosenza in Calabria was easily repressed; the brothers Bandiora, with a few followers, were captured soon after landing on the Calabrian coast, and all executed by the Neapolitan government, which had been acquainted of their projects by the English ministry, and was accordingly prepared to meet them. Italy.

The death of Gregory XVI. (1st June 1846), and the election of his successor, Pius IX. (Mastai Ferretti, June 16), opened another period in the history of Italy. On the 16th July, a month after his election, the new pope granted a general amnesty to all political offenders. The hosannas were countless. Pius IX. was hailed as a deliverer in every part of Italy. The cry of *Viva Pio Nono* became the rallying word of the liberal party. Reforms followed reforms, and hopes grew stronger every day. Austria became alarmed and threatened to interfere. The Nuncio, Monsignor Viale (who, at a later period, was to take a prominent part in framing the Austrian concordat), acting in direct opposition to his instructions from Rome, discussed with Metternich the excesses of the liberals, the weakness of the government, and the probability of its requiring aid. On the 17th July 1847, the Austrians crossed the Po and occupied Ferrara, where several outrages were committed by the Croats. The governor of the Legation, Cardinal Ciacchi, and the secretary of state, Cardinal Ferretti, protested strongly against the invasion of the papal territory; the Austrian cabinet replied; Ferretti protested again, and sent a remonstrance to the European powers; and the Austrians at last withdrew.

The agitation was everywhere on the increase. A handful of daring men proclaimed a constitution at Reggio, in Calabria, and attacked the troops at Messina, in September, but were easily beaten off. Then followed, as usual, arrests, a state of siege, councils of war, the brutal license of the army. In Lombardy, the commander-in-chief, Marshal Radetzky, imprisoned by hundreds, and brought the prisoners before councils of war. The affairs of the peninsula having called the attention of the European powers, the British government determined upon sending to Italy Lord Minto, who formed part of the cabinet of Lord John Russell. Lord Minto's instructions were to recommend to the Italian sovereigns those political changes and that good faith which would give security to their governments, and to their subjects that moderation which might lead to the establishment of liberty. He began by visiting Switzerland, whence he went to Italy, where he acted up to his instructions faithfully. He became the butt of numerous accusations and misrepresentations both abroad and at home; but he served his government with ability as well as with honour, and deserved well of Italy by his honest and faithful endeavours to inculcate good faith on her rulers.

The last months of 1847 saw the first important political change in the form of Italian governments. In Tuscany, a law of the grand duke (September 4th); in Rome, a *motu proprio* of the pope (25th October); and in Piedmont a notification of the king (29th October), established elective consultative bodies to act as councils of state. At Lucca, the same reforms having been called for, the duke withdrew, and the duchy was united to Tuscany, 11th October 1847.

Naples and Austria proclaimed that their states needed no reforms. On the 2d January 1848, a liberal demonstration at Milan caused the Austrian garrison to massacre many harmless old people and women in the streets. Funeral ceremonies for these victims were celebrated in

Italy. Piedmont, Tuscany, and the Roman States. On the 4th, proclamations were seen posted in the streets of Palermo, declaring that a revolution would take place on the 12th January, if the king, before that day, did not grant some reforms. No reforms were granted, and on the appointed day the population of Palermo rose in arms against a garrison of 8000 men, who, after four days, were strengthened by reinforcements of 5000 men and eight war steamers. The insurgents formed a provisional government, presided over by old Admiral Ruggiero Settimo. In Naples, on the 27th January, a large number of people assembled before the palace and called for a constitution; the king changed his ministry, and on the 29th promised to give it. On the 1st February a general amnesty was granted to all political offenders; on the 10th the constitution was published, to which, on the 24th, the king and all the members of the royal family took their solemn oath.

The period of consultative councils was over; that of representative institutions had begun. Constitutional statutes were published on the 15th February in Tuscany, at Turin on the 4th, and in Rome on the 14th of March. But in Sicily fighting was still going on; and as the royal troops had the worst of it, the king entreated the British government to interpose its good offices, and despatched a messenger with an invitation to Lord Minto, then in Rome, who arrived on the 4th of February, and began to confer with the government as to the terms to be offered to Sicily. Meanwhile the citadel of Palermo surrendered to the insurgents; the royal forces were everywhere defeated; and on the 24th the provisional government summoned a parliament in order to adapt their constitution of 1812 to the present times.

The breaking out of the French revolution gave a new turn to Italian affairs. New passions were called into play, new conflicts arose. A small republican party, stirred up and abetted by French agents, got the upper hand in many places. The peninsula was covered with blood, and at last, with the exception of Sardinia, lost all it had gained in the first four months of the eventful year 1848.

On hearing the news from Paris, the king of Naples entrusted Lord Minto with the terms which he was requested to take to Sicily; but on arriving at Palermo (9th March) with the squadron of Sir William Parker, Lord Minto found that a Neapolitan war steamer had brought those terms and published them as an *ultimatum* of the king, and that public opinion, excited by the contemporary arrival of the French news, had already rejected them. With great difficulty Lord Minto succeeded in obtaining from the government of Palermo that the royal terms should be accepted, with some trifling modifications. These, on being transmitted to Naples, were refused by the king, who protested against any act which might take place from that time in Sicily (22d March). The king, by this time, was possessed of no stronghold in the island except the citadel of Messina. Parliament having assembled at Palermo (25th March), decreed that the Bourbons had forfeited the throne of Sicily (13th April), and after accomplishing the reform of the constitution, called to the throne the duke of Genoa (11th July), the youngest son of the king of Sardinia. A messenger sent to announce the election was conveyed to Genoa by an English war steamer, speedily followed by a French one with a formal deputation on board. The duke neither accepted nor refused the crown.

In Naples the moderate constitutional ministry (of which Poerio was a member) was replaced, 3d April, in consequence of the events in France, by a more radical administration. The franchise was now extended by a new electoral law; a modification in the appointment of the upper house was announced; and an army was sent, under General William Pepe, to join in the war against the Austrians. On the 15th May, the day on which parliament was to meet, the republican party, encouraged by the presence of the French fleet, and prompted by the representative of the republic, raised barricades with the aid of many French officers and sailors, and called for a modification of the upper house. A collision ensued, which cost more than 1000 lives and great destruction of property. The fight lasted seven hours; and the royal troops, after carrying the barricades, were assisted by the lower classes in the pillage of the houses. The next day the king changed the ministry, dissolved the chambers that had never met, issued a proclamation stating "his most firm and immovable will to maintain the constitution," and recalled the army from Bologna, where it was on its way to the Po. A new electoral law was framed. The chambers met for the first time on July 1st, and supported the government in stifling the revolution originated in Calabria by the news of the 15th May. Italy.

The events of Piedmont and Southern Italy, and the news of the French republic, acted like an electric shock upon the Lombardo-Venetian kingdom; yet no important events took place until the rising of the people at Vienna, on the 13th March, had thrown the imperial government into confusion. Before proceeding to hostilities the Milanese demanded several concessions. Their refusal was followed by the insurrection of Milan (18th March 1848), and the expulsion of the Austrians (23d March), by the capitulation of the commander of Venice (24th), and by the rising of the whole kingdom.

Provisional governments were established, under the presidency of Casati at Milan, and of Manin at Venice. On the 23d King Charles Albert declared war against Austria. On the 8th April he forced the Austrian lines on the Mincio in three places, and, crossing the Adige, took up a position to the N. of Verona. On the 30th the Austrians were dislodged from Goito, and driven to the gates of Mantua. After these victories, Piacenza, Parma, Modena, Lombardy, and Venice, by universal suffrage, joined the Sardinian monarchy, on condition that the constitutional statute should be remodelled by a general constituency. Radetzky, who had received an accession of strength of 15,000 men brought by Nugent, on the 28th May with 40,000 men fell upon and defeated 5000 Tuscans and Neapolitans at Curtatone, and on the 30th attacked the right wing of the Sardinians at Goito. He was repulsed with great loss, and on the same day the fortress of Peschiera surrendered to Charles Albert. Radetzky recovered his loss by marching with 30,000 men upon Vicenza, where the papal army under General Durando were quartered, and having been joined by Welden with a reinforcement of 15,000 men, on the 10th June, after a bombardment of 48 hours, he compelled Durando to surrender on the terms that the Romans should recross the Po and not take up arms against Austria for the space of three months. The Sardinians, on the 13th July, invested Mantua; but in doing so they left their strong position, and lengthened their line too much. The watchful Radetzky at once saw their mistake, attacked them on all points, and gave them a severe defeat on the 25th at Custoza. The Sardinians withdrew to Milan, where, on the 4th August, they were again defeated. On the 6th they crossed the Ticino, and Radetzky entered Milan, where, on the 9th, he signed an armistice.

As soon as these events were known at Naples, the king hastened the preparations he had been making for attacking Sicily, and an expedition under General Filangieri finally left Naples for Messina on the 30th August 1848. The Neapolitan troops disembarked on the 3d September, reinforced the garrison of the citadel, and invested the town. They then opened fire upon the place, which was defended by the inhabitants with the energy of despair. After a murderous bombardment of five days they got possession of it; and rushing in, perpetrated such atrocities, that the

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commanders of the French and English fleets then in the Bay of Naples interfered and extorted an armistice from the conquerors.

Important events were meanwhile taking place in Rome. Soon after the papal troops had marched to the frontiers, Austria, by threatening to dissolve the spiritual connection between Germany and Rome, so powerfully influenced the pope, that on the 29th April 1848, in a secret allocution in consistory, he disapproved of the war with Austria, and the project of an Italian alliance for its prosecution. As soon as this became known, great dissatisfaction was expressed, and the pope began to grow unpopular. On the 13th September a new ministry was formed under the presidency of Cardinal Soglia. One of the leading members of the cabinet was Count Rossi, who, seizing the helm with a strong and skilful hand, steered the ship of state in a constitutional course. Meanwhile, the republican party, driven from Naples and Lombardy, had concentrated its strength in Rome. Seeing in Rossi an obstacle to the execution of their wild schemes, they murdered him on the 15th November on his way to the chambers. Several acts of disorder followed the perpetration of this crime; the pope grew alarmed, and, encouraged by Martinez de la Rosa, Spaur, and D'Harcourt, the Spanish, Bavarian, and French ambassadors, left Rome in disguise on the night of the 25th November. Flying for refuge to Gaëta, he was there received by the king of Naples. On the following day a supreme junta was formed, which, after a useless attempt to induce the pope to return, presented and passed a bill through the chambers (26th December) summoning a constituent assembly to deliberate upon the form of government.

The pope opened the new year 1849 with a protest from Gaëta, 1st January, against these acts, and with a threat of excommunication, which exasperated the people. The moderate party were now left unsupported, and the republicans gave practical effect to their principles without check or opposition. The constituent assembly met on the 5th February; on the 8th passed a decree abolishing the temporal sovereignty of the pope, and establishing a republic. On the 9th the republican flag was hoisted on the tower of the capitol.

After the disasters of the Sardinian army, and the truce of Milan, France and England mooted a mediation for the affairs of Italy, to which Sardinia easily acceded. Austria, after some objections, consented to send Count Colloredo to Brussels, where the conferences were to be held: Tuscany also sent a representative. But the flight and protest of the pope, and his appeal to the arms of foreign powers, and the flight which followed of the grand duke of Tuscany marred the whole project, and put an end to the mediation.

The events at Rome so far emboldened the small ultra party in Piedmont, that the government were compelled to resume the war against Austria. Accordingly, on the 12th March 1849, a superior officer, expressly sent to Milan, announced the cessation of the armistice to Marshal Radetzky. General Chrzarnowsky, a Polish officer, was appointed commander-in-chief of the Sardinian army, and the king accompanied it merely as a general officer at the head of the brigade of Savoy.

The hostile armies crossed the Ticino at the same time in order to invade the enemy's territory; the main body of the Sardinians at Buffaloro, and the Austrians 12 miles lower down the stream between Vigevano and Pavia. Chrzarnowsky had placed General Ramorino with a division of the army in an angle formed by the Po and the Ticino opposite Pavia, with injunctions to prevent the Austrians from crossing. Ramorino not only did not oppose the passage, but disobeyed orders so completely, that he was deprived of his command, and at the end of the war, tried by a court-martial, found guilty, and shot. By this neglect of duty on the part of Ramorino, Radetzky was placed between the two divisions of the Sardinian army, and in a position to command the road to Turin. The Sardinian vanguard had already advanced to within five leagues of Milan, when a retrogade movement became absolutely necessary. On the 23d March the duke of Savoy, who had remained behind with the reserve, attacked the Austrians at Mortara, but was driven back, and on the 24th Radetzky advanced and placed himself between Vercelli and Novara. It was here that the two armies met, and an engagement took place which put an end to the campaign. The Sardinians were defeated and driven back into divisions. At the end of the day, Charles Albert abdicated, and the duke of Savoy, now king Victor Emmanuel, concluded an armistice, which was afterwards changed into a final treaty. The terms were, that Sardinia should pay the expenses of the war, and suffer the fortress of Alessandria to be garrisoned by a joint Austrian and Piedmontese corps.

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Intestine revolution was added to the evil of a foreign defeat. When the news of the disaster and the armistice of Novara reached Genoa, the people were thrown into a state of excitement, of which the republican party took advantage. General Avezzana, the commander of the National Guard, summoned the citizens to arms; barricades were erected, a severe conflict with the royal troops followed, and a Ligurian republic was proclaimed. The government immediately sent a large force under the command of General della Marmora, who, on the 5th April, invested the place with such energy, that the insurgents begged for a truce, which was granted, and on the 11th, the town was unconditionally surrendered. A general amnesty was granted, except to Avezzana and eleven other chiefs, who took refuge on board an American war steamer.

Naples felt the effect of what was passing in Upper Italy. At the first news of the cessation of the armistice of Milan, the king, on the 13th March, dissolved the chambers, which were then sitting, and which were destined never to meet again. Meanwhile the English and French governments had failed to arrange matters between Naples and Sicily, and their respective admirals now ceased to enforce the armistice. As soon as the intelligence of the defeat of Novara arrived at Naples, the king sent orders to General Filangieri to resume hostilities. Catania, after the most desperate resistance, was captured on the 6th April; Syracuse next surrendered, and Palermo sent in its submission to the commander-in-chief on the 25th. The royal troops entered it on the 15th May, and the whole island submitted to Ferdinand II.

The summoning of a constituent assembly in Rome caused a small faction to call also for a constituent in Tuscany. The grand duke on the 10th January 1849, opened the session of the legislative chambers with a speech, in which he stated that the reasons for prosecuting the war against Austria still existed, and that he concurred in the wishes of his people. In less than a month (7th February), he silently abandoned Siena, where he was staying, and betook himself to the fishing village of Santo Stefano, in the Maremma, whence, on the 21st, he sailed to Gaëta on board H. B. M.'s war steamer the Bulldog. In a letter which he left behind for the minister Montanelli, he announced, that the pope having threatened to excommunicate him if he adhered to the Italian constituent, he saw no other means of extricating himself from the embarrassing position in which he was placed than by quitting Tuscany. On the arrival of this news at Florence, a provisional government was formed, and Mazzini, one of its members, tried to make Tuscany a province of the Roman republic. But the country had little sympathy with her extemporized administration. The members met at first with sullen opposition, but on 12th April, the municipality of Florence,

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amidst the acclamations of the multitude, and the support of the peasantry, drove them away, restored the monarchy, formed a new ministry, and recalled the grand duke. Delegates were sent to Gaëta, to tender him the crown on the base of the constitution. Leopold issued a proclamation in which he formally promised to uphold the free institutions; yet, shortly afterwards, under the plea that Leghorn had not agreed to the restoration, he called in the Austrians, who, under the command of General D'Aspre, entered Tuscany on the 5th of May 1849. The grand duke, encouraged by their presence, returned to his dominions and suppressed the constitution.

The numerous diplomatic intrigues that had been going on at Gaëta for the restoration of the pope came at last to an issue, and the Roman Catholic powers undertook a crusade against republican and antipapal Rome. A French expedition, under General Oudinot, landed at Civita Vecchia on the 25th April, and on the 29th reached the walls of Rome. A corps of 16,000 Neapolitans crossed the frontier and took up a position between Albano and Frascati. A large Austrian army entered the Legations; and even Spain, stirred by the piety of her ambassador, Martinez de la Rosa, sent a division, which landed at Fiumicino, and proceeded to Terracina, committing all sorts of excesses on their way.

The French professed to come as friends, but their presence was neither solicited nor desired. In a first attempt to enter the city, their advanced corps was vigorously attacked by the Romans and compelled to fall back. After protracted and unsuccessful negotiations between the triumvirate and the French agent, Mr Lesseps, whose arrangements were disavowed by the French ministry, Oudinot made preparations for a vigorous prosecution of the siege. On the 2d and 3d of June some sharp fighting took place near the Villa Doria, which was taken and retaken several times. On the 13th the French opened a brisk fire against the walls; on the 1st July, after forty-eight hours of cannonade, the breach was declared practicable, and the columns rushed to the attack. Resistance was now useless, and the triumvirate resigned their power into the hands of the municipality. On the 3d July the French entered Rome. The pope sent three commissioners, Cardinals Della Genga, Vannicelli, and Altieri, into whose hands Oudinot, on the 3d August, resigned the civil administration of affairs, reserving to himself the maintenance of public order. The commissioners began the usual work of imprisonment and persecution.

The pope did not as yet venture to meet his subjects, and on the 4th September 1849 moved from Gaëta to Portici. It was on the 4th April 1850, when tranquillity was deemed sufficiently re-established, that after blessing the king of Naples, who accompanied him to Terracina, he proceeded by Velletri to Rome, where he arrived on the 12th.

Venice alone, though blockaded by the Austrian fleet on the side of the sea, and vigorously bombarded since the month of June on the land side, continued to assert Italian independence. Famine, conflagration, the plague of cholera, and the usual horrors of a siege, failed to quell the unconquerable courage of the inhabitants. The war continued during July and August with unabated violence, maintained with skill and constancy by the Austrians, with desperate valour by the Italians. When the news arrived of the first Hungarian disasters, the assembly accredited Manin, the president, with full power to act to the best of his ability, for the safety and honour of the city. On the 23d August, having received certain intelligence that Hungary was entirely subdued, and seeing that it was hopeless single-handed to resist Austria and Russia, he gave up all authority into the hands of the municipality, and with the chief leaders escaped on board a French steamer. On the 29th the Austrians entered into silent Venice. There, and on that day, the war of Italian independence came to a close. There is no brighter fact in those two eventful years, than the orderly conduct, the calm endurance, and the noble defence of Venice, which cost the Austrians 20,000 men.

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The inhabitants of Italy are a mixture of races, composed of Greeks, Gauls, Germans, and Saracens, who at various but distant periods have immigrated into the peninsula, and mingled with the aborigines.

Language.

During the many centuries that the peninsula and its islands have been divided into numerous and often hostile states, with different institutions and interests, the common bond of the Italian people, as formerly with the Hellenic race, has been a common language and a common literature. From the valleys of the Alps to the shores of Calabria, in Sicily as well as in the island of Sardinia, notwithstanding the variety of dialects, any one who has the faintest claim to education can comprehend and enjoy the works of her great writers. Yet the origin of this bond of nationality is wrapped up in darkness. This, however, is not the place to discuss the origin of the Italian tongue. The learned Muratori endeavours to trace it to the corruption of Latin by the admixture of the words and phrases of the nations that overran the country after the overthrow of the Roman Empire. Perticari finds its origin in the modification of the Provençal. Bembo and Gravina, on the other hand, uphold it as the *vulgar* language of the country even in the best days of Rome, and maintain that it acquired importance and superiority in proportion as Latin, the literary language of the polished classes, died away. We shall only offer a few remarks on the subject. None of the various nations that at different times invaded Italy from the fifth to the twelfth century was in such numbers as to sweep away the inhabitants of the country, and substitute its own language for that which previously existed. The invaders seem, on the contrary, to have received the language of the conquered country. Even the Longobards, who, no doubt, were more numerous than any of the invading races that preceded or followed them, were, comparatively, a small minority in the country in which they settled, and instead of giving their own language to the conquered, we find that a few years after their settlement, not only their laws were drawn up in Latin, but even their chronicles, their private contracts, and their correspondence were in Latin, though a Latin widely different from the Latin of Cicero.

The numerous dialects of Italy and its islands have not originated in the corruption of the Italian language. On the contrary, the Italian language seems to have been formed, as Dante tells us, by a selection of the best words and phrases of all the different dialects. All the dialects, except those of the Riviera, Piedmont, and Lombardy, end their words in vowels. The dialects of the Riviera, and more especially those of Piedmont, are more akin to the Provençal than any of the other dialects of the north of the peninsula. The Lombard dialects, the harshest in Italy, are distinguished by the sound of the French *u*, which is supposed to have been left behind by the ancient Gauls. It is certainly a remarkable fact that the French *u* not only is unpronounceable beyond the Apennines, but disappears altogether even in Upper Italy as soon as we cross the Adige, which formed the ancient boundary between *Gallia Cisalpina* and *Venetia*.

Two lines drawn across the peninsula, the northern one from the mouth of the Magra, near the Gulf of Spezia to Ravenna, and the southern line from Terracina to the mouth of the Tronto, would include the best Italian dialects, which improve as from each of those lines we proceed towards the centre, so that at Siena and its neighbourhood the dialect, both with regard to words and to pronunciation, is almost a perfect type of the best classic Italian. As we proceed S. of Terracina and the Tronto, the dialects deteriorate, and in the central mountain range of Basilicata

Italy. and Calabria, we find the worst of dialects ending with vowels, with some guttural sounds which had disappeared S. of Florence. At Gaëta, at Naples, on the shores of Calabria, and more especially on the shore of Apulia, the dialects contain a very large and decided Greek element; and at Bari and Tarentum the broad Doric element breaks out not only in the words, but also in such a prolonged stress on the accent in words, as to resemble singing more than speaking. The Sicilian dialects are more like those of the S.E. end of the province of Otranto than those of Calabria, and on the W. coast of the island differ little in the words from the Italian.

It is remarkable how little the Italian language has changed from the beginning of the 13th to the 19th century. It has been enlarged with new words, but has not altered in its grammatical forms, and *very few* words have become antiquated. The language in which king Manfred used to sing songs at night in the streets of Barletta, is still the language in which a *prima donna* sings in the Scala at Milan, or the S. Carlo at Naples. The *Ode to Poverty* by Guido Cavalcanti, a Florentine who died in 1301, so far as language is concerned, might have been written by Leopardi, who died in 1837.

Literature. The real time at which the Italian language had acquired its well defined and distinct existence, has been the subject of great controversy. Early in the 13th century, however, it was already formed, and we find it employed in different and distant parts of the country. Ciullo d'Alcamo, a Sicilian, wrote poetry towards the close of the 12th century; and there is extant a hymn by St Francis of Assisi, who died in 1226. Italian poetry was cultivated in Sicily at the court of Frederic II. of Hohenstauffen, by himself, as well as by his son king Enzo, and by his unfortunate secretary Pier delle Vigne. Some events of the life of the great emperor and his natural son Manfred were chronicled in Italian by Matteo Spinello of Giovinazzo, near Bari, who died about 1247. At the same time the Florentine Ricordano Malespini was writing in good Italian the history of his country, and Guidotto da Bologna was translating precepts from Cicero, and embodying them in a flower of rhetoric, which he dedicated to king Manfred.

In the 14th century, which the Italians, in speaking of their literature, designate as the *Trecento*, besides numerous productions, most of which are now lost or forgotten, three works appeared, which alone would be sufficient, should every other literary monument perish, to keep Italian alive to the most distant ages:—the *Divina Commedia* of Dante Alighieri (born 1265. died 1321); the *Rime*, or poetry of Francesco Petrarca (1304–1374); the *Decamerone*, or tales of Giovanni Boccaccio (1313–1378), —all three Florentines. The *Trecento* was also the age of Giotto (1276–1337), of Giovanni da Pisa (1240–1320), and of Andrea Orcagna (1326–1389).

The impulse which Petrarch and Boccaccio had given to the study of the Latin and Greek languages, was maintained after their death, and caused Italian to be much neglected till towards the end of the 15th century; at that time its use, as a literary vehicle, was resumed, both by the encouragement and the example of Lorenzo de' Medici. With Angelo Poliziano (1454–1494), Lorenzo's protégé, who wrote some of the finest stanzas in the Italian language, a galaxy of poets, historians, and miscellaneous writers arose which shone with uninterrupted brilliancy to the end of the following century.

Of the numerous standard works that appeared during this period, which the Italians call the *Cinquecento*, it will be enough to record a few of the most remarkable. The historical and political writings of Machiavelli (1469–1527), the didactic poems of Giovanni Rucellai (1475–1526), Luigi Alamanni (1495–1556), and Bernardino Baldi (1553–1617); the letters, dialogues, plays, etc., of Agnolo Firenzuola (1493–1548), Cardinal Bembo (1470–1547), Annibal Caro (1507–1566), Antonfrancesco Grazzini (1503–1583); the histories of Francesco Guicciardini (1482–1540), Jacopo Nardi (1476–1556), Benedetto Varchi (1502–1565), and Camillo Porzio (1520–1580); the *Life* of Benvenuto Cellini, by himself (1500–1570); the *Lives of Painters* by Giorgio Vasari (1517–1574); and the well-known epic poems of the *Orlando Furioso* of Ariosto (1474–1533), and the *Gerusalemme Liberata* of Tasso (1544–1595). Italy.

The Cinquecento was also the golden age of Italian art—the age of Raphael (1483–1520), of Titian (1480–1576), of Michael Angelo (1474–1564), and of Palladio (1518–1580).

The decay of taste, which had begun towards the end of the sixteenth, prevailed generally in the seventeenth century, or the *Seicento*, to such a degree that the word *seicentista* has remained proverbial in Italian as descriptive of a writer whose style is turgid, strained, and bombastic, and whose thoughts are false, and replete with strange conceits. It is principally ascribed to the prevalence of the Spanish rule in most of the peninsula, though the falling of education into the hands of the newly established order of the Jesuits, and the introduction of the Inquisition by Pius V., had also their share of influence. Nowhere, certainly, did bad taste show so early and prevail so much as at Naples, which had become a Spanish province in 1504. Marini (1569–1625), a poet of great genius, but who did most to corrupt the Italian literature, was a Neapolitan. The arts had the same fate; and the age of Marini was also the age of the painter Michael Angelo da Caravaggio (1569–1609), the sculptor Bernini (1598–1680), a Neapolitan, and the architect Borromini (died 1667).

The causes of mental degradation and literary corruption, however, did not operate in an equal degree in those states of the peninsula which, with their independence, retained their national spirit. Accordingly, two remarkable authors escaped entirely, and a few more in part, the depraved taste of their age. Foremost stands Galileo Galilei (1564–1641), an acute observer, a profound philosopher, and an elegant and perspicuous writer, who, at the age of seventy, was imprisoned and tortured by the Inquisition for having adopted and expounded the Copernican system. Equal to him in elegance of diction, and not much inferior in the spirit of philosophical inquiry, was Francesco Redi (1626–1697), who wrote also the lively dithyramb of *Bacchus in Tuscany*. Gabriello Chiabrera (1552–1638), Fulvio Testi (1593–1646), Vincenzo Filicaia (1642–1707), and Alessandro Guidi (1650–1717), in spite of their faults, are among the best lyric poets; Paolo Sarpi (1552–1622), and Cardinal Sforza Pallavicino (1607–1667), both wrote the well known histories of the Council of Trent—the former a powerful but not elegant denouncer, and the latter an elegant but not powerful defender of the Court of Rome.

The earlier half of the eighteenth century saw several learned historical works, such as the *History of Naples*, by Pietro Giannone (1676–1748); the *Annals of Italy*, by Muratori (1672–1750); and the *Verona Illustrata*, by Scipione Maffei (1675–1755)—none of them remarkable for elegance of style. Towards the middle of the century, French writers began to have an unfavourable influence upon the Italian language and literature long before the French invasion took place; but later the *Drammi*, or operas, of Pietro Metastasio (1698–1782); the works of Gasparo Gozzi (1713–1786) and Giuseppe Parini (1729–1799); and, above all, the tragedies of Vittorio Alfieri (1749–1803), and the poetry of Vincenzo Monti (1754–1828), stemmed the current of deterioration, and opened up another bright era in the history of the Italian mind. This era has been continued in the present century in the histories of Carlo Botta (1766–1837), and Pietro Colletta

Italy. (1775–1833); in the poetry of Ugo Foscolo (1778–1827), Giacomo Leopardi (1798–1837), Giuseppe Giusti (1809–1850); in the novels and poetry of Tommaso Grossi, Alessandro Manzoni; in the philosophical and scientific works of Rosmini, Romagnosi, Gioberti, Delle Chiaie, Brocchi, and Volta; and in many other works which it would be tedious to enumerate.

Many of the dialects have also a literature of their own; the Venetian is, in this respect, the most important, and next to it the Sicilian, the Milanese, and the Neapolitan. The Anacreontics of Meli (1740–1815), who ranks among the first lyric poets, though in the Sicilian dialect, are generally read and highly admired in every part of Italy.

Religion. In Italy the inhabitants adhere almost universally to the Roman Catholic Church. The Jews in Venetian Lombardy, in Leghorn, in Rome, and in Ancona, have permission, but under some rigid restrictions, to establish synagogues. The foreign Protestants also may celebrate their rites in their own language, under the sanction of the ambassador or consul of their nation; but the number of persons not Roman Catholics is very small indeed. The established clergy are very numerous. The number of sees, which formerly exceeded that of the bishoprics in the rest of Christendom, though greatly reduced, amounts still, as we have seen, to 253, while in the rest of Roman Catholic Europe there are only 300. Many of the monasteries which once deluged the cities and large towns have been suppressed. The churches, however, still possess great riches, and are everywhere sumptuous in their decorations and ornaments, containing much of what is magnificent and glorious in art, and refined in taste and beauty. The exterior of the churches is very imposing, and the ceremonies are performed with vast pomp and solemnity.

The higher clergy possess great power, and enjoy some immunity for their persons and goods, and in many cases are freed from taxation. The secular priests are under the superintendence of the bishops, and the monasteries under the chiefs of their several orders. Though the extent of the influence and power of the church, and its universality, are the same as in Spain and in Portugal, its exciting cause and its associations are very different. In those countries the religion is a species of chivalry, originating in the idea of the conquests achieved over the Moorish Mohammedans, and combined with all the traditions on that subject. In Italy it is chiefly to be traced to the progress made in the fine arts. It is associated with painting and statuary, with music and with architecture, and, as in Spain, has no necessary influence on the moral sense of the individual.

In no part of Europe is the education of the humbler classes so neglected as in Italy, taken as a whole. Some progress has indeed been made in Lombardy, in Sardinia, and in Tuscany, yet nothing is thought of or projected in the other territories, on the subject. The instruction of the poor is wholly in the hands of the ecclesiastics, and nothing can be worse conducted. It is a wonder to find a rustic that can read, and a mechanic in the towns that can write his own name is equally rare. The institutions for the higher kinds of education are also far behind those in the other countries of Europe. Among these are the colleges and lyceums, where the instruction is partial, and not calculated to teach the manly virtues, or foster freedom of thought. The studies are directed to logic and the classics; but the sciences are neglected, as are the languages of other countries, their customs, their intelligence, and their modes of thinking and reasoning. Mathematics are not much known, but casuistry is sedulously inculcated. The *Collegio Ambrosiano*, and the *Collegio Brera* in Milan form exceptions to the description here given, but in everything but classical literature they are far from being well conducted.

The universities where education is completed are sufficiently numerous, and mostly of ancient date in their foundation. They are—Bologna, founded in the year 1119; Naples, in 1224; Padua, in 1228; Rome, in 1244; Perugia, in 1320; Pisa, in 1329; Siena, in 1249; Pavia, said to have been founded by Charlemagne in 774, but, at all events, remodelled in 1390; Turin, in 1412; Parma, in in 1422; Florence, in 1443; Catania, in 1445; Cagliari, in 1764; and Genoa, renewed and extended in 1783; to which may be added those of Palermo, Camerino, and Macerata, and that of Modena, which has been shut since 1849. Italy.

The dates of these institutions may serve to show the probable course of study originally introduced, when the works of the schoolmen and the casuists entirely engrossed the public mind. Several improvements have been ingrafted on these foundations, but they have been of little efficacy in exciting to study, or in forming a considerable proportion of enlightened scholars.

Literary societies. In almost every one of the cities of Italy there have been long-established literary and scientific societies, which have cherished and encouraged learning among their respective members. These were instituted in the fifteenth century, and have multiplied and increased ever since. They have contributed, since the revival of learning, to its preservation, and have been in a great degree the means of bringing the talents and industry of the scholars into public notice. They are too numerous to be even named here. One of the earliest, as well as the most celebrated, is the *Academia della Crusca* of Florence, which still exists, and has for its object the perfecting of the language. The most flourishing of these societies in the present day are the Imperial Institution of Milan, the Academy of Sciences at Turin, and the Royal Society at Naples. The institutions for the promotion of the fine arts are numerous. They are connected with schools, in which painting, sculpture, and architecture, are taught by competent masters. The most useful of these are at Florence, Rome, and Bologna.

Libraries. Italy abounds in collections of books, and especially of manuscripts of great antiquity, and of high value. The libraries in general are, however, deficient in modern foreign works of literature and of science. The most distinguished of the public libraries are—in Rome, the Vatican, which contains 23,500 MSS., the Minerva 120,000 printed volumes and 4900 MSS., and the Angelica 90,000 vols.; in Florence, the Laurenziana and the Magliabecchiana; in Naples, the Borbonica, 200,000 vols. and 4000 MSS., and the Brancacciana, 70,000 vols., 7000 MSS.; in Bologna, the university, 140,000 vols., 9000 MSS., the Comunale, 100,000 vols., and the Martini, 17,000 vols. (all music); in Milan, the Ambrosiana, 120,000 vols., 5500 MSS., and the Brera; Venice, St Marks, 112,000 vols., and very rich in MSS.; Padua, university; Brescia, Quiriniana, 90,000 vols.; Ferrara, 90,000 vols.; Mantua, 80,000 vols.; Parma, 90,000 vols.; Genoa, university, 50,000 vols., and Comunale, 40,000 vols.; Turin, university, 112,000 vols. and rich in MSS., and many smaller ones. There are in every part of Italy museums of great value, and most of them are arranged in the most perfect manner. All of them are with the greatest liberality thrown open to the public, and are thereby made the common property of all nations. Each palace of the men of eminent rank, and each public building, is a cabinet of art; and each city boasts of its antiques or of its modern works of art. The most distinguished of the museums are the Vaticano and the Capitolino at Rome, the Borbonico at Naples, and the Galleria at Florence. Picture galleries are to be found everywhere, and contain many of the finest specimens of art. The churches, too, are most abundantly graced, as well by their architecture as by the exquisite pieces which exhibit the skill of the painters or the sculptors. Many of the best works of art were removed by the French invaders; but, in 1814 and 1815, most of these were restored to the states

from which they had been carried off. There are botanic gardens attached to most of the universities, and several in the vicinity of the larger cities; and there are astronomical observatories in Bologna, Padua, Milan, Florence, Naples, and Palermo.

Social condition.

The Italian nobility consists of a vast number of families, the eldest member of which continues to retain the family titles, though utterly destitute of corresponding means. In most of the states they have little or no influence as a body on the measures of the government. In the papal states some patrician power exists, and some feudal rights are exercised, and in Genoa some vestige of their ancient dignity is retained; but in the other parts not even a shadow of power is to be found amongst them. They have the barren titles of prince, duke, viscount, marquis, or count. Many of them in the Roman states and in Tuscany possess extensive landed estates, which are for the most part entailed on the eldest son, and many of these are deeply mortgaged. As no provision is made for the junior members of such families, they commonly enter the church or the army, and sometimes, though rarely, obtain offices in the civil service of the government. Of late some of the nobility have directed their attention to agriculture; but none of them, except in Venice and in Genoa, have applied themselves to commerce. From the condition of this class, it is usual to find the whole of the family residing in the palace of its chief, with their wives and children, if they have any. As money rent is not commonly paid for the estates, but the produce of these divided between the proprietors and their occupiers, the necessaries for the support of such families reach them directly; and, except for purposes of show or of luxury, very little money is necessary. Although some members of the noble families have devoted themselves to the promotion of literature, of science, or of the fine arts, yet the great body live in the silent enjoyment of their rank and property. The limited means of these families do not allow them to show any hospitality.

The morals of the nobility have greatly improved of late years, and the practice of each married lady having her favourite lover or cicisbeo, after the birth of her first child, has almost entirely disappeared. Gambling is also much less fashionable among them now than it used to be. One of their commonest indulgences is a box at the opera, where they attend in the evening, and receive the visits of their friends, without interrupting the pleasures they derive from the representation and the music.

The burghers in the cities have now none of the power which they enjoyed in the many cities which were once denominated free. The municipal power is concentrated in the hands of the several governments; and, where corporations do still exist, they have no other right than that of making humble representations or suggestions on inferior and local subjects. The more affluent inhabitants of the cities, comprehending those of the legal profession, the bankers, the merchants, and the superior artists, amongst whom may be included the possessors of the smallest landed estates, are not numerous; but they mix more with strangers than the nobles, and have fewer national prejudices. They appear to know that all born beyond the Alps are not necessarily barbarians or semi-barbarians, and amongst them foreigners may find the best associates.

The lower classes of the population in large towns are in bad repute, both as to morals and instruction, and are represented as more acute than honest.

Whatever may be the faults of the Italian nation, one good quality is obvious; their ready assistance to suffering humanity. All the cities are filled with charitable institutions, in which infants, the helpless aged, the diseased, and the destitute, find refuge and relief; but it must be acknowledged, that no country has more need of such institutions, for in none are there to be found so great a number of beggars, nor so numerous a body as, in all the cities, take little care for anything beyond the passing day or even hour.

The greater part of the population of Italy is, however, to be seen in the country, devoted to the pursuits of agriculture. A few, a very few of them, are in circumstances of moderate affluence; a few more may be represented as in a state of comparative ease; but the great body, to whom all others bear a slight proportion, are in a poor condition. They are the occupiers of small portions of land, some of them not exceeding four acres in extent, and most of them less than ten acres. Living in small cottages, they labour in the fields, and maintain themselves and their families on half the produce of the land, the other half being delivered to the proprietor at the time of harvest as his rent. Their food, simple as it is, is barely sufficient to keep them in a healthy state. In no part of Italy does animal food form the staple of their diet; in most districts, indeed, they seldom taste it. In the northern and central districts their common fare is a kind of meal called *polenta*, made of Indian corn, pounded and boiled to the consistence of hasty pudding. In the south they live chiefly on bread and a polenta made of beans.

The Italians as a nation are a fine race of men. The men are well formed, rather slim than stout, but strong and agile, with a complexion, either from nature or from exposure to the sun, of a dark hue, with expressive countenances and dark sparkling eyes, and for the most part with black hair. Their gait is grave but not solemn, and their whole appearance is expressive of self-respect. The women have mostly narrow foreheads, black or dark-brown hair, large, brilliant, and expressive eyes, a beautiful nose, which, with the forehead, forms the elegant Roman profile; a small mouth, with lips rather swelling; a clear, white complexion, with slight red tinges showing through it, and a delicate, but well-formed figure. The lower classes, owing to their early marriages, their subsisting wholly on vegetable food, and the hard labour they endure under a burning sun, have their beauty checked before it has attained maturity; yet even they often display great attractions.

A hasty or an unobservant traveller, in passing through Italy, may well be charmed with the scenery of the country, the magnificence of the cities, the clearness of the sky, and the mildness of the climate. He will see only what is admirable and exciting. The prospects on descending from the Alps, adorned as they are by lofty precipices, with their tops buried in snow, and their sides discovering waterfalls descending into the beautiful lakes below, are all of a kind to charm the eye and feed the fancy. Flowers of every tint exhale the most grateful odours; and the fruits of every clime grow in plentiful profusion. On the plains, too, the beauty of the fields, surrounded with mulberry trees, with vines in graceful festoons, with their pendant fruit, the centre of the inclosure exhibiting heavy crops of corn, pulse, or culinary vegetables, all conspire to increase the delight. The excellence of the roads, the post-horses, and the inns, contribute their share to heighten the enjoyment. The appearance, too, of the cities, with their magnificent public edifices and their spacious private dwellings, though the streets may be narrow and crooked, presents a picture eminently calculated to convey to the beholder that feeling of pleasure which novelty usually creates in the mind. We have enjoyed these gratifications to the fullest extent; but, in the description here given, we have felt it a duty to look beyond the delightful surface, to view the interior of the land, the state of the several classes of society that inhabit it, and to communicate to the reader the most accurate view that could be produced after much careful investigation. (* * *)

ITCH (*Scabies*), is a contagious vesicular disease of the skin, attended with an intolerable itching, hence its name. The vesicles are minute and slightly acuminated, with a pearly transparency at their summit, and are most numerous at the flexures of the joints, and the soft skin between the fingers. It seems to be almost solely propagated by contagion, and a few days generally elapse between the infectious contact and the manifestation of the itching. This disease is now very generally ascribed to the presence of a minute insect resembling the cheese mite, and named *acarus scabiei*, which propagates with great rapidity, burrows in the skin, and is the cause of the intolerable itching; and numerous carefully conducted experiments have proved that this insect placed on the healthy skin soon burrows below the surface, and gives rise to the disease. A few, however, deny that the insect is the invariable cause of the disease, but assert that it is only generated in some cases of scabies. The disease in the dog termed the *mange* seems to be the same malady, and contact with a mangy dog will produce itch in the human subject as readily as contact with a person with that cutaneous disease. Sulphur is considered as the specific for the cure of itch. It is commonly applied in the form of ointment; the sulphur being simply mixed with lard or butter. It is much more efficacious, however, if combined with an alkali. The best proportion seems to be—sulphur two parts, subcarbonate of potass one part, and lard eight parts. Frequent washing of the parts affected with soap and water are essential to a speedy cure. Indeed, some practitioners assert that every case may thus be cured without using any specific ointment or lotion. Many other external applications may be used instead of sulphur ointment, such as ointment of white hellebore, solutions of the chloride of lime, or chloride of soda, solution of the muriate of mercury, &c. In inveterate cases sulphureous baths, or sulphureous fumigations, have been found efficacious.

ITHACA. See IONIAN ISLANDS.

ITHACA, a town, capital of Tompkin's county, state of New York, North America, situate on both sides of the Cayuga Inlet, about a mile S. from the head of Cayuga Lake, and 162 miles W. by S. from Albany. It is regularly built, and pleasantly situate, being surrounded on three sides by hills rising to the height of 500 feet. The Cayuga and Susquehanna railroad connects it with Owego, and another line extends northward to Auburn and Lake Ontario. It has one cotton and two woollen factories, a paper mill, and several iron foundries. Pop. (1853) estimated at 7000.

ITIUS PORTUS. There is hardly a spot of ground on the earth's surface of which the site has been so much disputed as the Itius Portus. The place itself is one of no importance, but it has a kind of factitious value as the spot from which in B.C. 55, and again in the following year, Cæsar set out to the conquest of Britain. To determine the site of the Itius Portus would be so far to fix the spot where the great captain first set foot on our island. Calais and Boulogne (*Gesoriacum*, afterwards *Bononia*), and every bay between these points, have been at various times upheld by different geographers as the scene of Cæsar's embarkation; but the best authorities are now agreed that the actual spot was the village of Wissant or Duessant, which lies about 3½ miles N.E. of Cape Grisnez (*Itium promontorium*). D'Anville and Long both strongly advocate the view which seems to be now very generally accepted. An admirable discussion of the whole question will be found in George Long's edition of *Cæsar*, Lond., 1853, pp. 248–257.

ITURBIDE or YTURBIDE, AUGUSTIN, the famous Mexican usurper. See MEXICO.

ITURUP, the largest and most important of the Kurile Islands, belonging to Japan, and separated from Kunashir on the S. by the Strait of St Anthony, and from Urup on the N. by Vries Strait, N. Lat. (S. point) 44. 29., E. Long. 146. 34.; length 140 miles, average breadth 20. It is of volcanic origin, well wooded, and fertile. The inhabitants are chiefly engaged in the chase and in fishing.

ITZEHOE, a town of Denmark, duchy of Holstein, on the Stör, 32 miles N.W. of Hamburg. As the river is navigable, the town carries on a considerable trade with Hamburg and other places. It has manufactures of tobacco, earthenware, leather, sugar, chicory, &c. Pop. about 5800.

IVES, ST, a market-town of England, county of Huntingdon, on the left bank of the Ouse, which is here crossed by an ancient stone bridge of six arches, 5 miles E. by S. from Huntingdon. Brewing and malting are carried on to some extent, but more important is its trade in cattle and agricultural produce, its market being one of the largest in the kingdom for cattle and sheep. Market-day, Monday. Pop. (1851) 3522.

IVES, *St*, a municipal and parliamentary borough and seaport-town of England, county of Cornwall, on the western shore of the bay of the same name, 8 miles N.E. of Penzance. It consists of several streets, for the most part narrow and irregular. The parish church is a low but spacious granite building of the time of Henry V., and has an elegant tower 90 feet high. The harbour is defended by a pier built by Smeaton in 1770, and is capable of accommodating vessels of 200 tons. On 31st December 1855, there were 166 sailing vessels of 13,404 tons, and 3 steam vessels of 584 tons, registered as belonging to the port. The number and tonnage of vessels that entered and left the port during that year were:—Coasting trade, inwards, sailing vessels 1699, tonnage 110,469; steamers 130, tonnage 29,700: outwards, sailing vessels 1155, tonnage 74,154; steamers 182, tonnage 36,498;—colonial trade, inwards, sailing vessels 4, tonnage 578; outwards 2, tonnage 220: foreign trade, sailing vessels, inwards 37, tonnage 4899; outwards 15; tonnage 2327. This is the principal station of the pilchard fishery. In the vicinity are extensive tin and copper mines. The town is governed by a mayor, four aldermen, and twelve councillors, and returns one member to parliament. Pop. (1851) of municipal borough, 6525; of parliamentary do., 9872.

IVIZA, IVICA, or IBIZA (the *Ebusus* of the ancients), one of the Balearic Islands belonging to Spain, and situate in the Mediterranean, 60 miles E. by N. of Cape San Martin, on the mainland of Spain, and 50 miles S.W. of Majorca, between N. Lat. 38. 50. and 39. 7.; and E. Long. 1. 15. and 1. 40. Greatest length from N.E. to S.W. about 25 miles, and greatest breadth about 13 miles. The coast is indented by numerous small bays, the principal of which are those of San Antonio on the N.W., and of Iviza on the S.E. coast. The surface, in some parts stony, is generally very fertile. The hilly parts are richly wooded. The climate is mild and agreeable, the heat in summer being tempered by the cooling sea-breezes. Oil, wine, corn, and fruits are the principal productions of the islands, but the inhabitants are very indolent, and their modes of cultivation very primitive. Salt is extensively manufactured, and constitutes one of the principal articles of exportation. The fisheries are also important. The capital is Iviza, a fortified town on the S.E. coast, with a good harbour, and containing about 4000 inhabitants. Pop. of island about 12,000.

IVORY, a dental substance, placed by chemists between bone and horn: that variety which is distinguished by the decussating curved lines on the surface of the transverse section of the tusk is peculiar to the African and Asiatic elephants; but the tusks of the walrus, the narwhal, and the hippopotamus, and the teeth of the same animals, also furnish ivory. The fruit of a species of palm (*Phytelephas macrocarpa*) from Peru, is imported under the name of *vegetable ivory*. The tusks of the elephant furnish the chief supply of ivory. In the Great Exhibition of 1851

Ivory.

were a pair weighing 325 lbs., obtained from an animal killed near the Lake Ngami, in South Africa: each tusk measured 8 feet 6 inches in length, and 22 inches in basal circumference. It is considered that the tusks deteriorate in length and quality by the domestication of the elephant. African tusks are preferred to the Indian as being denser in texture, and not so liable to turn yellow. The demand for ivory for knife-handles, billiard-balls, keys of musical instruments, mathematical scales, chess-men, for inlaying, for thin plates for miniatures, for carving, and for various other purposes is so enormous, and the supply is so well maintained, that surprise may well be felt that the noble race of animals which yield it has not long since become extinct, especially when we consider that the supply of small tusks annually imported is so vast as to reduce the average weight of the whole import to about 9 lbs. per tusk. Teeth under from 10 to 16 lbs. are called *scrivelloes*. A few years ago it was calculated that the consumption of ivory in Sheffield alone required the annual slaughter of 22,000 elephants. The collection of broken or shed tusks may somewhat mitigate the zeal of the hunter, and we may also refer to that remarkable source of ivory which exists in Eastern Siberia and the Arctic marshes, where the tusks of the mammoth, and other animals, are collected in vast quantities, and sold under the name of *Siberian Fossil Ivory*, although they do not appear to have undergone that species of transmutation implied by the term *fossil*, but are as useful to the artist or manufacturer as recent ivory. We are not aware that fossil ivory is imported into this country, although it is extensively used by the ivory-workers on the continent.

The engine-turned markings on true ivory render it unfit for the purposes of the dentist, who accordingly prefers the teeth of the hippopotamus or river-horse, especially the two external semicircular teeth in the lower jaw. This ivory is known by the inaccurate term of *sea-horse;* it is covered with a thick enamel, which is so hard as to resist steel tools, and even to strike fire with steel, and is removed by means of a grindstone, or by driving a thin chisel between it and the ivory within. The action of the blow-pipe is also used for the same purpose. This kind of ivory is harder than that of the elephant, whiter in colour, and of more than double the value; it has a slight blue tint, and scarcely any grain. The dentist also makes use of the teeth of the walrus or sea-cow. In this case the outer portion consists of ivory, while the brown oval centre resembles bone. Small supplies of ivory are obtained from the long, straight tusks of the narwhal or sea-unicorn, the masticating teeth of the spermaceti whale, and the grinders of the elephant.

Regarding the elephant's tusk as ivory, properly so called, we may distinguish between African and Asiatic ivory by the former being, when recently cut, of a mellow, warm, transparent tint, with scarcely any appearance of grain, in which state it is called *transparent* or *green ivory;* but, as the oil dries up by exposure to the air, it becomes lighter in colour. Asiatic ivory, when newly cut, appears more like the African, which has been long exposed to the air, and tends to become yellow by exposure. The African variety has usually a closer texture, works harder, and takes a better polish than the Asiatic. The teeth, however, of both kinds vary greatly in quality and solidity, so that the choice by the purchaser is always hazardous; he is usually guided by the appearance of the rind, which should be smooth and free from cracks, and of the tip, where the rind is to a certain extent worn away, but it is not until the tusk is cut up that flaws, cracks, and imperfections can be detected. It occasionally happens that the musket ball of the huntsman, which failed to kill the animal, has become embedded in the tusk, and encrusted with a fresh deposit of bony matter, to the great injury of the ivory. Gold and silver bullets have on a few rare occasions been found, showing that the shot was fired by royal hands.

The tusk or *tooth*, as it is generally called, is usually solid for about half its length, circular or elliptical in section, and free from vessels or pores such as occur in bone; and although containing a large proportion of lime, it has none of the harsh, meagre character of bone, but admits of exquisite smoothness, and displays all the niceties of the turners' and carvers' art in the slenderest proportions. Ivory.

Much judgment is required in cutting up a tooth, so as to apportion the various parts with economy. The ivory saw is a blade from 15 to 30 inches long, and about the fortieth of an inch thick, set in a steel frame, and tightly stretched, so as to make a very straight cut. The outside strips or *spills*, as they are called, are used for the handles of penknives; the scraps are burnt for ivory black; and the clean shavings and saw-dust are used for making jelly or size. The mode of cutting up the tooth must of course depend on the uses to which it is to be applied, but in any case it is desirable to mark out the tooth in some way beforehand, and also to pencil out the end of the piece before the saw is used longitudinally. Billiard balls are usually turned out of teeth of nearly the same diameter, called *ball-teeth*, the object being to prevent the unequal shrinking of the ivory in drying. The ivory shrinks in the direction of the length of the tooth, as well as in the width, but much less in the former than in the latter direction. A billiard ball will vary in its diameters, if used in a room of different temperature to that in which the ivory was kept, so that it is usual to turn the balls roughly to shape, and keep them for some months in the billiard room before the turning is completed. Ivory ornaments should not be kept on a chimney piece which is much exposed to the heat of the fire. The slices of ivory cut for the keys of pianofortes are placed for a few hours in an oven at a temperature sufficient to evaporate the oil, by which means they are not only whitened, but sufficiently shrunk to be at once glued to the wooden bodies of the keys. The action of the atmospheric moisture, in varying the length of ivory, is considerable, so much so that ivory drawing-scales are not to be relied on in accurate work. Scales of box-wood and lance-wood are much to be preferred.

The thin plates of ivory used for the keys of pianofortes, inlaying, and similar work, are usually cut from the solid block by means of a fine feather-edge veneer saw, in which case there is a considerable amount of saw-dust. The Russian method of cutting veneers spirally from a cylinder of wood, with a knife of the same length, has been adopted for ivory, although in such case a reciprocating saw is used, and ivory-dust produced. Mons. Pape of Paris furnishes veneers of this kind as large as 30 by 150 inches, and he has veneered a pianoforte entirely with ivory. We are not disposed to regard the result as pleasing or useful. In the United States department of the Great Exhibition was an ivory veneer 40 feet in length by 12 inches in width. Artificial or factitious ivory is prepared in France in thin plates or veneers, and it has the appearance of a dull, opaque cement. A superior substance was exhibited by Mr Henry Brown in the Great Exhibition, under the name of *British ivory*. A prize medal was awarded to the inventor, "on account of its being likely to turn out a valuable and important discovery, and in many cases calculated to supersede real ivory." The vegetable ivory already referred to is a good substitute for ivory where appearance and durability are not of importance: it soon tarnishes, and wears rapidly if exposed to much friction.

Ivory may be dyed of various colours. The red of billiard balls may be given by dipping the ivory for a short time into a mordant of nitro-muriate of tin, and then plunging it into a bath of Brazil wood, cochineal, or a mixture of those substances. A scarlet tint is produced by lac dye, and if the scarlet ivory be plunged into a solution of potash, it changes to cherry red. A yellow die may be pro-

Ivory-black.

duced by giving the ivory the tin mordant, and digesting it at a gentle heat in a clear decoction of fustic. A black dye may be given by boiling the ivory in a strained decoction of logwood, and then steeping it in a solution of red sulphate, or red acetate of iron. In dyeing ivory the surface should not be polished until the dye is set. As soon as the ivory is taken out of the hot-dye bath it should be plunged in cold water to prevent the chance of cracking; and should the dye appear in dark spots or patches, they should be rubbed down with chalk, and the ivory be dyed once more.

When ivory has become discoloured it is not easy to bleach it. Some recommend that it be scrubbed with Trent sand and water, but this is evidently inapplicable to works delicately carved by hand or at the lathe. Articles in ivory, which have suffered partial decomposition by exposure to air and moisture, have been restored by boiling them in a solution of gelatine. Such was the case with some works in ivory sent from Nineveh to this country by Mr Layard. They were in a state of decomposition, and the method of restoring them was suggested by Professor Owen. An attempt has been made to render ivory flexible by removing a portion of its lime by the action of hydrochloric acid. This plan has been adopted by a surgical-instrument maker, M. Charrière of Paris, who first gives the pieces of ivory their required form and polish, then steeps them in dilute acid, until they have become supple and elastic, after which they are taken out and dried, when they again become hard, but the flexibility can be restored by surrounding the ivory instruments with wet linen, or by placing wet sponge in the cavities of the pieces.

The art of working in ivory belongs to the turner, to the carver, to the inlayer, and other artists, and does not call for special notice here.

Ivory-Black. When bones are subjected to destructive distillation in close vessels, the substance of the bone is resolved into its constituent elements, which recombine and form new compounds. Some of these escape in the form of vapour or gas, such as carbonic acid and various hydro-carbons. Water holding carbonate of ammonia in solution is also formed, and an oil, which is collected and used for feeding the lamps, which, being burnt in close chambers, with a very limited access of air, the oxygen of which is just sufficient to combine with the hydrogen of the oil, but not sufficient to form any compound with the carbon, the results of the combustion are water and carbon, in a minutely divided form, which collects on the walls of the chamber, and forms *lamp-black*. In the distillation of bones muriate of ammonia and sulphate of soda are formed towards the end of the process; the latter is separated by solution and crystallization, and the former by sublimation.[1] When all the volatile products are separated, the mass which remains in the retort, consists of the earthy and saline portions of the bone, blackened by the carbon of the animal matter, and forming what is called *ivory-black*, *bone-black*, or *animal charcoal*. In this condition, from its strong attraction for animal colouring matters, it is employed in the refining of sugar for bleaching the syrup, and in other arts for similar purposes. If the bone-black be exposed to a red heat, with access of air, the carbon passes off as carbonic acid, and the bone-ash is left of a light colour, which ash is useful in making cupels for the assayer; it is also a good polishing powder for plate, and is the raw material for the manufacture of phosphorus.

Ivory ‖ Ixion.

When the material for the production of bone-black consists of ivory dust or shavings, the calcined matter is called *ivory-black;* it is ground and levigated on a porphyry slab, and produces a beautiful velvety black, which forms the chief ingredient in the ink of the copper-plate printer. Ivory black may be prepared on a small scale in a covered crucible at an ordinary fire. (C. T.)

IVORY, James, the most considerable British mathematician of his day, was born at Dundee in 1765, spent the most active period of his life as professor at the Military College of Marlow (afterwards removed to Sandhurst), and died Sept. 21, 1842, at the age of seventy-seven. (See Sixth *Preliminary Dissertation*, by Professor J. D. Forbes, § 103.)

IVREA (the ancient *Eporedea*), a town of Northern Italy, capital of a cognominal province, in the division of Turin, and kingdom of Sardinia, situate on the left bank of the Doire, 29 miles N.N.E. of Turin. It is an old-looking town, irregularly built and walled, besides being protected by a citadel and a small fortress upon an adjacent hill. It is the see of a bishop, and contains a cathedral supposed to occupy the site of a temple of Apollo, with six parish churches, several convents, a royal college, ecclesiastical seminary, hospital, &c. It has important manufactures of silk, and a considerable trade in cheese, cattle, and other produce of the Alps. It has been repeatedly taken by the French; and under Napoleon I. was made the capital of the department of Doire. Pop. about 8000.

IVRY-SUR-SEINE, a village of France, department of Seine, situate on a gentle eminence, near the left bank of the Seine, and 3 miles S.S.E. of Paris. It has manufactures of glass, earthenware, glue, chemical products, &c. Pop. about 8000. *Ivry la Bataille*, in the department of Eure, 17 miles S.E. of Evereux, is celebrated for the victory gained by Henry IV. over the Duke of Mayenne in 1590. Pop. about 1000.

IVY. See Hedera, Botany, *Index*.

IXION, in the *Greek Mythology*, was the king of the Lapithæ, and the father of Pirithous. When Deïoneus, whose daughter Dia he had married, demanded the usual bridal gifts, Ixion, under pretence of paying him, invited him to a feast, and arranged so that he fell into a pit of fire. For this treacherous murder Ixion was shunned by everybody, until Jupiter, taking pity on him, invited him to his table. Instead of showing gratitude for this kindness, however, he strove to wile away the affections of Juno. Jupiter, in indignation, chained him by the hands and feet to a winged wheel, and condemned him to roll round upon it eternally.

[1] The method of obtaining sal ammoniac from the waste products of the destructive distillation of coal is described under Gas Light.

J.

J
Jaca.

J, the tenth letter of the alphabet, is variously pronounced according to the language in which it is used. In English it is always equivalent to *g* soft in such words as *George*. In German it is equivalent to our *y*. In French it has the sound of the French *g* soft. Amongst the Romans such words as *Juno*, &c., were written *Iuno*, &c. The substitution of J for I as a consonant at the beginning of words is of modern date. Yet the letter itself existed before the Roman republic came to an end. The separation of J from I, however desirable, is not yet universally adopted in dictionaries and similar works.

JABLONSKI, PAUL ERNEST, an eminent German orientalist, was born at Berlin in 1695. His father, who was a Pole by birth, and a minister of the Protestant Church by profession, was desirous to see his son treading in his own footsteps. Accordingly the young Jablonski, after going through the usual course at the University of Frankfort-on-the-Oder, devoted himself to the study of the Eastern tongues—Coptic in particular. For these pursuits he showed such aptitude that at the age of twenty-one he was sent at the expense of the Prussian government to carry them out in the great libraries of Oxford, Paris, and Leyden. Returning home with vast stores of learning, and rich extracts from the best Coptic manuscripts, he was in 1720 made pastor of the Protestant church of Liebenberg; and two years later, professor of theology at Frankfort-on-the-Oder, and pastor of the Calvinistic church in that city. Shortly afterwards he became a member of the Academy of Sciences of Berlin. The remainder of his life he devoted to his favourite studies, sending forth treatise upon treatise in rapid succession. Before his death, which took place Sept. 13, 1757, he had published in all fifty different works, of which a complete list is given in Meusel's *Dictionary*.

Of these the principal are,—*Disquisitio de Lingua Lycaonica*, Berlin, 1714, in 4to; Thirty-nine Letters full of erudition, in the *Thesaurus Epistolicus Lacrozianus*, tom. i., p. 163 et seqq.; *Exercitatio Historico-theologica de Nestorianismo*, Berlin, 1724, in 8vo; *Remphah Egyptiorum Deus ab Israëlitis in deserto cultus*, Frankfort, 1731, in 8vo; *Dissertationes Academicæ viii. de terra*, Gosen, ibid. 1735, 1736, in 4to; *De ultimis Pauli Apostoli laboribus a B. Luca prætermissis*, ibid. 1746, in 4to; *Pantheon Ægyptiorum, sive de Diis eorum Commentarius, cum Prolegomenis de Religione et Theologia Ægyptiorum*, ibid. 1750, 1752, in 3 vols. 8vo; *De Memnone Græcorum et Ægyptiorum, hujusque celeberrima in Thebaïde statua*, ibid. 1753, in 4to, with figures; *Institutiones Historiæ Christianæ antiquioris*, ibid. 1754, in 8vo; *Institutiones Historiæ Christianæ recentioris*, ibid. 1756, in 8vo; *Remarks on the Canon of the Kings of Thebes*, by Eratosthenes, inserted in the *Chronology of Devignores*; Different Memoirs or Extracts in the *Miscellanea Berolinensia*, the *Nova Miscellanea Lipsiensia*, and other periodical collections; and *Opuscula quibus Lingua et Antiquitas Ægyptiorum, difficilia Librorum Sacrorum loca, et Historiæ Ecclesiasticæ capita illustrantur, magnam partem nunc primum in lucem protracta edidit Jan. Gulielm. Te-Water*, Leyden, 1804, 1813, in 4 vols. 8vo.

Of all these the most valuable by far is the *Pantheon Ægyptiorum*, which long held its ground as the most valuable essay on the subject which it discusses, and even still can hardly be regarded as quite superseded, though a great advance has been made in many matters of detail.

JACA, or JACCA, a fortified town of Spain, in the province of Aragon, situate at the foot of the Pyrenees, on the River Aragon, 60 miles N. of Saragossa, and about 20 miles distant from the French frontier. It is a town of great antiquity, and, from its position, has been the scene of many sanguinary contests. Its occupation was eagerly coveted by every invader of the peninsula, from Cato and Julius Cæsar to the generals of Napoleon. Jaca is the see of a bishop, who is suffragan to the archbishop of Saragossa. It is well built, and possesses an old cathedral, with several religious houses. The remains of an old Roman wall are still visible amongst its other defences. Pop. about 3200.

Jackson.

JACKSON, ANDREW, eleventh president of the United States, was born March 15, 1767, at Waxsaw in South Carolina. His parents, who were of Scottish extraction, had emigrated two years before that date from the N. of Ireland. His father died early; but his mother, though left with very scanty means, gave her son an excellent education with the view of fitting him for the church. He was only fourteen years old when the war of independence broke out, but he joined the ranks of the patriots. He was taken prisoner, and his military career was thus cut short. When peace was restored he turned to the study of the law, took an active part in framing the constitution of the new state of Tennessee, and next entered Congress, first as a representative, and afterwards as a senator. Having no taste for political intrigue he resigned his seat in a year, and was made one of the judges in the Supreme Court of Tennessee. From this time till 1812 much of Jackson's time was spent in harassing and dangerous conflicts with the Indian tribes on the frontier, among whom his name became a watchword of terror. In that year war was declared between Britain and America. Jackson was appointed to command the forces allotted for the defence of the southern states, and signalized himself by the energy and decision of his movements. Finding that some disaffection prevailed in the south, he suspended the Habeas Corpus Act on his own responsibility, and proclaimed martial law. These strong measures were peculiarly distasteful to his countrymen, and Jackson would probably have been brought to trial had he not changed the tide of public opinion by his decisive repulse of the English troops at the battle of New Orleans, Jan. 8, 1815. His military talent and his strong democratic leanings made him a great favourite with "the people" in America, whom he further pleased by always advocating territorial aggrandizement. The conservative party in the state regarded his principles and his conduct with equal dislike; and when he became a candidate for the presidency, in 1824, they contrived, though with great difficulty, to procure his defeat. In 1828, however, and again in 1832, he overcame all opposition, and was chosen president. During his tenure of office he more than once exhibited the same obstinate self-will and force of character which had marked his military career, and in the great discussion on the renewal of the charter of the United States he put his veto upon the decision of both the chambers of Congress. Had the constitution been less firmly established, it might have found in Jackson a very dangerous foe. His ambition, his disregard of the personal and civil rights of his countrymen, his fondness for war, and his habits of command, made it apprehended that, with a fitting occasion, he might make himself the Napoleon of the American republic. On resigning office, in 1836, Jackson retired to his farm, near Nashville, where he died, June 8, 1845.

JACKSON, *John*, a distinguished English portrait-painter, was the son of a poor tailor of Lastingham, in Yorkshire, where he was born in 1778. The strong taste for drawing which he early displayed gained him the notice of Lord Mulgrave and Sir George Beaumont, and rescued him from the humble trade of his father, to whom he had been apprenticed. Removing to London, he studied at the Royal Academy, and then began life as a portrait-painter. He

Jackson, William.

found the field occupied by Beechey, Opie, Hoppner, and Lawrence. Hopeless of rivalling these artists as an oil-painter, he confined himself to water-colours, and in that walk earned a great name for himself. Renewed study with matured powers, and under more favourable circumstances, made him a master in the higher branch of his art, and in 1817 he became a Royal Academician. Two years later he visited Italy with his friend Chantrey, and was made a member of the Academy of St Luke at Rome. His best portraits are those of his brother-artists, Canova, Chantrey, Stothard, and Flaxman. His likeness of Flaxman, as was said by Sir Thomas Lawrence, would have done honour to Vandyck himself. Many of the heads in Cadell's splendid *Portraits* are from drawings by Jackson. He died at London, June 1, 1831. Jackson is justly regarded as one of the ablest pupils of the Reynolds school. Less showy than Lawrence, but far more true to nature, he caught with admirable ease the characteristic expression of the face, and reproduced it with a rare effect. With all his rapidity of manipulation, he always put a careful finish on his pictures. His colouring is deep, clear, brilliant, and well relieved. In private life Jackson was amiable and pious. Without a spark either of envy or jealousy, he rejoiced in each new triumph of a brother-artist as in his own, and held out a helping hand to many a youth of promise in his struggles with obscurity and poverty.

JACKSON, *William*, an English musician of repute, was born at Exeter, in 1730. His father, a grocer, bestowed a liberal education upon him; but, on account of the lad's strong predilection for music, was induced to place him under the care of the organist of Exeter Cathedral, with whom he remained about two years. He then went to London, and studied under John Travers, organist of the King's Chapel. Returning to Exeter, he settled there as a teacher and composer; and in 1777 was appointed subchanter, organist, lay-vicar, and master of the choristers of the cathedral. In 1775 he published his first work, *Twelve Songs*, which became at once highly popular. His next publication, *Six Sonatas for the Harpsichord*, was a failure. His third work, *Six Elegies for three voices, preceded by an Invocation, with an Accompaniment*, was very successful, and placed him among the first composers of his day. Dr Burney considered these as the best of Jackson's works, and added that "no composer copied less from others than Jackson." His fourth work was another set of *Twelve Songs*, now very scarce; and his seventh work was again a set of *Twelve Songs*, all of which are now forgotten. He next published *Twelve Hymns*, with some good remarks upon that style of composition, although his precepts were better than his practice. A set of *Twelve Songs* followed, containing some good compositions. Next came an *Ode to Fancy*, the words by Dr Warton. *Twelve Canzonets for two voices* formed his ninth work; and one of them—*Time has not Thinned my Flowing Hair*—was long sung at every public and private concert. His tenth work was *Eight Sonatas for the Harpsichord*, some of which were novel and pleasing. He composed three dramatic pieces,—*Lycidas*, in 1767; *The Lord of the Manor*, in 1781; and *The Metamorphoses*, a comic opera, which did not succeed. In the second of these dramatic works, two airs—*Encompassed in an Angel's Form*, and *When first this Humble Roof I knew*—were great favourites, and are still admired. Some of his church-music, published after his death, did not please the critics. In 1782 he published *Thirty Letters on Various Subjects*, which are well written and interesting. In these he severely attacked canons, and described William Bird's *Non nobis Domine* as containing passages not to be endured. But his anger and contempt were most strongly expressed against catches of all kinds, and he denounced these as barbarous and shocking compositions. In 1791 he published a pamphlet, *On the Present State of Music in London*, in which he found fault with everything and everybody. It was a bilious and jaundiced effusion. He published in 1798 *The Four Ages, together with Essays on Various Subjects*; a work which gives a favourable idea of his character and of his literary acquirements. It appears that he cultivated a taste for landscape-painting, and imitated, not unsuccessfully, the style of his friend Gainsborough. For many of his latter years Jackson suffered severely from asthma, which he tried to cure by low diet. Dropsy ensued, of which he died in 1803, leaving a widow, two sons, and a daughter. According to his friend General Burgoyne, Jackson's character was highly amiable. (G. F. G.)

Jackson ‖ Jacobi.

JACKSON, a town of North America, capital of the state of Mississippi, situate on the right bank of Pearl River, 45 miles E. of Vicksburg, with which it is connected by rail. It contains a state-house, a lunatic asylum, and penitentiary, and supports several newspapers. About 30,000 bales of cotton are annually sent from Jackson to the Mississippi for shipment. Pop. (1853) about 3500.

JACKSON, a town of North America, capital of a cognominal county in the state of Michigan, situate near the source of Grand River, 32 miles S. of Lansing. From its position on the Michigan Central Railway its trade is considerable, while the River Grand supplies sufficient water-power for driving a number of mills. Coal and good building stone abound in the neighbourhood. The town contains a court-house, jail, penitentiary, and five churches, and supports two newspapers. Pop. (1853) about 3600.

JACKSONVILLE, a town of the United States of North America, capital of Morgan county, in the state of Illinois, situate 32 miles W. of Springfield, on the Sangamon and Morgan Railway, in an undulating and fertile plain near Movestar creek, a tributary of Illinois River. It is well built, and contains some elegant public buildings, the principal of which are the college, the asylums for the blind, deaf, and dumb, and the insane. The manufactures of the town include flour, cotton, leather, and machinery. Pop. (1850) 2745.

JACOB, St., a Swiss hamlet, about a mile S. of Basle, on the Bienne road, and the scene of a great battle fought in 1444, between 1600 Swiss and a vastly more numerous French force, under the dauphin, afterwards Louis XI. The Swiss fought for ten hours, slew three times their number of the enemy, but were themselves cut off to ten men. The battle is known as the "Swiss Thermopylæ," and, from the contest, the wine of the neighbourhood is still called "Schweizerblut," or "Swiss Blood."

JACOBI, Friedrich Heinrich, was born at Düsseldorf, 25th January 1743. At the age of sixteen he was sent to Geneva, where he completed his apprenticeship for the commercial career to which he was destined. Returning to Düsseldorf in 1763, he was, much against his will, placed by his father at the head of a commercial establishment. In that year also he married. In 1770 his elevation to the office of Councillor of Finance for the cities of Berg and Juliers afforded the opportunity, which he ardently desired, of exchanging commercial for literary pursuits. Soon after this he engaged, along with Wieland, in the publication of the *German Mercury*. In 1776 he was called to Munich to occupy a still more important political position. His honourable and successful defence of the freedom of commerce having brought him into disgrace with the government, he retired to the mansion of Pempelfort, near his native city, where he continued to enjoy a learned leisure till 1793, when the tide of French invasion compelled him to seek refuge in Holstein. The next ten years of his life were passed in the N. of Germany, in voluntary exile. In 1804 he was again called to Munich, as member of an Academy of Sciences about to be instituted; of which, in 1809, he was made president. In his sixty-sixth year he

Jacobi. resigned his functions, and spent the evening of his life in tranquil retirement. His last labour was the revision of his own works. He died before this was completed, on the 10th of March 1819, in the seventy-sixth year of his age.

The character of Jacobi was elevated and noble. When still a youth at Geneva, he exposed himself to ridicule by a disdainful rejection of the tricks and artifices of business; and throughout his career he preserved a stainless purity of life and exaltation of sentiment amounting to philosophical heroism. The foundation of this character was a profound piety, tinged, however, with mysticism. In his literary works the beauty of a great, profound, and harmoniously developed mind, shines forth with a lustre that has attracted universal admiration. It was the man himself that impressed upon his compositions those characters of ardour, profundity, and elegance, which have gained for him the name of the *German Plato*.

It is worthy of remark in relation to his philosophy generally, that while he was, with the exception of Kant, the most original thinker of his generation, his opinions were from first to last elicited not by solitary meditation, but rather by contact and conflict with other minds. His first impulse towards philosophy was received from his friend Lesage, at Geneva, and was sustained through life by extensive personal intercourse and correspondence with the most celebrated philosophers of his time. His principal works were in their origin polemical. The earliest of them,—the two philosophical romances, *Waldemar*, and *The Correspondence of Alwell* (1779–1781),—are directed against the prevailing sensationalism and gross materialistic utilitarianism of the French philosophers. The first of his purely philosophical works,—*Letters to Mendelssohn on the Philosophy of Spinoza* (1785), occasioned by a conversation with Lessing,—is a destructive criticism of materialistic pantheism. This completes the first period of his literary life. The second period is the epoch of his polemic against the idealism of Kant and Fichte. The principal works belonging to it are,—*David Hume, or, Idealism and Realism* (1787); a *Letter to Fichte* (1799); and an examination of *The Attempt of the Critical Philosophy to make Reason Intelligible* (1801). The last work of Jacobi (the great work of his old age),—*On Things Divine, and the Revelation of Them*,—is primarily directed against the idealistic pantheism of Schelling.

From the position of continued antagonism and protest which he occupied throughout his literary career, the philosophy of Jacobi presents, in the first instance, a negative, polemical aspect. As directed against Spinoza, Kant, Fichte, and Schelling, the leading principle of his criticism is the assertion that a speculative philosophy, when fully developed, must necessarily lead to atheism and fatalism. Thus he has shown in his *Letters to Mendelssohn*, that the Cartesian principle of the coincidence of thought and existence has only found its legitimate development in the materialistic pantheism of Spinoza. And again, in his later writings, he has pointed out the inconsistencies into which Kant fell, by attempting to give a solid basis to our knowledge of the actual, while yet in his speculative philosophy rejecting the *data* of experience; and he has farther shown how these inconsistencies have been escaped only by the *egoism* of Fichte, in which *self* is God and the universe, and by a return to Spinozism in the later idealistic pantheism of Schelling. Against all these he iterated and reiterated the assertion that it is vain to seek the *materials* of a philosophy in thought itself; that pantheism, with its baleful practical results, is the only consistent end of such a course; that while thought or intellect may *elaborate*, the *elements* to be so elaborated must be sought elsewhere.

We are thus brought to the *positive* aspects of Jacobi's philosophy. In maintaining that intellect itself can furnish no materials for metaphysics, he was frequently brought face to face with the question, Where, then, are they to be found? In his answer to this question, we find the distinctive feature of his system, the philosophy of *feeling, faith, reason*. His opinions on this point were formed during the earliest period of his career, and were suggested chiefly by the study of Spinoza, Berkeley, and Hume. His subsequent conflict with Kant and his followers occasioned no addition to the substance of his doctrine, but only served to bring it more distinctly and definitely out, by opposition and contrast. According to Jacobi, the materials of knowledge and philosophy are furnished antecedently, in the order of thought, to every exercise of the intellect. If it were not so, intellect or understanding could have had no domain in which to operate. They are furnished with what is above intellect, and beyond its comprehension. This highest faculty of an intelligence is *reason*. It is its office to apprehend *immediately*, without any intervention of the understanding, realities that are brought face to face with it as its objects. The data of this reason, as the basis of all that can be comprehended, are themselves incomprehensible. To attempt to *establish* their validity by any process of analysis or deduction, is to misapprehend their nature and place. They cannot be so established; they can only be accepted as primitive facts, of their own nature authoritative, and constraining us to unquestioning acceptance of them; and the trust which we thus repose in them, the instinctive *feeling* of reality, is denominated *faith*.

Thus, for example, in regard to the external world. It is the universal judgment of mankind that that world exists without us, and independent of us. The speculative philosophy in vain attempts to deduce the knowledge of it from our understanding. The necessary result of such an attempt is either to identify mind with matter, as in Spinoza's materialism, or to identify matter with mind, as in Schelling's idealism. The only legitimate course is to accept the fact of an external world, as immediately revealed to our reason; the only legitimate interpretation of the fact is a system of dualism and realism. Nor is it a valid objection that we are thus constrained to depend upon the mere *feeling* of the truth, to exercise *faith* in the reason which brings us into direct contact with the reality. For from the nature of the case such faith *must* be exercised, whenever we come into contact with a primitive and underived fact of consciousness. And what but the same feeling or faith have we to plead in behalf of the law of the understanding itself, the principle of identity or contradiction?

Again, in recognizing the reality without us, the external *not-self*, we are at the same time recognizing, in contrast to it, the reality within us—the internal *ego* or self. It is true that at first the emphasis is laid upon the assertion of the *non*-ego; but this implies the assertion of the contrasted *ego*—it is impossible to recognize the one, without at the same time a conscious recognition of the other. And thus, along with the external world, reason also immediately reveals to us the internal. Indeed, it is especially in so doing that reason is the *life* and soul of the human mind. Our individuality, our personality, our identity, it gives as primitive facts, beyond question and beyond explanation. And in thus enabling us to say "*I am*," it constitutes the peculiarly divine in man, who in this respect, as distinctly self-conscious, is the image of the Supreme Being, the great "I am" Himself.

And it is here that we find the peculiar and appropriate sphere of reason, in immediate contact with the great realities of the soul—God, liberty, immortality, the true, the beautiful, and the good. In this highest sphere especially, it appears how reason is the *life* of the mind. It alone can reveal to us the objects which form the food of that life. And it is only in proportion as we are in harmony with these that the revelation can be made.

In this way Jacobi traced back our knowledge to a pri-

Jacobins. mitive revelation, made by reason, faith, feeling, of realities independent of thought. This supreme revealer, from its very nature, is itself mysterious and inexplicable. But that does not imply that we may not seek to construct a system by collecting the *data* that are thus furnished to humanity, and, using this same reason as a test, purifying them from the various prejudices with which, in the blindness of spontaneous life, they may have been adulterated. Jacobi mainly occupied himself in vindicating the place and authority of this primitive revelation; he has not attempted any complete systematic exposition of its contents. In the words of a reviewer cited by Chalibaeus, "Jacobi is like a solitary thinker, who, at the dawn of day, has found some ancient riddle hewn in an eternal rock. He believes in the riddle, but in vain endeavours to solve it. He carries it about with him the whole day, coaxes out of it some important meaning, coins this into doctrines and images, which delight the hearers and animate them with noble wishes and presentiments; but the solution fails, and he lays himself down to rest at eventide in the hope that some divine dream, or the morrow, will give to his longing the true interpretation in which he has so firmly believed."

Jacobi's influence has been less felt in the formation of a distinct school than in contributing to modify the opinions of the followers of Kant and his successors. In this respect his avowed mysticism was perhaps the best antidote to the reigning rationalism. But both in philosophy and in theology this mysticism, so far as erroneous, is in itself an evil; and in Germany the mysticism of Jacobi has already produced its bitter fruits. So far as the positive elements of his philosophy are concerned, the British student cannot fail to be struck with their coincidence with the leading doctrines of the Scottish school. In his earliest publication, in the person of one of the heroes of the tale, he bases his opposition to empiricism and epicurism upon Ferguson's *History of Civil Society*, and also expresses ardent admiration of the works of Thomas Reid. His doctrine of the immediate knowledge of the external world is identical with that of Reid; and his doctrine of reason and faith in general, so far as it goes, coincides in the main with the generalizations of Sir William Hamilton.

His whole works have been collected and edited by one of his disciples, with an introduction containing a sketch of his philosophy. This edition was published at Leipzig, 1812-25, in six octavo volumes. (J. M'G.)

JACOBINS, THE, one of those clubs which played so conspicuous a part in the first French Revolution. When it became evident in 1789 that a social crisis was at hand, the members elected by the people considered it advisable to have conferences among themselves about questions of public interest. At these meetings the deputies from Bretagne took the lead, and from this fact the society was, for some time, called the Breton Club. The three orders of the National Assembly were represented in it—all desirous of a change of things. The clergy were represented by the bishop of Autun (Talleyrand), the Abbé Siéyes, and others; the nobility by the Duke de la Rochefoucauld, the Viscount de Noailles, &c.; the magistracy by Duport, Target, &c. At first the club, during its sittings at Versailles, made no great noise, but immediately after the events of October 5th and 6th, in 1789, they publicly opened their meetings in the monastery of the Jacobins in the Rue St Honore, at Paris. Although inaugurated as *The Society of the Friends of the Constitution*, they got the name of the *Jacobins* from their place of meeting, and by that title they are now best known. Their hall was thronged by crowds of listeners, including most of the remarkable public men of the period. The club itself became the parent of numerous affiliated societies throughout France. At the funeral of Mirabeau in 1791 the Jacobins mustered 1800 strong. They were almost powerful enough, by their vehement denunciations of the king and his ministers and their own numerical weight in the assembly, to subvert the government. In 1792 they took the name of *The Society of the Friends of Liberty and Equality*. Their influence, however, was for a time somewhat lessened by the rise of a moderate party which had been forming in the society itself, and which occasioned a temporary secession. Immediately after the fall of the king, the Jacobins began that struggle against the Girondists which ended in the destruction of the latter. After this, the violence of the club knew no bounds, and often hurried many of the members into the most outrageous excesses. After the fall of Robespierre during the Convention they rapidly lost influence, and were at last suppressed. The history of this club is closely interwoven with the history of France during the first Revolution. See FRANCE.

Jacobites ‖ Jade.

JACOBITES, THE, were those who, at the English Revolution in 1688, adhered to the cause of the dethroned king, James II. Some, as Middleton, Melford, &c., shared his exile, and formed his little court at St Germain. In Ireland the adherents of the Stuarts rose in rebellion, but were vanquished by force of arms. In Scotland attempts were made in 1715 and 1745 by the descendants and adherents of James II. to expel the House of Hanover. Both were unsuccessful, and involved the ruin of many noble families. It is now known that during the reign of Queen Anne, Marlborough, Bolingbroke, and others in the government, were secretly intriguing, whether sincerely or not, for the restoration of the banished house of Stuart. See BRITAIN.

JACOBUS, a gold coin, worth twenty-five shillings, and so called from King James I. of England, in whose reign it was struck. There are two kinds of *Jacobus*, the old and the new; the former valued at twenty-five shillings, weighing six pennyweights ten grains; the latter, called also *Carolus*, valued at twenty-three shillings, and in weight five pennyweights twenty grains.

JACQUERIE. This name was given to the revolt of the French peasantry against the nobles in the fourteenth century. It arose from the term Jacques Bonhomme, by which the peasants were in jest designated by the nobles. The struggle was carried on with great fury on both sides, and was not suppressed till several counties had been completely devastated. See FRANCE, anno 1356.

JADE, an ornamental stone, of which there appear to be two varieties, *common jade* or *nephrite*, and *saussurite* or *jade tenace*. Common jade is a silicate of magnesia, oxide of iron, and alumina. Its specific gravity varies from 2·9 to 3·0; hardness 7·0. Its colour is leek green, passing into grey. It is very tough, and scarcely fusible before the blow-pipe. Nephrite was formerly worn as a charm, and was supposed to be a cure for diseases of the kidney, whence the name from *νέφρος*, *kidney*. From its toughness it has been used for the blades of hatchets by the New Zealanders, and other savage nations. Humboldt speaks of jade stones being an article of trade among the natives of the N. and S. sides of the Oroonoko. Jade is much used in Turkey and Poland for the handles of knives, daggers, swords, &c.; and in India, ornaments and trinkets, delicately worked, are made of it. In China, the jade is of a whitish colour, and is called *yu*. It is formed into vases, rings, and other articles. A great variety of jade ornaments from India and China appeared at the Great Exhibition of 1851. Such articles are very costly, on account of the extreme difficulty of working this refractory substance, but it has been suggested that mortars, pestles, and some other objects required by chemists, could be manufactured of jade of larger size than can now be made of agate, and, from the simplicity of the forms, at moderate cost. Jade is polished like carnelian, but it takes only a greasy, not a brilliant polish.

Saussurite is a double silicate of magnesia, lime, and

oxide of iron, with silicate of alumina; specific gravity 3·2 to 3·4, hardness 5·5. Its colour is greenish-white, or ash-grey; its cleavage is in two directions, meeting at an angle of nearly 120°. Its lustre is pearly, resinous, or vitreous; it is extremely tough, and is fusible before the blow-pipe. (C. T.)

JAEN, a province of Andalucia, Spain, lying between N. Lat. 37. 30. and 38. 40., and W. Long. 2. 50. and 4. 20; and bounded N. by the province of Cuidad-Real, E. by Albacete and Granada, S. by Granada, and W. by Cordova. It is about 80 miles in length from E. to W., by about 70 in average breadth; area 4445 square miles. It is surrounded on every side by lofty mountains, which almost exclude it from communication with the surrounding provinces. Its surface is a constant alternation of hills and valleys, the latter being well watered and fertile, whereas the former yield little except some pasture for sheep, which come here in the winter season from the more northern provinces. Agriculture is in a very backward state, so that, notwithstanding the great fertility, the quantity of grain produced does not meet the amount consumed in the province. The Guadalquivir, with its affluents, drains the entire province. Jaen was celebrated for its mineral productions even in the time of the Romans, and at present its lead and iron mines are extensively wrought. The Moorish kingdom of Jaen was not so extensive as the modern province. Pop. (1849) 307,410. See ANDALUCIA and SPAIN.

JAEN, the capital of the above province, stands on an acclivity near the River Jaen, a tributary of the Guadalquivir, 37 miles N. of Granada, and 120 miles E. of Seville, in N. Lat. 37. 48., and W. Long. 3. 47. Its position is very important in a military point of view, defending, as it does, the mountain road into Granada. On the top of the hill behind the town there is a castle, with which the walls of the city are connected. The streets rise above each other on this hill-side, and are irregularly built, narrow, and dirty. The principal public building is the cathedral, a Græco-Roman structure, erected in 1525, on the site of an old Moorish mosque. In it is preserved the relic called "El Santo Rostro," or the impression of our Lord's face on the handkerchief of St Veronica. Jaen was long in the hands of the Moors, and has suffered many sieges. In 1808 it fell into the hands of the French under Cassagne, who committed great atrocities on the inhabitants. Jaen is the see of a bishop, conjointly with the town of Baeza. Besides the cathedral, the town contains 12 churches and 15 convents. The manufactures, now unimportant, consist of silk, woollen cloths, and mats. But the trade of the place is brisk, from its situation, surrounded by the most fertile lands. Pop. (1845) 17,327.

JAFFA, or YAFFA (the ancient *Joppa*), is a seaport town of Palestine, in N. Lat. 32. 3., E. Long. 34. 45. It is situate on an eminence projecting into the sea, about 40 miles N.W. of Jerusalem. It is mentioned in the Old Testament as the port at which the timber for the building of Solomon's temple was unshipped. During the wars of the Maccabees its shipping was set on fire by Jonathan; and it was again pillaged during the wars between the Romans and the Jews, 8400 of its inhabitants being put to the sword, and the town burnt. Having subsequently become a refuge for pirates, the place was utterly destroyed. Gradually, however, it seems again to have risen to importance, for during the reign of the Christian emperors it was made the seat of a bishopric. In A.D. 636 it was taken by Omar. In the crusades it was taken by Baldwin I., and in 1186 retaken by Saladin. In more recent times it was stormed by Napoleon in 1797, when 500 Turkish prisoners were put to death.

The harbour of Joppa has always been dangerous, owing to its exposure to the sea, and, being now nearly choked up with sand, vessels are obliged to keep at a distance from the shore. Notwithstanding all danger and difficulty in landing, Joppa has for many centuries been the resort of pilgrims on their way to Jerusalem.

The town chiefly faces the N. The buildings are surmounted by flattened domes, which rise in rows above one another like terraces, on the steep face of the eminence on which the town is built. The summit of the height is crowned with a castle; but though the general situation of the town is thus somewhat picturesque, its appearance on closer inspection is mean and comfortless. A wall 12 feet high defends the town on the landward side, and two forts protect the harbour. Joppa carries on trade in cotton, soap, fruit, coral, &c. The fruits, consisting of water melons, oranges, lemons, &c., grow well in the sandy soil of the numerous neighbouring gardens. It imports rice from Egypt. The inhabitants consist of Turks and Arabs, Romanists and Greeks, with some Armenians, as may be inferred from the three mosques, three churches, and three Armenian convents to be seen in the town. A British consul resides here. Pop. 4000.

JAFNA, the capital of the district of Jafnapatam. It stands at some distance from the sea, but communicates with it by a river navigable for large boats, and which falls into the sea near Point Pedro. The town is fortified and possesses a good citadel, which, though small, is exceedingly well built; but it was given up in 1795, after a short resistance, to the British troops. The situation is salubrious, and living is cheap; on which account many families have removed to this place from Columbo. The greater part of the inhabitants are of Mohammedan extraction, and are divided into several tribes, known by the names of Lubbahs, Moplays, Chittees, and Cholias. The foreign settlers are more numerous than the native inhabitants. There are manufactures of coarse cotton cloths, calicoes, handkerchiefs, shawls, stockings, &c.; and there are also many artificers, such as goldsmiths, jewellers, joiners, and cabinet-makers.

JAFNAPATAM is the name of a district in the northern extremity of Ceylon. It is considered as the most healthy and populous part of the island, as it escapes, owing to its maritime situation, the intensely hot winds which prevail on the continent. It is clear of woods, produces a variety of fruit and vegetables, and abounds also in poultry and game; whilst the tract that lies between Point Pedro and Jafna is favourable to the breeding of sheep. In the islands dependent on this district, namely, Delft, Harlem, Leyden, and Amsterdam, so named by the Dutch from their native cities, government has an establishment for breeding horses and cattle, for which the islands afford excellent pasture. The woods towards the interior, separating the district from the Candian provinces, are inhabited by a savage race of people known by the name of the Vadahs or Bedahs, who are supposed to be the ancient inhabitants of the country.

JÄGERNDORF, or KARNOW, a town of Austrian Silesia, circle of Troppau, and 14 miles N.W. of the town of that name, between the Great and Little Oppa. It is surrounded by high walls, and has a palace belonging to the princes of Lichtenstein, and a handsome church, with a spire 230 feet high. Its linen and woollen cloth manufactures are considerable. Pop. about 4800.

JAGHIRE, an assignment made in Bengal by an imperial grant upon the revenue of any district, to defray civil or military charges, pensions, gratuities, and the like.

JAINS, called by some JOINUS, a sect or rather race of Hindus, found in considerable numbers in different parts of India, particularly in the southern peninsula. They form a class of dissenters from the established faith of Brahminism, so generally considered throughout India as alone founded on an orthodox basis. They deny altogether the authority

Jains.

of the Vedas, regarded by the genuine Hindu as the holiest of books. They either disown, or sink into a subordinate rank, all the grand objects of Hindu veneration. In their hypothesis concerning the origin of the world, they have adopted opinions which seem to partake of the character of atheism. They do not, like the followers of the Vedas, acknowledge any spiritual and eternal Being, from whom the universe derived its origin. The material world, as well as the minds of all men and animals, are held by them to be eternal. They refuse to acknowledge anything which is not, or has not been, the object of the senses. Upon this principle they deny the existence of any beings superior to man, and admit no objects of worship except men who have raised themselves by their merits to the rank of divinities. As, however, they set no bounds to the perfection which the human soul may arrive at, their most eminent saints and pontiffs (amongst whom they particularly celebrate Gomat Iswara Swami) partake almost of the attributes of supreme divinity. To this station, however, they are exalted, not in consequence of a virtuous life, or of benefits rendered to mankind, but of those excesses of absurd and extravagant penance to which, throughout all India, such sovereign merit is attached. They have three ranks of ascetics, whom they call *Yatis*. The first, called *Anuvrata*, can be attained only by him who forsakes his family, entirely cuts off his hair, holds always in his hand a bundle of peacock's feathers and an earthen pot, and wears only clothes of a tawny colour. The second rank, *Mahavrata*, requires that all dress should be abandoned except a mere rag to cover nakedness, and that the hair instead of being shaven off, should be pulled out by the roots. He who aspires still higher, and seeks to attain the third degree, or *Nirvana*, throws aside even rags, and remains entirely naked; he eats nothing but rice, and that only once in two days. The name is nearly synonymous with that of Deity, and he is held in nearly equal veneration with the priests and rajahs, whose images are worshipped in the temples. At Billicull, or Belligola, the residence of their high priest, they have a gigantic image of Gomat Iswara Swami, the foot of which is 9 feet in length, so that the height of the entire statue cannot be less than 54 feet; and there is a similar one at Kurcul, near Mangalore. This worship of gigantic images is common to them with the followers of Buddha, whom they also closely resemble in their theological tenets; nay, Samana and Gaudma, the main objects of Buddh veneration, are enumerated by the Jains amongst the earliest and most venerated of their priests. On the other hand, they differ from them entirely in being divided into four castes, distinguished from each other by the same privileges and manners as amongst other Hindus. The Jains observe also similar penances, carrying them only to a still greater extreme. They are also scrupulous to a still greater degree as to causing the death of any living thing, even the minutest insect. The strictest Jains, to guard against this danger, do not eat after sunset; they have always a small broom to sweep the ground before them, and never drink water unless strained through a cloth. The orthodox Hindus have ceremonies by which any involuntary offence of this kind may be expiated; but the Jains, not allowing the efficacy of these, have no means of relieving their soul from the burden of such a trespass. Like the other Hindus, they consider it as unlawful for the widow to marry again, but discourage the barbarous practice of sacrificing herself on the body of the husband. On the whole, it would appear that whilst their doctrines and belief closely coincide with those of the Buddhists, their civil and social life is discriminated only by minute shades from that of the Hindus. They have a system of their own with regard to history, chronology, and physics, of which we need only observe, that its tenets are still more extravagant and absurd than those contained in the orthodox pages of the Vedas and Puranas. (See *Asiatic Annual Register*, vol. ix.; Dubois *On the Manners of the People of India*, Lond. 1817; Ward *On the History, Literature, and Religion of the Hindus*, Lond. 1817.) (H.M.)

Jalap ‖ Jalapa.

JALAP. In Mexico, from 4000 to 6000 feet above the sea level, grows the plant which yields true jalap, and which has been called by botanists *Convolvulus purga*, and *Ipomœa purga*, the latter name being adopted by De Candolle. It has since, however, been placed in the genus *Exogonium*. The true jalap (*Exogonium purga*) has a tuberous, perennial root, a smooth, twining, annual stem, a salver-shaped corolla, with long cylindrical tube, a calyx of five small, unequal sepals, and herbaceous stems. Its leaves resemble the ivy, and its beautiful red flowers open only at night. The dried tubers of this plant supply the drug jalap, so named from Jalapa, a town in Mexico, where it abounds, and which is the only market for the tubers. These, as found in commerce, rarely exceed 1 lb. in weight; they are oval in form, and covered with a dark skin or cuticle. Internally they are yellowish gray, with deep brown concentric circles, and are hard and difficult to powder. Inferior sorts are more irregular in form, and are called *spurious jalap*, or, from their shape, *cocked-hat jalap*. Some roots are much *worm-eaten*, and are so called; but, as the insects do not touch the resinous portions, such roots are available for extracts.

Four kinds of jalap are known in English commerce, two genuine and two spurious,—first, dark, heavy, resinous tubers; secondly, lighter coloured and less resinous; thirdly, *white* or *false jalap*, pieces of which are occasionally mixed with the true; and, fourthly, *jalap-stalk* or *woody jalap*, the slices of which are more fibrous and woody than the genuine. There are about 200,000 lbs. of the pure jalap annually exported from Vera Cruz on the Gulf of Mexico, the seaport of Jalapa.

The resinous portion, *jalapine*, is the active ingredient of jalap. It is obtained by mixing the alcoholic tincture of jalap (prepared by percolation or digestion) with water. The precipitated resin is to be washed in warm water, and then mixed with alcohol. By evaporation the tincture yields the resin, which, according to Mayer, who names it *rhodeoretine*, consists of C. 72, H. 60, O. 27. It is insoluble in ether, and is convertible by the action of alkalies into rhodeoretinic acid, which is soluble in water. The powdered root of jalap, as well as the resin, is a local irritant: in the human subject jalap acts as a powerful and drastic purgative, 3 or 4 grains of the resin sufficing for the purpose. Jalap is tolerably certain in operation, and does not disorder the system so much as some other purgatives, the effect being principally confined to the alimentary canal. It is used as a vermifuge; also in cerebral affections, dropsies, and some other diseases. The dose of jalap, in *powder*, is, for an adult, from 10 to 30 grains; for young children, from 2 to 5 grains. Jalap is sometimes exhibited in gingerbread; such are the *purgative cakes*, and the *biscuits purgatifs* of England and France. (C. T.)

JALAPA or XALAPA, a town of Mexico, capital of a cognominal department, in the state of Vera Cruz. It is situate on a small plain at the foot of a range of hills 55 miles N.W. of the town of Vera Cruz, and about 4500 feet above the sea level. On account of its exhilarating climate it is a favourite resort of the inhabitants of Vera Cruz when the *vomito prieto* is prevalent there. The only building of importance is an old church, which is believed by the people to have been founded by Cortes. Cotton is manufactured, but its trade has greatly diminished. In the neighbourhood grows the creeping-plant, *Exogonium purga*, or, as it is called from this town, *Jalap*. The population of the department is estimated at 45,000, and of the town, at 16,000 persons.

JAMAICA.

Jamaica. An island lying off the Bay of Honduras, between the Caribbean Sea and Gulf of Mexico, within N. Lat. 17. 40. and 18. 30., and W. Long. 76. 10. and 78. 30., about 4000 miles S.W. of England, 80 miles S. of Cuba, 90 miles W. of St Domingo, and 515 miles N. of Chagres, the Atlantic port of the Isthmus of Panama. It is the most southern of that group, which is called by some the Greater Antilles, by others the Leeward Islands. The latter name, however, is now generally applied to the smaller islands on the N.E., and sometimes to those on the S. of the Caribbean Sea. It is the largest, and was formerly the most valuable of the British West Indies, being 140 geographical miles in length, by 50 in extreme breadth, and containing about 4,080,000 acres, or 6400 square miles. Within its government are comprised, besides the three small islands called the Caymanas, Belize, or British Honduras, on the mainland of Central America, with Ruatan and other islands in the Bay of Honduras. These places, though distant respectively 600 and 460 miles, have been called the dependencies of Jamaica, and are ruled by superintendents appointed by the governor. The title of Britain was disputed by Spain in the early part of the last century, and the Bay Islands were given up to that power by the treaty of London in 1786, but were reoccupied by the British during the subsequent war. Having, with the Mosquito Territory, formed the subject of dispute between Great Britain and the United States, arising out of the Clayton-Bulwer Treaty, they have (1856) been constituted as free territory under the republic of Honduras, with provisos against alienation, the erection of forts, and the introduction of slavery.

Jamaica was discovered by Columbus on the 3d of May 1494, while coasting along the S. of Cuba, during his second voyage. He called it St Jago, after the patron saint of Spain, but it is now generally known by its Indian name Jamaica, a word signifying the Isle of Springs, according to the best authorities, though Long derives it from a kind of fruit. It is sometimes written Xaymaca by the Spaniards.

On approaching the shore, Columbus called the nearest land after his first ship, Santa Maria, a name still preserved in Port Maria. He effected a landing a little to the westward, at Ora Cabessa, where, after a slight opposition from the natives, he took possession of the country, with the usual formalities, for the king of Spain.

The inhabitants were the same mild, inoffensive race as those of Cuba and Hayti. Like the Arowaks of Trinidad and Guiana, they were probably offshoots of the great Mexican stock, and very different from the fierce Caribs of the Windward Islands. After a short stay, Columbus quitted Jamaica, which remained undisturbed for nine years. In June 1503, on his fourth and last voyage, he was driven by a tempest, in which he lost two ships, to a bay on the N. side of the island, which he named Sta. Gloria (now St Ann's Bay), where he ran his remaining vessels ashore in a small inlet still called Don Christopher's Cove. The shipwrecked mariners were received with the greatest kindness by the Indians, and here Columbus remained upwards of a year awaiting the return of messengers he had dispatched to Ovando, governor of Hispaniola, as Cuba was then called. During this time he suffered much from disease, as well as from the mutiny of his followers, whose gross misconduct alienated the Indians, and provoked them to withhold their accustomed supplies, until he dexterously worked upon their superstition by prognosticating an eclipse.

After the second departure of Columbus, Jamaica seems to have remained unvisited until 1509, three years after his death, when his son Diego, having established his right in the council of the Indies to the governorship of Hispaniola, which included Jamaica, sent Don Juan d'Esquivel to take possession of the island in opposition to Alonzo d'Ojeda, who claimed it under a royal grant. Jamaica.

By Esquivel the natives were treated, according to Herrera, with unusual humanity. That his successors did not imitate him in this respect is proved by the astounding fact that of the Indian population, at this time estimated at from 60,000 to 100,000 souls, not a descendant of either sex existed in 1655, when the island fell into the hands of the English, nor, it is supposed, for nearly a century before. After a short sway, Esquivel died in Sevilla d'Oro, a town founded by himself on St Ann's Bay, which is supposed by some to have been deserted on account of the ravages of ants, by others to have been destroyed during an insurrection of the Indians. Its premature fall was, however, most probably owing to the attacks of French flibustiers, or pirates, who for a long period infested these coasts. The site of the town may still be traced by mounds of earth, as well as in the names of certain fields belonging to the Seville sugar plantation. Melilla, near Port Maria, or, according to another opinion, at Martha Brae, near Falmouth, shared the same fate.

About the year 1523, Diego Columbus, visiting Jamaica from Hispaniola, founded, on the River Cobre, inland to the S. of the mountain range, St Jago de la Vega, St James of the Plain, which gave the title of Marquis to his descendants, and is still the official capital, under the name of Spanish Town. At some distance westward, on the coast, was built Oristan, which is now called Bluefields. Down to 1596 the history of Jamaica is only a record of the rapid disappearance of the Indians, under the Spanish yoke, and of intrigues at the court of Spain, having for their object the dispossession of the descendants of Columbus, whose rights were, however, successfully defended, and eventually centred in an heiress, through whom they passed by marriage to the house of Braganza, reverting afterwards to the Spanish crown, in consequence of the revolution of 1640, which placed John, duke of Braganza on the throne of Portugal. Long anterior to this last event, the union of the crowns of Spain and Portugal, under Philip II., in 1580 occasioned an influx of Portuguese colonists into Jamaica, who contributed much to its strength and prosperity, but were usually on indifferent terms with the Spanish settlers. Attention had at an early period been paid to agriculture, the cotton-plant was extensively cultivated, and the sugar-cane, vine, and various kinds of corn and grass had been introduced; and whereas a small species of dog, called the alco, was the only domestic quadruped known to the aborigines, horses, horned cattle, and swine had been imported from Hispaniola, which multiplied amazingly, and a flourishing trade sprang up in lard and hides, as well as tobacco, sugar, and ginger. In 1596, during the alliance of Queen Elizabeth with the Low Countries, and the consequent war with Spain, Sir Anthony Shirley, a British admiral, invaded Jamaica with a large fleet, and landing at Passage Fort, plundered St Jago and the neighbouring territory, but made no attempt at occupation. After thirty-nine years' tranquillity, during which, under the government of Don Arnoldo de Sasi, the island rose to a high pitch of prosperity, it was again invaded in the reign of Charles I. by Colonel Jackson, who defeated the inhabitants in a severe engagement at Passage Fort, and did not retire till he had ravaged the whole country, and laid the capital under heavy contributions. The Spanish colonists never recovered from this attack. At the termination of the next twenty years we find the whole island divided into eight districts, and in the nominal possession of eight noble families, whilst the

Jamaica. rest of the population is said, but the statement seems scarcely credible, to have consisted only of 1500 Spaniards and Portuguese (though the Portuguese had, according to some accounts, been expelled by the Spaniards), and about the same number of blacks and mulattoes.

The preposterous claim by Spain to the exclusive right of navigating the American seas, and the outrages committed upon British subjects in these parts, provoked Cromwell to send an expedition, consisting of 6500 men, under Admirals Penn and Venables, against Hispaniola. Failing in their attempt, for which they were afterwards committed to the Tower, they attacked Jamaica, which capitulated, after a trifling resistance, on the 3d of May 1655, after having been 161 years in possession of the Spaniards.

After the capture of the island, until the restoration of Charles II., Jamaica remained under military jurisdiction. Great exertions were made by Cromwell to establish a firm and peaceable government, as well as to people the island from Scotland and Ireland, from the Windward Islands, and from the English colonies in North America; but these efforts were for some time neutralized by the incessant attacks of the Spaniards and their negroes, who had retreated to the mountains, by the disaffection of the troops, and rapid mortality among the settlers. A better state of affairs was at length established by Colonel D'Oyley, a man of courage and capacity. A formidable armament from Hispaniola was totally defeated at Rio Nuevo, on the 8th of May 1658, and the remnant of the Spaniards was soon after driven from the island. Their slaves, however, for the most part, remained, and maintained themselves in the mountains, where, being constantly augmented by runaway negroes, they afterwards became formidable, under the name of Maroons. The troubles in England after Cromwell's death caused a considerable accession to the number of colonists, and in 1661, soon after the Restoration, the first establishment of a regular civil government in Jamaica was made by Charles II., who appointed D'Oyley governor-in-chief, with an elective council. Lord Windsor, who succeeded him the following year, was instructed to summon a popular assembly, with power to pass such laws for the internal regulation of the country as should not be subversive of dependance on the parent state. At this date negro slaves began to be imported in large numbers, and even Indians from Yucatan, though this latter traffic was soon prohibited. Jamaica became also about this time the resort of the buccaniers, a band of freebooters composed of adventurers and outlaws of all nations, whom the war with Spain enabled to carry on their trade of piracy under the British flag. Their ill-gotten wealth was recklessly squandered in Port-Royal, and their barbarous outrages applauded by the inhabitants, who shared their gains, and, it has been said, connived at for the same reason by the king himself.

In 1670 peace was made with Spain; the title of England to Jamaica was recognized by the treaty of Madrid, and it became necessary to put down the buccaniers. This was effectually done by their own former leader, Sir Henry Morgan, who had been knighted for the capture of Panama, and was lieutenant-governor of Jamaica in 1675. He was succeeded by Lord Vaughan, during whose administration was formed in England the 4th, or Royal African Company, which established a monopoly in the slave-trade. In 1678, under Lord Carlisle, an attempt was made to saddle the island with a yearly tribute to the crown, and to take away the legislative power of the House of Assembly, which was to be in future a mere instrument for voting supplies and passing those laws which, after being prepared by the governor and council, were approved at home. In consequence of the strenuous resistance of the colonists, the privileges of the Assembly were restored under Sir Thomas Lynch in 1682, but the tribute question was not settled till 1728, when L.8000 a-year (currency) was settled on the crown, on condition, among other things, that all the laws and statutes of England should equally apply to Jamaica: this bill, which was considered the Magna Charta of Jamaica, was passed under the administration of the Duke of Portland. This L.8000 currency, afterwards commuted to L.6000 sterling, was at the disposal of the governor. Out of it he provided for certain allowances and salaries, as well as for the repairs of certain forts. It was called the Council Fund, and from it seems to have arisen the erroneous idea, repeated even in the latest publications, that the crown draws a revenue of L.10,000 a-year from Jamaica. This council fund was in 1854 merged in the civil list. Jamaica.

Before this event many calamities had happened. In 1692 occurred the great earthquake, when the chief part of the town of Port-Royal, built on a shelving bank of sand, slipped into the sea, and was destroyed. Two years after, a powerful French armament from St Domingo, commanded by the governor, Ducasse, committed the greatest cruelties and devastations on the S. and E. coasts, but was at length driven back by the gallantry of the militia. In 1712, and again on the same day in 1722, there were dreadful hurricanes, the anniversary of which, as well as that of the great earthquake, was by Act of Assembly set apart as a fast. This last hurricane was so destructive to Port-Royal, that the seat of commerce was transferred to Kingston. In 1744 there was another hurricane, and no less than five in 1780 and the six following years, at which time the distress occasioned by these visitations was much aggravated by a decree of the Imperial Parliament, virtually prohibiting trade with the United States, and confining the colony, for her American supplies, to the inadequate markets of Canada and Nova Scotia. The next hurricane seems to have occurred in 1812. There was a slight one in the next year, another more severe in 1815, others again in 1819 and 1846.

In 1738, under Governor Trelawny, a pacification took place with the Maroons, after a contest of nearly forty years, during which a body of Mosquito Indians was employed against them. The Maroons were henceforth confined to certain specified localities—an ill-judged policy, which perpetuated the distinction of race and separation of interest. They proved in consequence, from time to time, very troublesome; and, in 1795, during the administration of the Earl of Balcarras, a serious rebellion broke out, chiefly confined to the Trelawny Town Maroons, which was quelled the next year, after great loss of life, when 600 of the insurgents were transported to Nova Scotia. There are now three Maroon settlements in Jamaica, which have, however, no longer any separate political existence, viz., Accompong Town, Charles Town, and Moore Town. The Maroons are perhaps even more averse to labour than the ordinary creole negro, and certainly more thievish and dissolute; but the wild life they have led for so many generations has made them taller, and more active and vigorous. In 1760, a dangerous revolt of the Koromantyn slaves was speedily repressed, and punished by the most barbarous executions. In 1765 the Assembly expressed a wish to limit the importation of slaves, but the governor, by instruction, refused his consent. In 1774 a bill passed the Assembly for the same object, but was disallowed by the Board of Trade in England. From 1700 to 1786, the number of slaves imported into the island was 610,000, of whom about one-fifth was re-exported.

In 1782 Jamaica was threatened with an invasion by the combined fleets of France and Spain under De Grasse. It was saved by the victory of Rodney and Hood, off Dominica, in commemoration of which a statue of Lord Rodney, by Bacon, has been erected in Spanish Town. The chief events of the following years were,—a fire which con-

Jamaica. sumed nearly the whole town of Montego Bay—the Maroon war above mentioned,—an apprehended invasion of the French from St Domingo—a conspiracy among the slaves in Kingston—disputes with the Imperial Government on the introduction of black troops, and the excessive taxation of the island staples.

In 1806 Admiral Duckworth defeated the French squadron destined to invade Jamaica. In 1807 the slave-trade was abolished, at which time there were 323,827 slaves in Jamaica. During the last eight years of the trade, 86,821 slaves were imported, of whom about one-tenth was re-exported. At this period Jamaica had reached the highest pitch of prosperity. Its fields teemed with sugar, coffee, cacao, cotton, pimento, ginger, and indigo; and it was the depôt of a lucrative transit-trade between Europe and the Spanish main, employing, in the year 1816, no less than 199,894 tons of shipping; in 1828, 254,590 tons; in 1830, 130,747 tons.

In 1823 the agitation in England against slavery had reached such a height that Lord Bathurst, in a despatch to the Colonial Legislature, recommended the adoption of certain measures for ameliorating the condition of the slaves. This moderate suggestion was unfortunately rejected, and, during the following year, a proposal for the emancipation of children of a certain age shared the same fate. From this period, till the moment of emancipation, we find in Jamaica ill-advised and indefensible proceedings by the colonists, and unwarrantable interference on the part of the dissenting missionaries; in England violent and unscrupulous agitation. An examination of the history of these events proves that a measure, the success of which depended upon the anxious and cordial co-operation of both parties, became at length, on all sides, with few exceptions, a mere party, and too often a mere personal question.

In 1831, a recommendation by Lord Goderich, of the same nature as the one previously mentioned, seems to have excited the colonists, in spite of the efforts of the Earl of Mulgrave, the governor, to acts of intemperate folly against the crown, as well as of scandalous violence against the missionaries; and the negroes, led by the latter to believe that England had decreed their emancipation, rose in 1832 in a revolt, which was not subdued till many hundred lives had been sacrificed, property to the amount of upwards of a million destroyed, and the atrocities usually attending a servile war perpetrated on both sides. These events created great excitement in England, and that class of philanthropists, which is ready to be generous at the expense of others, clamoured for instant and unconditional emancipation. The English government, however, with more justice, passed, on the 14th May 1833, "An Act to Abolish Slavery," but fixing an apprenticeship of twelve years, reduced afterwards to six, and eventually to four; and granting to the owners a compensation of twenty millions sterling, of which L.6,161,927, 5s. 10d. was awarded to Jamaica, being rather more than L.19 a-head on a slave population of 309,338. This sum, though much less than the assessment of the government commissioners themselves, was a noble sacrifice by a nation in the cause of freedom, and one which a better and more statesmanlike measure might have rendered unnecessary; but as Earl Grey remarks in his *Colonial Policy*, it was a measure which "is now generally admitted to have been most unhappily defective."

All parties were determined that the apprenticeship should be a failure. The magistrates sent to protect the negroes were prejudiced against the employers, who, on their part, could not give up their power without a struggle. Their manner was more overbearing and tyrannical than in the days of slavery; and they frequently displayed the bitterness of their feelings, by turning the negroes out of their houses, destroying their provision grounds, and subjecting them to every kind of annoyance. The Marquis of Sligo who had succeeded Lord Mulgrave in July 1834, was recalled in 1836, having incurred unpopularity, in consequence of the interference of the British government with the House of Assembly, relative to the "Act in Aid of the Abolition of Slavery." He was succeeded by Sir Lionel Smith, during whose administration, on the 1st of August 1838, the apprenticeship was terminated by an act of the Assembly itself, and entire emancipation took place; and early in the ensuing year the House of Assembly having refused to transact business in consequence of renewed interference by the British legislature in the case of the "Prisons' Act," a bill was introduced by Mr Labouchere into the House of Commons to suspend the constitution of Jamaica, the rejection of which measure occasioned the resignation of Lord Melbourne's ministry. On resuming office, in consequence of Sir Robert Peel's failure to form an administration, they passed an act to compromise the Jamaica dispute, and Sir Lionel Smith having become unpopular in consequence of these events, was superseded in October 1839 by Sir Charles Metcalfe, whose wise and conciliatory policy restored tranquillity to the colony. He brought about a better understanding between the labourers and employers, and took measures to provide religious instruction and the due administration of justice. The number of the island curates was doubled. Acts were passed for the selection of the two puisne judges from barristers of a certain standing, and for the appointment of nine chairmen of quarter sessions, also barristers. These changes were readily granted, though involving an increased expenditure of L.30,000 a-year. He turned his attention also to substitutes for the laborious cultivation of sugar. Agricultural societies were formed, and attempts made to develope the resources of the colony in silk, cotton, fibrous materials, tobacco, arrowroot, and copper. Silk works were established on a grand scale in St Ann's, mines were opened, and a new prosperity seemed about to dawn upon Jamaica. None of these schemes, however, rewarded the enterprise of the promoters. They failed in succession, and from the same cause, the want of cheap and continuous labour. Fully alive to this deficiency, Sir Charles was a zealous advocate of immigration, which commenced in 1839, from Sierra Leone and the Kroo Coast; and in 1840 the first Jamaica Immigration Act was passed. Groundless fears, however, on the part of the mother country, of a renewal of slavery under another name, led the Imperial Government to impose restrictions on immigration, not yet entirely removed, which, by enhancing the difficulty and expense, have prevented such a comprehensive scheme as could alone be permanently beneficial. Meanwhile, the planter, compelled to waste his capital on unproductive labour, has seen the superabundant population of other countries swept off by his rivals, though the condition of the immigrant is nowhere to be compared with that which humane policy has secured for him in a British colony. Sir Charles Metcalfe resigned in 1842, to the extreme regret of the colonists, who commemorated his administration, by forming a new parish called after his name, out of portions of St George and St Mary. He was succeeded by the Earl of Elgin, who adopted the same policy, and under whose auspices a railway, 12 miles in length, was opened, connecting the two capitals, Kingston and Spanish Town. On his advancement to Canada, he was succeeded by Sir Charles Grey at the commencement of troublous times. The act of 1846 had passed, admitting slave-grown sugar into the English markets, and the most sanguine began to despair.

The proverbial luxury of a Jamaica plantation had been exchanged before this for an almost equally remarkable frugality. The hoe had given way to the plough, and other implements of the most improved construction; and the hereditary estates of many absentee proprietors had passed for a mere trifle into the hands of the practical planter; but

Jamaica. neither improved agriculture, nor strict economy, nor the residence of the proprietor, availed against the superior advantages of the slave-owner; and though the prospects of copper mining, which was resumed with vigour, seemed promising, the necessity of retrenching the island expenditure became evident. The first bill for carrying this into effect was rejected by the Council as inadequate in its general effect, but at the same time bearing unjustly upon individuals, by making in some instances a reduction of more than 30 per cent. on the salaries of permanent offices, without compensation to the holders. The second was disallowed by the Imperial Government for similar reasons. Again the Assembly resented interference, and refused to perform its functions. The result was most disastrous. In 1849 the rum duties were allowed to expire, by which L.50,000 were lost; and in 1853 taxes and import duties were uncollected for six months, causing a sacrifice of more than L.177,000, and adding L.130,000 to the permanent debt of the island. Public functionaries remained unpaid except by an issue of inconvertible paper called island cheques. In the midst of these troubles came the cholera, which is supposed to have decimated the population. During this crisis party feeling ran high. There was open hostility between the Council and Assembly, and among many disgraceful scenes the imprisonment of one of the judges for an alleged libel on the House of Assembly was perhaps the most remarkable. Many non-resident proprietors urged the suspension of the constitution. On the other hand, delegates were sent from Jamaica to lay the case of the colonists before the English government, which eventually decided to recommend—that permanent provision should be made for the salaries of permanent offices; that the initiation of all money grants should be left to the crown; that certain members of the legislature should be responsible for the expenditure of the public money. Conditional on the acceptance of these suggestions was made the imperial guarantee to that part of the Jamaica debt which bore 6 per cent. interest, amounting to L.500,000, as well as to an additional loan of L.50,000 for compensation to the holders of those permanent offices which were to be reduced, and an absolute grant of L.3500 for three years towards the governor's salary. The despatch containing these recommendations was carried out by Sir Henry Barkly, who had successfully guided the colony of British Guiana through a similar crisis. He succeeded Sir Charles Grey in the autumn of 1853, and found the colonists wearied of the unequal contest, and anxious for peace. In the next year was passed, in England, the "Encumbered Estates (West Indies) Bill," in relation to which the Duke of Newcastle said, on the 22d June 1854, "That in Jamaica nine-tenths of the estates were under heavy incumbrances, a large portion of which was for sums in excess of the value of the estates, so that it was utterly impossible for the proprietors to obtain any further advances." This remedial measure became a dead letter, partly on account of the jealousy of the island government, but chiefly because, in the case of most of these estates, it was less difficult to make a title than to find a purchaser. During the last few years Jamaica has been tranquil, but it has been the tranquillity of prostration. Sir Henry Barkly, who induced the Assembly to consent to many salutary changes during this period, has been replaced by C. H. Darling, Esq., late governor of Newfoundland. The island has also suffered severe loss in the retirement of the chief-justice, Sir Joshua Rowe, who for twenty-three years presided over the Supreme Court with integrity and ability, stamping its judicial proceedings with a character far above the ordinary colonial standard.

The constitution of Jamaica has been modified, in many important particulars, by several acts passed in the island in the years 1854 and 1856. The ruling body now consists of a governor or captain-general, advised by a privy council, of a legislative council, and of an elective legislative assembly. The governor, who is styled "His Excellency," is commander-in-chief and vice-admiral, and has the disposal of several appointments, is nominated by the crown through the secretary of state for the colonies. He receives from the Imperial Government a salary of L.3500 a-year, and from the colony, including the salary of his secretary, L.2746, besides sundry allowances. His privy council is appointed by himself during pleasure, without limitation of number or qualification; and its president, or senior member, administers the government during the absence of the governor, should no lieutenant-governor be appointed, though the commission is usually given to the commander of the forces. The Legislative Council is also appointed by the crown, through the governor, for life, subject to certain disqualifications, such as crime, absence without leave, loss of property, &c. It consists of seventeen members, five of whom may be office-holders without other qualification; the remaining twelve must be in possession of a freehold estate in the island of the annual value of L.300, or must pay taxes on freehold property to the amount of L.30. The president receives a salary of L.600 a-year. The Legislative Council forms the upper chamber, and may initiate any measures not involving imposition of taxes, or appropriation of money. The House of Assembly consists of forty-seven members, being two for each parish, and an additional one for the towns of Spanish Town, Kingston, and Port-Royal. These are elected by holders of freeholds of the annual value of L.6, a qualification which it has been in contemplation to alter for the payment of L.1 taxes, the present constituency amounting only to 3000, as stated by Lord John Russell in 1853. The qualification of members of the Assembly consists of the payment of L.10 taxes, and they become disqualified by crime, insolvency, fraud, &c. The House of Assembly is summoned by the governor in council; it may be adjourned, prorogued, or dissolved by the governor alone—unless so dissolved, its duration is for seven years. It forms the lower chamber, and, in conjunction with the council, and with the consent of the governor, may pass laws for the colony, provided they be not repugnant to the spirit of the English law; but all laws so passed are subject to the approval of the Imperial Government. The House of Assembly had formerly the power of originating and appropriating grants of money, a privilege manifestly open to the greatest abuse. But by the act of 1854 this was abolished, and no grant is to originate in the Assembly except by message from the governor, or through the executive committee. This last body is an innovation, and forms the ministry of the crown. It consists of one member of the Legislative Council, and three members of the Assembly, not office-holders, chosen and changed at pleasure by the governor, who are to act as his medium of communication with the Council and Assembly, and to assist him in preparing estimates, levying and disbursing money, and in the general administration of the affairs of the colony. They each receive a salary of L.800 a-year, and allowances.

The parishes are under the government of a chief magistrate appointed for life by the governor, termed the *custos rotulorum*, who is styled "Honourable," and presides over the vestry, a body consisting of the rector and churchwardens, justices of the peace, and ten vestrymen, who must be freeholders, tax-payers, electors, and be able to read and write; they must be of good repute, and not have been insolvent within two years. The churchwardens must be also members of the Established Church. The vestries meet quarterly. They raise and appropriate local taxes, by authority of an annual act of Assembly, for the relief of the poor, and repair of churches and public buildings; they regulate markets, and generally the affairs of the parish; and it is their duty to prepare yearly an account of the taxable

Jamaica. and real property in the parish for the executive committee. A committee of the vestry, elected by ballot, decides upon applications for relief from taxes, a return of which is made to the executive committee and receiver-general, and may be carried by appeal before the circuit judge, who has the power of inflicting punishment for perjury.

Such is the existing constitution, and though the alterations in the management of its finance, and the check to the practice of reliefs in the vestries, have removed the most flagrant evils of the former system, it may be doubted whether Jamaica is not daily becoming more unfitted even for this modified form of popular government. It is generally agreed that it would have been better to have suspended the constitution at the period of emancipation, and to have entrusted the introduction of the new arrangements rendered necessary by that important measure to a prudent and able governor; for as the late Mr C. Buller said, in 1839, "It was not possible for any similarly constituted colony to furnish persons competent to execute so great a task;" and the refusal of the legislature in 1853 to pass the Customs Duties Acts, a measure ruinous to the country at large, but if report speak truly, highly profitable to certain members of the ruling body, is one of the most remarkable instances on record of the perversion of representative institutions. If such has been the past, there is little ground for hope of amelioration in future. Wealth and intelligence are leaving the country; even now it is impossible to fill up the number of the Legislative Council.

The white and mulatto races are inimical to each other, and though Sir Henry Barkly, by dexterously enlisting the more moderate of each in the cause of order, managed to carry on the government, it is to be feared they will not long act harmoniously together. The blacks, ignorant and impulsive, incline first to one side, then to the other. Meantime, the thinned ranks of the whites are very poorly recruited—for capital seeks a better and more certain return; and there is little prospect of lucrative employment to divert the enterprising emigrant from Australia or Canada. The judicial system has been entirely remodelled by the act of 1855–56. The chief-justice, and assistant-judges, and chairmen of quarter sessions, having retired with pensions, the following take the place of the former arrangements: The chief-justice, who must be a barrister of five years' standing, discharges also the duties of vice-chancellor, and sits with the ordinary as surrogate; his salary is fixed at L.1800 a-year. Associated with him are three assistant-judges, barristers of three years' standing, with salaries of L.1200 a-year. None of these judges are eligible to seats in the Assembly. The attorney-general discharges, in future, the duty of advocate of the admiralty, with an additional salary of L.500 a-year. The supreme court, presided over by the bench of judges, holds sittings in Spanish Town three times a-year. It has an appellate jurisdiction, and out of it all process is to issue. The island is divided into four circuits,—the Home, the Cornwall, the Surrey, and the Middlesex,—in the first of which the chief-justice presides, and sits three times a-year in Kingston, and three in Spanish Town. The assistant-judges preside over the others three times a-year. They take cognizance of crimes, insolvencies, and civil causes, and hear appeals formerly heard by chairmen of quarter sessions. These changes have been made for the sake of economy, and to bring inexpensive justice within the reach of every man. The courts of common pleas and quarter sessions are replaced by the circuit courts. Almost all fees are replaced by fixed salaries. Summary jurisdiction is given in small amounts to two justices of the peace. Besides the unpaid magistracy of the country there still remain (in 1856) seventeen stipendiary justices, with salaries and allowances amounting to L.450 each, paid by the English government. As these posts become vacant, no fresh appointments are made. The common, and much of the statute law of England, is in force in Jamaica, but the latter must be re-enacted in the island. The bankruptcy laws have not been adopted; but by the Insolvent Debtors Act, a debtor making oath that he is possessed of nothing besides bare necessaries, and delivering his books into the hands of the deputy-marshal, is, after remaining three months in prison, released from all claims. For the protection of creditors, it was formerly requisite to give three weeks' notice, and obtain a passport before leaving the island. Civil cases are decided by a majority of five in a jury of seven. The same number tries criminal cases, but the verdict must be unanimous. A special jury consists of twenty-one, of which each side may strike off seven. The law of capital punishment is by this act assimilated to that of England. Jamaica.

The great abuse of patent offices, the holders of which, living in England, received at one time L.30,000 a-year from Jamaica for duties performed by deputy, has long been suppressed, and the last sinecure of this kind has now expired. The ecclesiastical establishment consists of a bishop, whose diocese includes the Bahamas and Honduras, with L.3000 a-year, first appointed in 1825, previously to which the bishop of London was diocesan. This salary is paid by England, which also allows L.2000 a-year for archdeacons, and L.2000 a-year for assistants, and L.400 for a commissary. The present bishop, Dr Spencer, having resigned, receives a pension of L.1400 a-year out of his former salary, the rest of which is paid to his co-adjutor, Dr Courtenay, who is styled Bishop of Kingston and who receives, in addition, L.400 a-year as archdeacon and commissary of Middlesex,—making in all, L.2000 a-year. There are two other archdeacons, those of Cornwall and Surrey; the last being vicar-general. There are 22 rectors, corresponding to the number of parishes, and 50 island or perpetual curates, whose salaries are secured under an act which expires in 1859; but by the recent act of 1856 it is proposed to make an immediate reduction to the extent of about twelve and a half per cent., holding out the inducement of continuing this scale for fourteen years, and the threat of a larger reduction to those who will not agree. The rates under the bill are as follow:—

Rectors.	A-year.	Rectors.	A-year.
Kingston	L.600	St Andrew	L.450
St Catherine	500	The Seventeen others	400
St James'	500	The Fifty curates	340
Trelawney	500		

By these means the church establishment which, in the year 1855, cost L.36,777, 7s. 10d., is estimated for the year 1856 at L.29,398.

There are in addition seventeen Presbyterian, sixteen Moravian, three American, forty-four Baptist, twenty-two Wesleyan, ten Independent ministers, besides Roman Catholics and Jews.

The schools of these different denominations are calculated to contain 13,641 pupils. There are ten endowed schools under private charities, such as the Mico, Wolmer's, Munro and Dickenson's, Vere, &c., capable of instructing 1710 children; there are private schools educating 500; making a provision for the education of 15,841 children free of expense to the public. To these must be added 5733 belonging to the established church, making a total of 21,584 out of a population of about 380,000, or between five and six per cent. who are nominally receiving education, but the desultory attendance of the negro children makes these advantages more apparent than real. There has been no state provision for education independently of that for the ecclesiastical establishment for some years; in 1856 a vote of L.6000 for this purpose was negatived. As nearly connected with education the island press may properly be noticed here. There are in Kingston four daily papers—the *Morning Journal, Colonial Standard, Daily Adver-*

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tiser, and *Banner of the People*; an advertising sheet and a Gazette appear occasionally. In Spanish Town there is the *Watchman*; in Falmouth, the *Falmouth Post* and *Trelawny* weekly; and in Montego Bay, the *Cornwall Chronicle*, and *County Union* weekly. They are not liable to stamp duty.

The population, according to the return of 1855, consists of 181,633 males, and 195,800 females; but this is based upon the last census, that of 1844, when the population was returned at 380,000, of whom 16,000 were white, 68,000 coloured, and the rest black, of whom about 1200 were maroons. Since then upwards of 40,000 people have died from cholera and small-pox, and about 2000 have emigrated to Navy Bay to work on the railway over the Isthmus of Panama, a portion of whom only have returned. The careless treatment of children by the negroes, and their almost invincible repugnance to pay doctors' fees, which has necessarily reduced the number of medical practitioners, prevent the natural rate of increase; and the waste of public money during the protracted dispute between the Council and House of Assembly, has caused the number of immigrants imported to fall very short of other colonies. We find, in consequence, that while 49,000 arrived in British Guiana between the years 1840 and 1852, only 14,000 were brought to Jamaica. The following returns have been made by the Emigration Commissioners of Immigrants introduced into Jamaica from 1848 to 1855, both inclusive :—

Emancipadoes from Havana	276
Sierra Leone	1870
St Helena	2198
Madeira	379
China	472
	5195

Besides which there were still in the island 1684 coolies who had arrived before 1847, and a considerable number of recaptured Africans. The criminal returns of this population are remarkably favourable; the number in prison throughout the island on the 31st December 1855 was only 583; and Sir H. Barkly reports that the numbers convicted of crimes in Jamaica when compared with British Guiana were as 18 to 33.

The feeling of security arising from the orderly behaviour of the lower classes, as well as of economy motives, have led to the disembodiment of the militia, who in 1816 numbered about 8000 foot, and 900 horse, and in 1830 were increased to 18,000 men, including artillery. There is still a nominal staff at head-quarters, and though the expenditure in 1852 was only L.2, 14s., it had reached L.297 in 1855, and was set down at L.300 in the budget of 1856. The garrison of Jamaica has also been much reduced; in 1816 it consisted of about 5000 men. It is now generally composed of about 1400, of whom 600 are white, and the remainder Africans. The head-quarters of the white troops are at Newcastle, a cantonment originated by Sir W. Gomm in the Blue Mountains, about 4000 feet above the sea. A detachment is quartered at Maroon Town, formerly Trelawny, about 2000 feet above the sea in the Mountains of St James. The climate of these stations is so good that the troops are said to be less inured to heat at the end of a year there than when first landed. The head-quarters of the black troops belonging to one of the three West India Regiments are at Up Park Camp, near Kingston. This corps was formerly recruited entirely from the coast of Africa, but creole negroes, and even coolies, are now enlisted in its ranks. There are white and black artillerymen at Port-Royal, and a few men at Port-Henderson; at Lucea, the extreme E. of the island; and at Port-Antonio on the N. side. The whole of these troops are commanded by a major-general, whose official residence is at Kingston, and are paid entirely by the Imperial Government, the island allowance having been for some time withdrawn. A small sum from the island civil list is expended annually upon the fortifications, which are, however, scarcely defensible. The naval department is under a commodore, whose flag-ship lies off Port-Royal, where the naval yards and hospital are situate. It is occasionally visited by the admiral and squadron of the North American station, which embraces the West India Islands. The police force has been reorganized by an act passed in 1856. It is now to consist of 41 sergeants, and 406 privates; and the custos of each parish is empowered, in case of emergency, to raise a constabulary consisting of one in every hundred of the inhabitants as an auxiliary force. The police are composed almost entirely of black and coloured people.

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We now come to the revenue, and the property and commerce from which it arises.

The revenue of Jamaica was estimated, in a calculation made in 1830, on an average of ten years, at L.490,000 currency, or about L.327,000 sterling. This was independent of that raised by the vestries for parochial purposes, which amounted to about L.300,000 currency, or L.200,000 sterling. The public revenue of 1841 was L.226,959, 18s. 3d.; the parochial, L.177,491, 12s. 10d. sterling. The public expenditure, L.291,415, 16s. 0d.; the parochial, L.150,357, 16s. 8d. In the year 1854, owing to the suspension of the import and rum duties, and consequent large accumulation of taxable articles which had paid nothing to the treasury, the revenue fell to L.96,624 sterling, while the expenditure was L.197,633. In 1855 the following return was made :—

INCOME.

Ordinary revenue	L.199,647	6	5
Casual revenue	26,771	17	0
Total	L.226,419	3	5

EXPENDITURE.

Ordinary expenditure	L.193,461	9	4
Casual expenditure	49,643	10	8
Total	L.243,105	0	0

In the same year the local or parochial taxes amounted to about L.80,000.

In the budget for 1856, the following estimates of the revenue and expenditure for the current year were presented to the Jamaica legislature :—

INCOME.

Import dues	L.125,000	0	0
Rum duties	30,000	0	0
Stamps	11,000	0	0
Tonnage dues	11,000	0	0
Fees	1,000	0	0
Stock and Hereditaments	16,000	0	0
House-tax (disallowed)	6,000	0	0
Land-tax	5,000	0	0
Interest on balance of guaranteed loan in Colonial Bank	1,000	0	0
	L.206,000	0	0

EXPENDITURE.

Collection of revenue	L. 20,105	0	0
Parochial items transferred	14,058	0	0
Church establishment	29,398	0	0
Administration of justice	20,292	3	8
Police	23,455	0	0
Governor and Privy Council	4,450	0	0
Legislative Council	2,064	0	0
House of Assembly	3,345	0	0
Executive committee	3,320	0	0
Sanitary establishment	10,120	0	0
Education (disallowed)	6,000	0	0
Printing	4,000	0	0
Public works	3,500	0	0
Lighthouses	1,000	0	0
Prisons	17,700	0	0
Carry forward	L.162,807	3	8

Brought forward.....	L.162,807	3	8
Insolvent deposits.....	2,000	0	0
Interest on loans.....	38,411	8	0
Miscellaneous, including L.300 for militia, L.300 to geologist.....	3,546	10	4
Total.....	L.206,765	2	0

By an act of Assembly in 1854, the Council Fund of L.6000 a-year, originally granted in 1728, ceased, and it was provided that L.25,000 should be raised annually as a permanent civil list, for the purposes of the government of the island, and a further sum of L.30,000 for the interest on, and repayment of the guaranteed debt.

It is difficult to fix the value of the moveable and immoveable property in Jamaica, once estimated at 50 millions. The latter, however, that is, the land with the buildings on it, is periodically valued for taxation, and the hereditament tax is raised upon a sum equal to six per cent. on such valuation—that being, according to an arbitrary assumption, the net revenue of the land. Though the tax is paid upon many properties on which the cultivation has been given up, and which produce no revenue at all, this sum was fixed in 1850 at L.693,382, 4s. 3d., on an estimated value of about 11 millions and a half. Since then the decline has been rapid; and when it is remembered that the fall in rateable property in the next year exceeded 2 millions, there can be little doubt that the difference in value since the prosperous days of Jamaica amounts to at least 80 per cent. For many once valuable estates no purchaser could now be found on any terms. It is on record that 231 sugar estates have been abandoned, besides 243 coffee plantations, and 132 grass pens. It is notorious that the paper circulation, which amounted to L.258,816 in 1844, has dwindled to L.70,000 in 1855. It is clear, therefore, that though the public and parochial taxation has been reduced from about L.800,000 currency to less than L.300,000 sterling, it is much more burdensome to the tax payer now. Indeed, when it is considered that the value of articles exported, expensive as they are to produce, does not reach one million, it is evident that the estates in the aggregate yield no rental at all, but are maintained by non-resident proprietors possessed of other means, who are unwilling to abandon the hope of future improvement. Even supposing the whole money expended in raising these articles of export amounted to little more than double the public revenue of the country, a proportion, highly taxed as the island is admitted to be, quite beyond belief, it would follow that after payment of production, expenses, and taxes, little or no surplus would remain for the proprietor; but such expenses must in reality far exceed L.600,000, and can only be provided, as before observed, by those proprietors who have other funds at their disposal..

It is necessary to explain the two forms of calculation to which reference has been made—currency and sterling. The former was an arbitrary mode of reckoning, unrepresented by any coinage, employed until the year 1840, by which L.140 currency equalled nominally L.100 sterling; but a premium of about 18 per cent. was paid in addition to place this sum in England, so that upwards of L.166 in Jamaica were needed to pay L.100 in England. In 1840, an act passed, establishing the English computation, fixing the pound sterling at 5 dollars, or L.1, 13s. 4d. currency, and making English money the legal tender. Spanish and Portuguese coins are still current, the highest being the doubloon, or ounce, worth about L.3, 6s. 8d. Before this date, a "fivepenny," worth 3d. sterling, was the lowest coin. There is still no copper, and the lowest coin is the silver three-halfpence, coined especially for Jamaica, and called a prædial, as intended for the payment of agricultural labourers. In former days, the only paper currency consisted of island cheques issued by the treasury. There are now two banks of issue, a branch of the Colonial Bank, and the Bank of Jamaica. A third, the Planters' Bank, has been given up since the trade of the colony declined. The present issue is usually from L.70,000 to L.80,000. *Savings* banks have also been established in the island.

The commerce of Jamaica depends almost entirely on its agriculture. It has gradually lost the greater portion of the transit trade in consequence of the revolt, and subsequent disorganization of the Spanish colonies on the mainland, the establishment of St Thomas as a free port, and the rapidity of steam communication between Europe and the American coast, which diminished the advantages of an emporium in the West Indies. Its agricultural prosperity has declined in equal proportion, though, from different causes, the value of its staple having been depreciated by successive acts of the Imperial Government, whereby the differential duties, under the protection of which the scheme of emancipation was originally intended to be carried out, were discontinued. In 1840, East India sugar was admitted on equal terms into the British market. Four years afterwards the same advantage was conceded to foreign sugar, the produce of free labour; and in 1846 to slave-grown sugar. Protection has also been removed from molasses, coffee, and cocoa. Under these circumstances, the want of adequate labour has prevented Jamaica competing with those countries in which, from slavery or other causes, there is a sufficient supply.

The following tables illustrate these observations:—

Years.	Value of Imports.	Value of Exports.
1809..	L.4,068,897	L.3,033,234
1810..	4,308,337	2,303,579
1853..	864,094	837,276
1854..	403,520	932,316

The exports consist of her own products only, the imports include those intended for re-exportation, as well as those taken for home consumption, which explains why, in the flourishing era of the transit trade, the balance should be apparently so much against Jamaica. The exports, too, are entered at their value in the place of growth, while to imports are added charges for freight, &c. The small imports of 1854 were partly owing to the goods imported in anticipation the year before, when the duties were not levied. The same cause accounts for the small quantity of rum exported in 1853, and the excess of the two following years, enough for two years' home consumption having been entered in the same year duty free. The following table gives the trade and navigation report for 1855:—

Arrivals in Jamaica in 1855.

From	No. of Ships.	Tonnage.	Men.	Value of Imports.
Great Britain	122	43,029	...	L. s. d.
United States	94	13,784	...	British, 494,019 15 6
Colonial.....	145	15,435	...	Foreign, 405,487 12 4
Foreign.....	127	11,804	...	
Totals.....	488	84,052	4322	899,507 7 10

Departures from Jamaica in 1855.

To	No. of Ships.	Tonnage.	Men.	Value of Exports.
Great Britain	123	38,997	...	L. s. d.
United States	77	13,502	...	1,003,325 9 5
Colonies.....	63	8,347	...	of which
For. countries	240	26,014	...	953,123 10 0
Totals.....	503	86,860	4462	represented island produce.

Of the ships in this list 40 were ships of war, 44 steamers, and 38 colliers.

Jamaica. *Imports into the United Kingdom from Jamaica, of the principal articles of Native Produce in* 1817 *and* 1855, *showing, as far as possible, the Increase or Decrease in each at the latter date.* Jamaica.

Year.	Sugar. cwts.	Rum. galls.	Molasses. cwts.	Coffee. lbs.	Cocoa. cwts.	Cotton. lbs.	Pimento. lbs.	Ginger. lbs.	Arrowroot. lbs.	Logwood & Fustic. tons.	Mahogany. tons.	Indigo. lbs.	Bees'-wax. lbs.	Honey. galls.
1817	1,400,500	2,706,969	95	14,653,538	260	1,021,674	1,627,612	340,373	no return.	11,819	1,396	32,011	no return.	no return.
1855	450,282	2,109,291	nil.	5,657,103	nil.	280	7,666,580	799,796	87,900	11,544	feet. 147,929	nil.	81,536	6,487
Increase or Decrease.	Dec. 950,218	Dec. 597,678	Dec. 95	Dec. 8,996,435	Dec. 260	Dec. 1,021,394	Inc. 6,038,968	Inc. 459,423	...	Dec. 275	...	Dec. 32,011	...	...

The largest sugar crop was in 1805, which exceeded 150,000 hhds.; that of 1855 did not reach 30,000 hhds. that of 1856 had fallen to 20,000 hhds. The largest coffee crop was in 1814, and exceeded 34 million pounds. The great increase of pimento is unfortunately accounted for by the rapid spread of the tree, which grows wild in Jamaica, over lands formerly under cultivation. Since 1852 a small quantity of copper ore has been exported, amounting in 1854 to 37 tons. Besides these principal articles, there is exported a small quantity of tamarinds, cocoa nuts, succades, shrub, ebony, lignum vitæ, and lancewood. There are five mining companies in Jamaica, all in their infancy—the Clarendon Consols, and Wheal Jamaica, in Clarendon; the Port-Royal and St Andrews, and the Ellerslie and Bardowie, in St Andrew; the Portland Mining Company in Portland. Of these the first two are at present the most promising. The principal imports into Jamaica are salt pork and beef, salt fish and oil, butter, lard, cheese, corn, corn-meal, oatmeal, flour, biscuits, rice, tobacco, wine, and beer; hardware cutlery and ironmongery; ready-made clothes, boots and shoes, and dry goods of all sorts; soap, candles, saddlery and harness; shingles, lumber, wood-hoops and coals.

There is a steam communication between England and Jamaica, and *vice versa*, twice a month, in 19 days. The Royal Mail Steam Packet Company's ships leave Southampton on the 2d and 17th of each month, calling at St Thomas, Porto Rico, and Jacmel, in Hayti, and reach Kingston on the 21st and 6th. They leave again for England on the 27th and 12th, making the course of post about 44 days. They also sail once a-month between Jamaica and Honduras; course of post 10 days. There are frequent opportunities between Jamaica and Havana, and the United States. In the island there is a post twice a-day between Kingston and Spanish Town, and a communication twice a-week between these capitals and the country districts; besides expresses, the arrival and departure of the mail packets. Jamaica being on the direct route from England to Nicaragua, can scarcely fail to share in the growing importance of the states of Central America.

Hitherto its history, since emancipation, has been discouraging to the friends of liberty. The negro, on whom the cultivation of the island depends, has gradually retired from labour, and retrograded in the social scale. This does not arise from any hostile feeling towards the whites, with whom he usually lives on the most amicable terms; it is the natural result of removing all restraint from a people low in civilization, and consequently with few artificial wants, in a country where land is superabundant. The Jamaica negro can earn enough in a sugar plantation in a few weeks to buy a small patch of freehold land. The wood upon it forms his cottage; the vegetables which grow almost spontaneously support him in tolerable comfort. When his little property does not require his care, he works from time to time for hire; but as plantation after plantation is abandoned, and the country returns to its primeval forest, he is confined more and more to the society of his own race; and though not more addicted to crime, is rapidly receding into a savage state. During slavery the dissenting ministers possessed great influence over him; he now prefers the established church, because it costs him nothing, but he cares little for either. Not feeling the want of education, he does not seek it for his children, whom he prefers employing in his own service. Hence, neither churches nor schools are wanted in Jamaica, but congregations and scholars. These observations are confirmed by the last returns, which fix the diminution of children in the schools in 1854, as compared with the previous year, at 2000, and show this decrease to be less conspicuous in those belonging to the established church of England and Scotland, than in those of the Baptists and Independents. We can scarcely blame the negro for following the bent of his inclination; but it is evident that under these circumstances, unless there is a large and immediate supply of immigrants, to meet the expense of whose introduction, averaging at least L.10 a head, there are no available funds, all society will come to a speedy end, and the island become a second Hayti. Already the enormous depreciation of property has caused the ruin of so many, that the name of Jamaica proprietor, once used proverbially to indicate wealth, is now associated with poverty and distress.

Jamaica is of a long oval shape, and has been compared to a seal with the head pointed to the west. Its surface is beautifully diversified with hills and valleys. An elevated range, called, in the eastern or highest part, the Blue Mountains, and terminating in Dolphin Head, to the W., runs longitudinally through the island, and other high ridges intersect this chain. On the S. the mountains are generally steep, with gigantic spines or buttresses rising from the plain at an average distance of 12 miles from the sea. Though difficult of access they are traversed by bridle roads in various directions to the height of nearly 6000 feet; and several passes, or gaps, as they are called, of great altitude, connect the two sides of the island. On these elevated ranges the coffee attains the greatest perfection, and above, dense forests ascend to the highest peak, composed chiefly of beef-wood, as it is called from its colour, and satin-wood. Under their shade the tree-fern grows to the height of 15 feet, and the flute-like note is heard of the solitaire, a bird only found in these wildernesses. On the N. side the mountains approach the sea closely, but more gradually, their conical forms are gently rounded, and in St Ann and Trelawny the lower slopes are shaded by pimento woods, the indigenous growth of the island, and elsewhere by orange groves, mango, and cedar forests, above which frequently towers the gigantic silk-cotton tree. The shady valleys between were once occupied by cacao walks, now destroyed; and on the lowlands, near the sea, were formerly the indigo works, long since abandoned. Here are now the sugar estates, in which the dark green of the cane is varied by the golden tint of the guinea grass, and the cabbage and cocoa-nut palms shoot up in long lines close to the water's edge, from which they are separated by a fringe of mangroves, growing below high-water mark, and the beautiful but poisonous manchineel. The waving

Jamaica. field of canes is broken at intervals by the white cluster of buildings composing the sugar works. The mill, the boiling-house, with its tall chimneys, and the stables, stores, and bookkeepers' houses surround a large court-yard. Above, on an eminence, is usually the proprietor's mansion, and close by, though completely buried in the broad foliage of the plantain and banana, the negro village. On these plantations during crop the scene is most animated. Bands of negroes, with cutlasses, attack the rows of canes which tower above their heads; waggons, drawn by oxen or mules, in endless succession, carry the canes to the mill; women and children hurry with the dry stalks to feed the fires; and the shouts, without which a negro seldom does any thing, announce afar off, in this clear atmosphere, the neighbourhood of a sugar estate. It is here, too, that the traveller sees most clearly the decline of the country. At each end of the island, in the parishes of Hanover and Portland, he may journey for miles through deserted plantations. Ridges, overgrown with guava bushes, mark the site of the corn fields; rank vegetation fills the court-yard, and even bursts through the once hospitable roof. A curse seems to have fallen upon the land, as if this generation were atoning for the sins of the past. For while we lament the ruin of the present proprietors, we cannot forget the unrequited toil which in times gone by created the wealth they have lost, nor that hapless race, the original owners of the soil, whose fate saddens the darkest page of history.

The sugar estates resemble generally those of the other islands, but Jamaica has a feature peculiar to itself. In the centre of the island, and towards the S. and W., are large plains, or table-lands, at an elevation of about 1000 feet, covered with a luxuriant growth of guinea grass, dotted with groves of tall trees, and, at greater intervals, with white houses and villages. From an eminence the whole country resembles a series of English parks. These are the pens, or grazing farms, where horses and cattle of most excellent quality are bred. They are chiefly in St Ann, Manchester, St Elizabeth, St James, and Hanover. The climate, at this elevation, is well suited to an European population, who cannot work on the sugar plantations, but may with safety be employed on the light and healthy duties of the farm. From one of the many points of view on the mountain range the country presents an aspect of beauty and grandeur scarcely to be surpassed. Above tower the lofty peaks, with clouds resting on their summits—around are magnificent forests—beneath are the peculiar hollow basins, called cock-pits—below them deep ravines, or wider valleys; through these flow rivers or mountain torrents, occasionally falling from the rocky ledges in cascades which would attract notice in any part of the world. At a greater distance the wide plains are spread out like a map, chequered with towns and villages; and the deeply indented coast, terminating to the east in lofty cliffs, is washed by the glittering waters of the Caribbæan Sea. The view of the island from the sea has long been celebrated. Soon after leaving Cape Tiburon, the western point of Hayti, the Blue Mountains are in sight, and along the S. coast of Jamaica, from Point Morant to Kingston, the inhabited plains, sloping gradually up, till cultivation terminates in forest, present an aspect of no common beauty. From Fort Nugent, which is conspicuous under a steep hill to Port-Royal, runs a narrow sandy promontory, called the Palisades. Here is the great cemetery where so many victims to yellow fever lie buried that the name has become proverbial; and this neck of land incloses the harbour of Kingston, which is entered by a most intricate channel between Port-Royal and Port-Henderson, and beyond which the capital is seen stretching northwards towards the amphitheatre of the Liguana Hills, and protected by the loftiest range of the Blue Mountains. The heights of the principal peaks have been computed as follows:—Blue Mountain Peak, 7770 feet; Portland Gap ridge, 6501 feet; Portland Gap, 5640 feet; and St Catherine's Peak, 4970 feet. It is stated, however, by some authorities that the three highest peaks on the grand ridge of the Blue Mountains, called Coldridge, have their respective summits 8184, 7656, and 7576 feet above the level of the sea. Jamaica.

Jamaica is, as its name imports, abundantly supplied with water. Upwards of two hundred rivers have been enumerated, few of which are navigable for vessels of any burden. Black River, the largest and least rapid of these, flows through a level country, and is accessible to small craft for about 30 miles. Salt River, and the Cabarita, both also on the S. side, are navigable by barges. The others on the S. are the Yallahs, Cobre, and Rio Minho; on the N., Martha Brae, the White River at Buff Bay, the great Spanish River, and Rio Grande. Many of these are perfectly dry for six months in the year, leaving a stony channel, many hundred feet across, and twelve feet deep. These channels, which are commonly used as roads, are liable to be filled in an instant by an impetuous torrent, which comes down without warning, in consequence of a storm or waterspout bursting far away in the mountains, and many fatal accidents have been the result. The writer once saw the streets of Kingston laid suddenly two feet under water from a similar cause, with a perfectly clear sky overhead. Many of these rivers are of great value in turning mills and irrigating the plantations. The springs and rivulets are very numerous but unequally distributed; and from the uncertain supply of water, most estates are obliged to keep up large tanks or ponds at a great expense. Several of these springs are medicinal, the most remarkable of which are a hot salt spring near the mouth of the Milk River, in Vere, and a sulphureous spring, of the temperature of 123° Fahrenheit, near the beautiful village of Bath, in St Thomas in the East. Jamaica has sixteen secure harbours, the chief of which are Port Morant, Kingston, Old Harbour, Green Island, Montego Bay, Falmouth, Port Maria, and Port Antonio, besides thirty bays, roadsteads, or shipping stations, which afford tolerable anchorage. Those on the N. side are, however, exposed to the N. wind, or norther, which often sweeps over these seas with little warning, and irresistible force.

Jamaica is divided into three counties—Surrey, Cornwall, and Middlesex; and these are subdivided into twenty-two parishes, many of which are as large as English counties. The towns are not remarkable for architecture, drainage, or cleanliness. The official capital, Spanish Town, or St Jago de la Vega, as it is still called in official documents, is a small town of 7000 inhabitants, on the Cobre, about six miles from the sea. The governor's palace, called the King's House, is a large building occupying one side of a square, on the other sides of which are the public buildings of various kinds. Spanish Town is the residence of the judges, barristers, and other officials, and contains the cathedral; near it, on the way to St Ann's, is the beautiful road on the banks of the Cobre, called the Bog Walk. Kingston, the commercial capital, is considerably larger, with a population of 30,000: it is also hotter, and more unhealthy. In 1803 it was incorporated as a city, and is governed by a mayor, aldermen, and common council-men. There is a good theatre here, and a large English and Scotch church, besides other places of worship. It is on the sea, and the quays are very commodious, and well constructed. On the point of land which forms Kingston Harbour is the naval station of Port-Royal. Independently of the dockyards and barracks, the town is a wretched place, inhabited chiefly by people of colour. Savaña la Mar, a hot unhealthy town, destroyed by the sea in 1780, is the chief place of the county of Cornwall; and Falmouth and Montego Bay are the principal towns on the N. of the island. None of them contain any remarkable buildings, public or private. All who can, prefer living a little way in

Jamaica. the country, in the usual one-storied house of the tropics, with its green jalousies and deep verandah.

The soil is in most places deep and fertile, and for the growth of sugar, pimento, and ginger, and, as some think, of coffee, has never been surpassed. On the N. there is a reddish yellow soil. The brick mould, reckoned the best in the West Indies for the cane, is a deep warm hazel mould, easily laboured, and requiring little manure. The black-shell mould owes its fertility to the mineral salts and exuviæ which it contains. On the S. side are large natural salt ponds, which of late years have been neglected. The principal soils in the interior are a red clay, a yellowish clay, a red grit, a loose conchaceous mould, a black mould or clay or marl, a loose vegetable mould on rock, a fine sand. The red sandstone of the lower mountains resembles much the porphyrite conglomerate of the higher, and both produce coffee; but while that grown on the former has been driven out of the market by the cheaply grown coffee of Ceylon, the latter retains its value, being considered by many superior to the Mocha which springs from a similar soil. Among minerals are—argillaceous dark purple schist; gneiss; steatite, and even serpentine; sienites, highly micaceous; and the hard lamellated amianthus, resembling petrified wood; white freestone; quartz of different kinds; limestone, and a kind of marble. Rich lead ore, impregnated with silver is found in St Andrew; radiated antimony and rich copper ores, abounding in malachite, are found chiefly in Clarendon, Portland, and St George; magnetic iron and cobalt in St George and Metcalf; anthracite coal in Portland and St George; but neither gold nor pure silver have been found, though the Indians possessed ornaments of both when discovered by the Spaniards. A species of marl, common in Jamaica, was eaten by the negroes during slavery, so much to the detriment of their health and value that the practice was made penal. The honeycomb limestone rock, of which a great part of the island is composed, contains no minerals, but is hollowed into innumerable caverns and fissures. Many of these are beautifully ornamented with stalactites, particularly one on the Roaring River estate, near Savaña la Mar. In some of these fissures called "sinks," rivers suddenly disappear to rise again at a considerable distance. On the Sweet River estate several springs rise like fountains with great force in one field. On the road from Falmouth to Maroon Town, a considerable stream pours from an opening in the solid rock several feet above the ground, and the Rio Bueno streams at once from the foot of a perpendicular rock in St Ann. There are fewer traces of fire in Jamaica than in the other islands; but the Burnt Hill, near Hope Bay, seems to be an extinct volcano. There is great variety of climate; the medium heat at Kingston is about 80°, and the minimum 70° Fahrenheit, throughout the year. At an elevation of from 4000 to 5000 feet, the average range is from 55° to 65°; the minimum in winter being 44°. On the Blue Mountain peak, in August, the writer found the temperature 44° at sunrise, and ice of some thickness has been formed there in March. Snow has never been known to fall. The alternation of temperature is from 8° to 10° on the S. side, and more on the N., but the transitions are not so sudden and detrimental as in many parts of the continent of North America. The grand compensation for excess of temperature is afforded by the breezes which regularly every morning set in from the sea, to the land, and every evening from the land to the sea, to preserve the equilibrium which the noonday sun has disturbed; when these are sometimes interrupted the heat is intense, the thermometer rising to 100° Fahrenheit, and the island becomes unhealthy. There is no striking variety in the length of the day, or in the seasons, except the alternations of wet and dry. Storms of thunder and lightning are prevalent, and sometimes very mischievous in autumn. The hurricane season ranges from July to October. The periodical rains, which last ordinarily for six weeks, are called the May and October seasons, but there is great irregularity in the time of their falling. The N. side usually suffers less from drought than the S., but even there the rains are sometimes very capricious, following the course of a river, or being stopped by a ridge of hills. The parishes of Vere and St Dorothy, on the S. side, have sometimes been more than a year without rain, to the destruction of vegetation and cattle. Jamaica.

Some parts of Jamaica, particularly near morasses, are extremely unhealthy, and there few escape intermittent fevers, or "fever and ague," as it is called, but in general the climate is favourable to those who live carefully, though when the yellow fever comes as an epidemic, which happens every seven or eight years, it carries off all alike. It is, however, rarely known at an elevation of 1000 feet, and in some of the hilly districts, especially the Santa Cruz Mountains and Pedro Plains, there are remarkable instances of longevity among the English settlers. The annual mortality among the white troops for twenty years ending 1837 was 130 in the 1000, or a seventh of the entire force. Since they have been fed on fresh provisions, and more especially since they have been encamped on high ground, this has been reduced to 34 per 1000. Of late years the cholera has made its appearance, and committed extraordinary havoc; and since emancipation smallpox has been more prevalent, on account of the negroes neglecting the vaccination of their children. The vegetable productions of Jamaica are far too numerous to be described. There are forest trees fit for every purpose, from shipbuilding to cabinet-making, among which the ballata, rosewood, satinwood, mahogany, lignum vitæ, lancewood, and ebony, are conspicuous; but the scarcity of labour makes it cheaper to import planks ready sawn from America. The logwood, the trunk of which resembles the clustered columns of Gothic architecture, and the fustic, are largely exported for dyeing. The Jamaica cedar (*Cedrela odorata*), with ash-like leaves, is valuable for the interior of houses, as its scented wood keeps off insects. The silk-cotton tree (*Ceiba Bombax* or *Eriodendron*) is one of the largest in Jamaica; its silky pods are used to stuff pillows, but, from want of adhesion in the fibres is useless for manufacture. The pimento is indigenous, and furnishes the allspice. The bamboo, the coffee, the cacao or chocolate tree, are well known productions; the last, however, is disappearing, and the export has ceased. Several species of palm abound, the macca, the fan palm, and screw palm, but the noblest is the palmetto royal (*Areca oleracea*), the green top of which is called the mountain cabbage, and eaten as a vegetable. The cocoa-nut is the most valuable of all this tribe. The mango, which overspreads the island, forming a splendid forest tree, and affording food for man and beast, was introduced by Rodney, who took it from a French ship; the breadfruit by the famous Bligh in 1793. The papaw has the peculiar property of rendering meat tender. The lace-bark tree, found near Maroon Town, has an inner bark of so delicate a texture that ladies' dresses have been made of it. The guava, from which the delicious preserve is made, is a weed of the country, and the fruit when raw scarcely eatable. The palma christi, from which castor oil is made, is a very abundant annual. A new species of silkworm (the *Bombyx Cynthia*), which feeds on its leaf, has lately been introduced from India, by the Jamaica Society of Arts, founded by Sir C. Grey. The sunflower is sometimes cultivated for oil. A variety of the *Cactus Opuntia*, on which the cochineal feeds, is common, and from which, as well as from the insect, recent experiments have proved that a dye may be obtained. English vegetables grow in the hills; while the plains produce the plantain, cocoa, yam, cassava, ochra, beans and peas of various sorts, ginger, and arrowroot. Maize

Jamaica. and guinea corn are generally cultivated, and the guinea grass, accidentally introduced in 1750, has overspread the whole island, and forms the most wholesome and strengthening food for horses and cattle. The principal fruits are the orange, the shaddock, the lime, the grape or cluster fruit, the pineapple, neseberry, granadilla, star-apple, custard-apple, mammee sapota, mango, banana, grapes, melons, the avocado pear, the breadfruit, and tamarind, though the last three would be more correctly ranked among vegetables. There is a botanic garden near Kingston, and a finer one at Bath, where many now naturalized exotics were first planted. The sarsaparilla is erroneously supposed to grow in Jamaica, though it is classed in the customs' returns there among the imports. It is brought from the Spanish main, and re-exported by the Jamaica Jews, in whose hands the trade is; hence it is called Jamaica sarsaparilla. The sugar-cane was cultivated at an early period in Jamaica by the Spaniards, and was so much extended by the English that, in 1671, we read of sugar works scattered over the whole island. There are several varieties, the most valuable being the one brought from Bourbon in 1799, which is of a bright yellow; and the Mont Blanc, of three sorts, white, violet, and blue. Besides which is the ribbon-cane, beautifully striped with various colours, which is coarse and dry, but more hardy than the other sorts. The statistics of the sugar and coffee cultivation have been given elsewhere. There are many beautiful flowers in the island, the most remarkable of which are the aloe, the yucca, the datura, the mountain pride, the portlandia; the cactus and cereus tribe, the various kinds of convolvulus and ipomœa, and two beautiful descriptions of plumeria, called the tree jasmine. Innumerable varieties of ferns grow in the mountains, and orchids in the woods. The pastures are infested by that interesting mimosa, the sensitive plant. It is eaten by sheep, but is armed with minute thorns, which make troublesome wounds in their feet. There are many beautiful insects, among which the fire-flies are most remarkable. There are fourteen sorts of *Lampyridæ* or fire-flies, besides the *Elateridæ* or lantern beetles, which are larger and more luminous; but neither in flowers nor insects is Jamaica so rich as more southern islands. To compensate for this it has no venomous serpents, though abounding in harmless snakes and lizards. A large lizard, the iguana, is considered a delicacy, as are the land-crab and tortoise. The scorpion and centipede are poisonous, but not very common or dangerous. Ants, mosquitoes, and sandflies, swarm in the lowlands. Bees, among which is a stingless variety, are numerous in the woods, and produce excellent honey. It is a popular error that in the tropics flowers have no scent and birds no song. The datura and orange are among many instances to the contrary in the former case; and as to the latter, Goss enumerates some twenty different song birds in Jamaica, among which may be mentioned the Jamaica nightingale, a kind of mocking-bird (*Merula Jamaicensis*), and a species of humming-bird (*Mellisvga humilis*). Parrots and pigeons are common, and the wild Guinea fowl; also a species of goatsucker, called the mosquito hawk, and a great variety of water-birds, among which is the pelican and a sort of albatross. The crane, heron, plover, snipe, ortolan (or rice-bird of Carolina), and quail, are migratory. The aura vulture, or Turkey buzzard, called the John Crow, is numerous, and valuable as a scavenger. By its instinct the concealed body of a murdered man has more than once been traced in Jamaica. The sea and rivers swarm with fish; among the larger ones are the shark, the nurse shark, the bonito, the sword and saw fish; besides the snapper, mullet, king-fish, Spanish mackerel, the flying-fish, &c. The cachalot is found. Turtles abound; and the seal and manatee, or river cow, are sometimes found, and the crocodile (called erroneously alligator). Jamaica, when discovered, contained but few species of animals. Besides the alco, there was the utia or Indian cony, the musk-rat, the armadillo, monkey, agouti, peccary, opossum, and racoon. At present the only wild animals are the wild hog (an African variety, introduced from the Canaries), a kind of deer (the cariacou), goats, rats, and mice. The rats commit serious ravages among the canes, and those which feed only in the cane-fields are by some esteemed a delicacy. This species, called the Charles Price rat, was introduced to destroy a smaller kind; but the remedy seems to have proved worse than the evil. The breed of oxen has been much improved by judicious crossing, and can scarcely be surpassed. The horses have much of the Arab blood. They are small but fleet, and at the island races have often beaten English racers, particularly some taken out by the Marquis of Normanby, when governor. The Cleveland bay has lately been introduced from England, with a view to size and bone. The mules are large, hardy, and sagacious, and much used for mountain-riding, as well as for carrying baggage and working on the estates. The sheep and pigs are of excellent quality, and the pork of Jamaica is considered much more wholesome than that of England, being frequently recommended to invalids. Goats are much reared by the negroes, but they are very mischievous in sugar and coffee plantations. The Cuba bloodhound is used as a watchdog, being the species which thrives best in a hot climate; the English hound and terrier, which have frequently been introduced, soon degenerate and die. Poultry succeeds well, particularly the turkey, the Guinea fowl, and Muscovy duck. Jamaica.

The principal publications relating to Jamaica are—Long's *History*, 1774; Bryon Edwards' *History*, 1809, with an Appendix, 1819; Renny's *History*, 1807; Mathison, 1811; Howard's *Laws of Jamaica*, 1827; Beckford's *History;* Dallas' *Maroon War;* Stewart's *Jamaica;* Monk Lewis' *Tour;* Madden's *Jamaica;* Montgomery Martin, 1836; Philippo's *Past and Present State of Jamaica*, 1843. The earlier histories are scarcely applicable to the present day, while many of the later publications are mere vehicles for conveying the author's views for or against slavery. By far the best and most reliable information is contained in the despatches of successive governors, published in the parliamentary Blue Books; many of which, and particularly those of Sir Charles Grey, contain admirable expositions of the state of the country, and causes of its decline. The natural history of Jamaica has also been the theme of many writers—Sloane, in 1692; Brown, 1754; Barham, 1794; Lunan, 1814. These authors have a most able and enthusiastic successor in Gosse, whose *Journal of a Naturalist in Jamaica*, 1851, and *Birds of Jamaica*, 1847, are delightful books. For vivid pictures of scenery and life in Jamaica, *Tom Cringle's Log*, and *The Cruise of the Midge*, by Michael Scott, a Kingston merchant, are unrivalled.

Before concluding this article it is necessary to refer to a dependency called the Caymanas, or Cayman Isles. These are three small coral islands or keys, in N. Lat. 19. to 19. 20., and 30 to 40 leagues W.N.W. from Point Negril, Jamaica, and about the same distance S. of Cuba. Grand Cayman lies off the centre of the Yucatan Passage; Cayman-Braque or Brac, and Little Cayman are near each other, and about 34 miles N.E. from Grand Cayman. They were discovered by Columbus, but no settlement was ever made by the Spaniards. Grand Cayman, the only one occupied, is about a mile and a half long by a mile broad, and contains about 1000 acres. It is very low, entirely without springs, and overgrown with low stunted shrubs. These islands are favourite breeding-places for turtles, immense shoals of which animals frequent the low sandy shore for the purpose of depositing their eggs. The present race of inhabitants are entirely coloured people, whose ostensible

James || James, Epistle of.

occupation is that of fishermen and pilots, but they have the reputation of being also pirates and wreckers. They live in two wretched villages, dignified by the names of George Town and Bodder Town, and are in no way interfered with by the Jamaica authorities, but are governed by a captain of their own choosing, who seems to possess despotic power. There is a church on the island, but entirely in ruins. They appear to be under none of the restraints of law or religion; and a Presbyterian missionary who devoted himself to their instruction was lately obliged to leave in despair. Their numbers have much decreased, and at present do not reach 100, as during the last few years many families have left this barren rock for the more fertile shores of Ruatan Island. (S. C.)

James, St || James River.

JAMES, the name of several persons mentioned in the New Testament.

1. JAMES, the *son of Zebedee and Salome*, was the brother of John the Evangelist. His occupation was that of a fisherman, probably of Bethsaida. Along with John and Peter he was chosen to witness the transfiguration, the restoration of Jairus' daughter to life, and to be with Jesus in Gethsemane on the night of his agony. From their bold, warm, and impetuous temperament, he and his brother were called Boanerges, *sons of thunder*. He was the first of the apostles to suffer martyrdom, having been executed A.D. 42 or 44 in Jerusalem, by order of Herod Agrippa. When led to execution, his firmness was so impressive, that the officer in attendance became a Christian, and suffered death along with him in the same cause.[1]

2. JAMES, the son of *Alphæus and Mary*, was one of the twelve. He is called the Less, either from being younger than the previous James, or on account of his little stature. In the Gospels there is mention made of James, *the brother of Jesus;* and Neander pronounces it one of the most difficult questions in apostolic history, to determine whether he was the same as the son of Alphæus.

JAMES, *Epistle of*, one of the canonical epistles of the New Testament, concerning the true authorship of which frequent doubts have been raised. It has been claimed for the son of Zebedee, on account of the inscription on a Syriac MS. published by Widmanstadt; and also of an Arabic MS. cited by Cornelius à Lapide. This claim, however, has found few supporters. In regard to James, the Lord's brother, and James the son of Alphæus, all who believe these to be different personages, agree in ascribing the epistle to the former. According to Hegesippus he was surnamed the Just, from the equity with which he governed the church at Jerusalem; and, according to Eusebius, he was the first who had the pastoral charge in that city, an office which he held for thirty years. The claims of the *pseudo*-James invite the question of the *authenticity and canonical authority* of the epistle. The objections which have been raised to the epistle are the following:—Eusebius expressly refers to it as a spurious production, and Jerome uses expressions to the same effect, probably merely repeating Eusebius. It was rejected in the fourth century by Theodore of Mopsuestia, and in the sixth by Cosmos Indicopleustes. On the other hand, it has been cited by Clemens Romanus, Irenæus, Origen, and Ephrem Syrus, and was commented on by Clemens Alexandrinus. Still more important is the fact, that the epistle forms part of the Syriac version made so early as the close of the first century. After the Council of Nice, it was received by the churches of both the East and the West. It remained as a canonical portion of Scripture till, on purely dogmatic grounds, doubts were raised by Erasmus, Cajetan, and Luther. The second of these observed, that the salutation with which the epistle begins is that of a heathen rather than of an apostle, and one who does not even claim to be an apostle. Luther called it an epistle of straw, and considered the doctrine of justification, as set forth in James, opposed to that of St Paul. In conformity with these views, De Wette started the hypothesis that the epistle was written by some one who assumed the name of James, in order to add weight to his attack upon Paul's doctrine of justification. This has been successfully refuted by Neander, who shows that the real difference between Paul and James consists in the different circumstances in which they wrote, and the different objects which they had in view. Paul had to enlighten those who put their trust in the justifying works of the law; James had to show the Jews that their faith as a solitary principle, without conformity of life, was valueless.

The epistle, then, is to be considered the production of James the Just, bishop of Jerusalem, and was written A.D. 62 or thereabout, immediately before his martyrdom. Some commentators complain of the want of connection in thought, but Bishop Jebb shows that there is a strong logical chain binding together what at first sight appears the most incongruous and irrelevant materials. He has also applied the principle of Hebrew parallelism with success to several passages in the epistle.

JAMES, *St, of the Sword* (*San Jago del Espada*), a military order in Spain, instituted in 1170, under the reign of Ferdinand II. king of Leon and Gallicia. Its object was to put a stop to the incursions of the Moors, these knights obliging themselves by a vow to secure the roads. An union was proposed and agreed to in 1170, between these and the canons of St Eloy; and the order was confirmed by the pope in 1175. The highest dignity in that order is that of grand-master, which has been united to the crown of Spain. The knights were obliged to give proof of their descent from families that had been noble for four generations on both sides; they also were required to make it appear that their ancestors were neither Jews, Saracens, nor heretics, nor had ever been called in question by the inquisition.

JAMES, the name of seven princes of the house of Stuart, the first five of whom were kings of Scotland, while the last two reigned over the whole kingdom of Great Britain. James I., the younger son of Robert III., was born in 1393, came to the throne in 1424, and was assassinated February 21, 1437. His son, James II., was born in 1432, and was accidentally killed by the bursting of a cannon at the siege of Roxburgh, in 1460, being then in his 29th year. James III., the son of the last-named, was born in 1454, came to the throne in 1460, and was murdered in 1488, in his 35th year. His son, James IV., born in 1474, began to reign in 1488. He was slain with the flower of his nobility at Flodden, in 1513. James V., born in 1512, came to the throne on his father's death, in the following year, and died in 1544, in his 33d year. James VI. of Scotland, born in 1566, became king of England under the title of James I., on the death of Elizabeth, in 1603. After a reign of 36 years in Scotland and 22 in Great Britain, he died in 1625, in the 60th year of his age. James VII. of Scotland, and II. of England, the second son of Charles I., was born in 1633, and died in exile in 1701, in the 68th year of his age. (See SCOTLAND, ENGLAND, GREAT BRITAIN, &c., &c.)

JAMES RIVER, a river of the United States of America, rising in the Alleghany Mountains, and flowing through the state of Virginia to the Atlantic Ocean. It first flows in a south-easterly direction, then changes to the N.E., after passing Lynchbury, and returns to its former direction a few miles above Columbia, in which course it continues to Chesapeake Bay. It is 450 miles in length,

[1] Clem. *Hist. Eccl.* i. 9.

Jameson, George || Jameson, Robert.

and is navigable for vessels of 130 tons to the port of Richmond, 150 miles from the sea, where the river meets the tide. At this point the James River and Kanawha Canal begins. The trade of the James River is considerable and increasing, forming, as it does, a great outlet for the tobacco, cotton, and other produce of Virginia.

JAMESON, GEORGE, an eminent artist, the Vandyck of Scotland, was the son of Andrew Jameson, an architect, and was born at Aberdeen in 1586. He studied under Rubens at Antwerp; and after his return, applied with indefatigable industry to portraits in oil, though he sometimes practised in miniature, and also in history and landscape. His largest portraits were generally somewhat less than life. His pieces are all distinguished by their delicacy and softness, and their clear and beautiful colouring; his shades are not charged, but helped by varnish, with little appearance of the pencil. When King Charles I. visited Scotland in 1633, the magistrates of Edinburgh, knowing his majesty's taste, employed Jameson to make drawings of the Scottish monarchs, with which the king was so pleased, that he sat to him for a full-length picture, and rewarded him with a diamond ring from his own finger. Jameson always drew himself with his hat on, either in imitation of his master Rubens, or from having been indulged in that liberty by the king when his majesty sat to him. Some of Jameson's works are in the colleges of Aberdeen; but the best collection of his works is at Taymouth Castle, the seat of the Marquis of Breadalbane. He died at Edinburgh in 1644, and was interred in the Greyfriars' churchyard, but without a monument. Jameson was but little known in England, and has not been noticed by any English writer on the fine arts, except Lord Orford. But he was much esteemed in his own country; and Arthur Johnston, the poet, addressed to him an elegant Latin epigram on his portrait of the Marchioness of Huntly.

JAMESON, *Robert*, the late distinguished professor of natural history in the University of Edinburgh, was born in Leith on 11th of July 1774, and received the elements of his education in the public grammar school of his native town. It is stated that his schoolboy acquirements gave small promise of future distinction, and his residence in a seaport not unnaturally inclined him to become a sailor; but his father strenuously opposed the wishes of the boy, and he was bound apprentice to an eminent surgeon in Leith. In due time he commenced his medical studies in the University of Edinburgh; and among other branches, he became, in 1792-3, a student of natural history, under the Rev. Dr Walker, who may justly be considered as the reviver of a taste for that science in the capital of Scotland. Young Jameson soon became a favourite pupil of that master, accompanied him in some of his mineralogical excursions, and assisted him in the arrangement of a museum which Walker endeavoured to accumulate.

This predilection for the study of natural history was increased by a visit which Jameson paid to London in 1793, when he became acquainted with Sir Joseph Banks and with Dr Shaw, then employed in that department of the British Museum. On his return to Scotland, Jameson seems to have adopted natural history as his chief occupation; and he also attended the chemical lectures of the celebrated Dr Black.

In 1794 he commenced his explorations of the isles of Scotland by a visit to Shetland, from which his father's family had sprung. Among other mineralogical excursions in different parts of Scotland, he examined the interesting Isle of Arran in 1797. The first fruit of these researches appeared in his *Mineralogy of Arran and Shetland*, published in 1798. This work contains dissertations on *kelp* and *peat*, which present little interesting, except the author's remarks on the analogy between the acid found in peat bogs and the suberic acid of chemists, and the employment of charred peat, in some countries, for the manufacture of iron. In the year 1798, accompanied by a friend, afterwards Sir Charles Bell, he carefully explored the Hebrides; and in the following year he visited the Orkney Isles, and Arran for a second time, preparatory to his work termed *The Mineralogy of the Scottish Isles*, which appeared in 1800 in two thin 4to volumes, and contained his former account of Arran and Shetland.

Jameson, Robert.

Besides these publications, Jameson had read occasional papers to the Natural History Society of Edinburgh, and sent a few communications to some philosophical journals; but none of them seem to have been afterwards considered by their author as of much importance.

In 1800 he proceeded to Freyberg, for the avowed purpose of completing his mineralogical studies under the celebrated Werner. Freyberg was, at that period, considered the great mineralogical school of Europe. The impressive manner of Werner in communicating instruction, and the enthusiasm with which he contrived to impress his students, is well known; and Jameson became a devoted follower of all the dogmas of Wernerian geology. Among his fellow-students was Von Buch, and the illustrious Von Humboldt had preceded him in the same school. Both these great geologists commenced as supporters of the hypothesis of Werner, and, like Jameson, both afterwards saw reason to adopt very different geological theories.

During the two years succeeding his Freyberg studies, Jameson visited different parts of the continent, to increase his mineralogical knowledge; but in 1804 he returned to his native country, where he speedily obtained the chair of natural history, as successor to his old master, Dr Walker. The duties of this chair embraced a very wide range of subjects, which, in most continental schools, are assigned to different professors. Jameson adopted the arrangement of his predecessor, dividing natural history into—1*st*, Meteorology; 2*d*, Hydrology; 3*d*, Mineralogy, including geology; 4*th*, A slight sketch of phytology; and, 5*th*, Zoology. It was in the three first divisions of the subject, especially the third, that the prelections of Jameson were chiefly valuable; but his acquaintance with animated nature was more limited. He exhibited his anxiety to discharge his academical duties to the utmost, and his enthusiasm on his favourite subjects he failed not to impart to his students, by which a strong stimulus was given to mineralogy and geology in Scotland.

The Wernerian doctrines of Jameson were not universally received. A very different theory of the earth had been promulgated some years before by the celebrated Hutton; and it was most ably supported by the experiments and papers in the *Transactions of the Edinburgh Royal Society*, of Sir James Hall, and the admirable *Illustrations of the Huttonian Theory* of Professor Playfair; while a good abstract of Hutton's views was annually given in his chemical course by Professor Hope. The principal supporters of the Wernerian or *Neptunian* theory were Jameson and Dr John Murray, in his well written *Comparative View of the Neptunian and Huttonian Theories*. The controversy was carried on with spirit at the meetings of the Royal and other societies, and it did not fail, from the ingenuity and earnestness of the supporters of each theory, to impart a high interest to geological speculations. It is not a little creditable, however, to the candour of Professor Jameson, that, after having long believed and zealously taught the Wernerian theory of the earth, he did not hesitate publicly to renounce his long-cherished geological speculations, and do justice to the extraordinary merits of Dr Hutton.

Before Jameson became the professor of natural history, he seems to have resolved on producing a mineralogical survey of all Scotland; and in 1804 he published the first part of the first volume of such a work, comprehending the county of Dumfries; but the increasing duties of his chair, and his resolution of forming a museum worthy of the uni-

Jameson, Robert.

versity, suspended that work, which was never farther realized. We may here state that, by the inattention of some of his predecessors, and the ravages of time, the considerable collections bequeathed to the college by Sir Robert Sibbald and others had disappeared; and most of the acquisitions made by Dr Walker were, after his death, claimed by his relations as private property; so that, when Jameson began to teach, he was almost without any public museum for the illustration of his lectures. He had, however, made a fine collection of minerals in Germany and elsewhere, which he used in that part of his course; and the few and imperfect zoological specimens he found in the museum were soon augmented by his indefatigable exertions, and considerable sacrifices both of valuable time and money. In after years the purchase of the noble Dufresne collection at Paris by an anticipation of funds about to accrue to the university, a small annual grant by the government for the support of the museum, and the fees for admission, together with numerous contributions obtained at Jameson's request from former pupils, have rendered this one of the noblest museums in our islands devoted to the teaching of natural history.

These engrossing occupations did not prevent Jameson's cultivation of his favourite study. In 1804 appeared his *System of Mineralogy*, in two octavo volumes, with a separate dissertation on Werner's *External Characters of Minerals*. In the first he gave most accurate descriptions of individual minerals; in the latter, he introduced, for the first time to the British public, Werner's capital definitions and nomenclature of colours, as applicable to descriptions of minerals and animals. The third volume of his *System* was published in 1809, under the title of *Elements of Geognosy*, in which, with the phraseology, he adopted all the hypothetic views of Werner, which he there contrasted with the fiery theory of Hutton. This work never became popular, partly from the growing tendency of geologists to dispute the dogmas of the Neptunists, and no doubt also from the intermixture of German idiom in which it was delivered. A second edition of his *System of Mineralogy*, in three octavo volumes, was published in 1816; and at the same time, an enlarged edition of his *External Characters*. In both editions of his *System* the arrangement of Werner is scrupulously followed; but in his *Manual of Minerals and Mountain Rocks*, which appeared in 1821, Jameson adopted the arrangement and nomenclature, as well as the crystallography of Professor Mohs. This may be considered as his last separate publication.

Jameson, however, was otherwise engaged in the cause of science. We have already noticed his labours in the formation of the university museum, an object to which he devoted a large portion of the best years of his life; and he assured the writer of this memoir that to *this* he had sacrificed his intention of completing the mineralogical survey of Scotland. A knowledge of his exertions in this cause induced his friends, some years before his death, to place the fine bust of him by Steel in the principal saloon of the museum.

The Natural History Society of Edinburgh had languished for several years after the death of Smellie; but it was revived through the exertions of Jameson, Dr Neill, and some other naturalists, and, under the designation of the *Wernerian Society*, has published seven volumes of *Transactions*, containing valuable memoirs, some of which are by Professor Jameson.

In 1819 he established *The Edinburgh Philosophical Journal*, in which, for a time, he was ably assisted by Dr Brewster; but it was afterwards solely conducted by Professor Jameson.

Jameson continued to give two annual courses of lectures, until the few last years of his life. His lectures were well attended, and he had the art of inspiring his pupils with his own love of a favourite science. This was much enhanced by those frequent instructive excursions, in which for many years he was accustomed to lead his students, among the interesting geological localities around Edinburgh, during which he explained the theories of the earth, and the succession of geological epochs.

Jamestown ‖ Janesville.

At length his health gave way, and for five winter sessions the class of natural history was taught for him by his friend and colleague, the present professor of medical jurisprudence. Increasing debility came on, and Professor Jameson died with tranquillity on 17th April 1854, in the fiftieth year of his professorship, and the eightieth year of his age. (T. S. T.)

JAMESTOWN, the capital and port of St Helena, is situate at the mouth of James Valley, on the N.W. side of the island. It contains several schools, and a military and seaman's hospital. The latter is supported by a duty of a penny per ton levied on every vessel entering the port.

JAMIESON, JOHN, DD., author of the *Etymological Dictionary of the Scottish Language*, was born in Glasgow in 1759. He took orders in the Secession Church, and was for some years a minister in connection with that body in Forfar. About the year 1795 he was translated to Edinburgh, where he spent the latter half of his long life, faithfully fulfilling the duties of his office. From time to time he continued to publish essays on religious and theological subjects. Among these were his *Alarm to Great Britain; or an Inquiry into the Causes of the rapid Progress of Infidelity*, 1795; *Vindication of the Doctrine of Scripture*, in reply to Dr Priestly's *History of Early Opinions; The Use of Sacred History*, and some other works of this class, besides sermons. Far more valuable than any of these, however, were his *Etymological Dictionary of the Scottish Language*, 1808-9, by far the best work on that subject that has ever appeared; and his *Hermes Scythicus*, 1814, in which he tried to show the radical affinities of the Greek and Latin languages to the Gothic. Dr Jamieson died at Edinburgh in 1838.

JAMYN, AMADIS, a celebrated French poet of the sixteenth century, was born about 1540 at Chaource, in Champagne. Trained under Dorat, Turnebus, and other great scholars of that era, he early showed a great fondness for literary pursuits. Ronsard, then the acknowledged coryphæus of French poetry, was pleased with his youthful effusions, and had him appointed secretary and reader to Charles IX. On the death of this benefactor, Jamyn quitted the court, and returned to his native town, where he died about 1485. His *Œuvres Poétiques* were published at Paris in 1575, and again in 1577. They are divided into five books, and consist chiefly of amatory and lyrical pieces, sonnets, elegies, and eclogues. He seems to have taken his friend Ronsard as his model, and though he does not equal him in fancy or passion, he is more true to nature, and shows a finer taste. Besides his original works, Jamyn published (Paris, 1574, and again in 1780 and 1784) a translation of the last thirteen books of the *Iliad*, and of the first three of the *Odyssey*, in Alexandrine verse. These translations contain many beautiful lines and numerous passages that happily recal the splendid thought and diction of the Greek original; but they are sadly marred by barbarous solecisms, giving the idea rather of a travestie than a translation.

JANESVILLE, a town of the United States of North America, capital of Rock county, in the state of Wisconsin, situate on both sides of the River Rock, 45 miles S.E. of Madison. The court-house occupies a prominent position on the summit of the crags which overlook the town. A plentiful supply of water from the river, and ample railroad communication, are local advantages which give an increasing impetus to the trade and manufactures of the town. Janesville was settled about 1836, became capital of the

Janizaries ‖ Jansen.

county in 1839, and was incorporated as a city in 1853. Pop. (1850) 3451; in 1853, estimated at 5000.

JANIZARIES, or JANISSARIES. See *Ottoman Army*, under ARMY.

JANSEN or JANSENIUS, CORNELIUS, bishop of Yprès, and the author of the celebrated *Augustinus*, was born in 1585 at Acquoi, near Leerdam, in Holland. He studied theology at Utrecht and Louvain, where he became acquainted with De Hauranne, afterwards Abbé of St Cyran. After completing his studies with this friend at Paris, he went with him to Bayonne, and there became the head of a newly founded college. Returning in 1617 to Louvain, he was made principal of the college of St Pulcheria. Two years later, he graduated as doctor in theology. In 1630 he was made professor of the Holy Scriptures; and in 1635, bishop of Yprès. He only enjoyed his bishopric, however, for about three years, being cut off by the plague, May 6, 1638. The works of Jansen published during his life were chiefly polemical in their character, and did not attract much notice. The most important of them, and that to which he owed his mitre, was his *Mars Gallicus*. France was at that time endeavouring to break the power of Spain by alliances with Protestant states. The Spaniards, in their turn, alarmed by the success of the French diplomacy, raised the cry of heresy against the French, and Jansen, at the request of the Spanish court, wrote the work in question with the view of holding up to Catholic Europe the dangers that threatened the true faith were France allowed to pursue her policy unchecked.

Jansen died in the bosom of the Romish Church, and was one of her most devoted champions; but he left behind him in MS. a work which was the means of damaging the cause of that church very nearly as much as the Reformation itself. This was the *Augustinus Cornelii Jansenii*, published two years after his death by his literary executors Fromond and Calen. The last twenty years of his life had been spent on this self-imposed task. "Ten times," says Sir James Stephen, "he read over every word of the works of St Augustine; thirty times he studied all those passages of them which relate to the Pelagian controversy. All the fathers of the church were elaborately collated for passages illustrative of the opinions of the bishop of Hippo. With St Austin as his text and guide, Jansen proceeded to establish, on the authority of that illustrious father, those doctrines which in our times and country have been usually distinguished by the terms Calvinistic or Evangelical. Heirs of guilt and corruption, he considered the human race, and each successive member of it, as lying in a state of condemnation, and as advancing towards a state of punishment, until an internal impulse from on high awakens one and another to a sense of this awful truth, and infuses into them a will to fly from impending vengeance. But this impulse is imparted only to the few; and on them it is bestowed in pursuance of a decree existing in the divine intelligence before the creation of our species. Of the motives of their preference, not even a conjecture can be formed. So far as human knowledge extends, it is referable simply to the divine volition, and is not dependent on any inherent moral difference between the objects of it and those from whom such mercy is withheld. This impulse, however, is not irresistible. Within the limits of his powers, original or imparted, man is a free agent—free to admit and free to reject the proffered aid. If rejected, it enhances his responsibility; if admitted, it leads him, by continual accessions of the same supernatural assistance, to an acquiescence in those opinions, to the exercise of those affections, and to the practice of those virtues which collectively form the substance of the Christian system." The appearance of a work putting forward such views as these threw the city of Louvain into a ferment; but the harsh measures taken to suppress the heresy only caused it to take deeper root and spread its branches more widely. From Louvain it passed into France. Fiercely opposed, especially by the Jesuits, it was as keenly defended by Jansen's old friend St Cyran, the young Arnauld, and with him the whole Port-Royal. The theological faculty of Paris then took up the case, and Cornet, the syndic of that body, named a commission to select and report upon the offensive views in Jansen's book, and end the dispute by referring the whole affair to the pope. The five following points were fixed upon—1. That there are some of God's commandments beyond the power of even the best of men to obey, however anxious they may be to do so, inasmuch as they have not yet received the measure of grace necessary to an acceptable obedience. 2. That even in an unregenerate state man is incapable of resisting inward grace. 3. That in the fallen state of nature, merit and demerit do not depend on a liberty which excludes necessity, but on a liberty which excludes constraint. 4. That the semi-Pelagians, while they admitted the necessity of an inward preventing grace for the performance of each particular act, were yet heretical in maintaining that this grace was of such a nature that the will of man was able either to resist or obey it. 5. That it is semi-Pelagianism to say that Christ by his death atoned for the sins of all mankind. After much intriguing and delay, the whole affair was laid for judgment before the reigning pope, Innocent X. In his bull of May 31, 1653, entitled *Cum Occasione*, that pontiff pronounced the first four points heretical, and the fifth rash, impious, and blasphemous. This bull was accepted and promulgated in France and the Netherlands with the royal consent. But it was far from giving universal satisfaction, and the Jansenists, who now counted in their ranks Pascal and Nicole with the whole Port-Royal, began to oppose and expose the intrigues of the Jesuits with all their might. Acknowledging that the five propositions in question were rightly condemned by the pope, they denied that they were to be found in the *Augustinus* in the sense in which they were condemned. Again the Jesuits appealed to the sovereign pontiff, and Alexander VII., in his bull of Oct. 16, 1656, entitled *Ad sacram*, declared that the five propositions were contained in Jansen's book, and had been condemned by his predecessor in the sense intended by their author. Not content with this settlement of the question, Alexander sent into France a formula embodying the substance of this bull, which all the ecclesiastics of that country were called upon to sign, on pain of suspension, and even excommunication. The whole body of the French clergy, except four bishops, refused to comply, and their obstinate resistance holds a conspicuous place in the church annals of that era. It was proposed to bring them to trial; but they had powerful friends at court and in the parliament, and the idea fell to the ground. Meanwhile the Port-Royalists, not content with a passive resistance, carried the war into the enemy's country. Besides exposing the wide-spread corruption of the whole Romish Church, they singled out the Jesuits as winking at, and even openly promoting it, for their private ends. To counteract the evil influence of this false priesthood, they wrote admirable text-books on various branches of education, disseminated biblical knowledge, and by their own lives set the example of a high and pure morality. The appearance of the *Provincial Letters* embittered the controversy which raged with unabated fury till the "Peace of Clement IX." restored quiet to the church for a time. This pontiff declared himself satisfied if the bishops would subscribe themselves, and make others subscribe, purely and simply, though they expressly declared that they did not desire the same submission for the fact but for the right. The liberal policy of Innocent XI. went far to restore general harmony. In 1698, however, the smouldering fire again broke out into a fierce and open flame. In that year appeared the *Moral Observations on the New Testament* of Father Quesnel, then re-

Jansen.

Janssen ‖ Janssens.

garded as the head of the Jansenist party. Louis XIV., now a mere tool in the hands of the priests, showed at once his orthodoxy and his piety by banishing Quesnel. A few years later, he suppressed and destroyed the monastery of the Port-Royal, and offered the most revolting indignities to the ashes of its illustrious dead. The famous bull of Clement XI., issued in 1713, and entitled "Unigenitus," which condemned the 101 propositions of Quesnel's work, may be considered as having put an end to the controversy. After this date, at least, it became mixed up with many other questions, in which the original ground of dispute was lost sight of and finally merged. (See Reuchlin's *Geschichte von Port Royal;* Dumas' *Histoire des Cinq Propositions;* Sir James Stephen's *Ecclesiastical Biographies*, &c., &c.)

JANSSEN, CORNELIUS, an eminent portrait-painter, was born at Amsterdam, though, in the *Chronological Tables*, and in *Sandart*, it is asserted that he was born in London. He resided for several years in England, where he was engaged in the service of King James I., and painted several excellent portraits of that monarch, as also of his children, and of the principal nobility of his court. He had not the freedom of hand nor the grace of Vandyck; but in other respects he was accounted his equal, and in the finishing of his pictures superior. His paintings are easily distinguished by their smooth, clear, and delicate tints, and by that character of truth to nature with which they are strongly marked. He generally painted on pannel; and his draperies are for the most part black, probably because that tint threw out his flesh colours more brightly than any other. His pieces have retained their original lustre in a very rare degree. His fame began to be somewhat obscured on the arrival of Vandyck in England; and when the civil war broke out some time afterwards, he returned to his own country, where his paintings were held in the highest esteem. He died in 1665.

JANSSENS, ABRAHAM, a contemporary of Rubens, and regarded as in some respects his successful rival, was born at Antwerp in 1569. He delighted in strong contrasts of light and shade, and gratified this taste in his torchlight and similar scenes. His subjects were generally chosen with a view to setting off to the best advantage his powers of colouring, which, in his day, were reckoned inferior to those of Rubens alone. His flesh tints, in particular, were very highly admired, and have retained their original lustre with little change. Janssens was also a good draughtsman, and had a fine eye for the composition of a picture. His best pieces are still to be seen in the churches of Ghent, Antwerp, and Dusseldorf.

JANSSENS, *Victor Honorius*, was born at Brussels, in 1664, and died in 1739. After an apprenticeship under Volders he became painter to the Duke of Holstein, and held that office for four years. He then migrated to Italy, and, settling at Rome, devoted himself to the study of Raphael and the antique, and revelled in the beautiful landscape scenery on every side. His pieces soon rose in value, and he obtained more commissions from the Roman nobility than he was able to execute. He remained eleven years at Rome, and during part of that time he worked in company with the celebrated Tempesta, in whose landscapes he used to paint the figures. His own walk was historical painting, which he practised both on a large and small scale; but his smaller sizes were most appreciated. On returning to Brussels he became as popular as he had been in Italy, and he also found a market for historical pieces on a great scale. His own taste, as well as his domestic circumstances, led him to paint in this style for the remainder of his life. He found it more lucrative, more easy, and more expeditious. His industry and rapidity of execution are amply attested by the numerous pieces from his hand which adorn many of the Flemish churches.

Januarius ‖ Janus and Jana.

JANUARIUS, ST, or SAN GENNARO, the patron saint of Naples, was bishop of Beneventum, and flourished about the close of the third century after Christ. The traditions of the church assert that, having been condemned to death, he was thrown to the lions in the amphitheatre of Puteoli. The lions, instead of devouring him as had been expected, laid themselves down in tame submission at his feet. This miracle gained so many converts to Christianity, that Diocletian ordered the martyr to be beheaded. This cruel sentence was executed in A.D. 305. The remains of the saint were buried in Pozzuoli, but were removed, after a few years, to Naples. In the ninth century, Sicon, Prince of Beneventum, carried off the bones of the saint to Beneventum, of which city he had been bishop. In 1497 the body was again taken to Naples, and buried with great pomp in the cathedral. When the saint was martyred some of his blood was collected in two phials, which are now kept in the cathedral church. Twice a-year—in May and September—this blood liquefies, and the recurrence of the miracle is looked forward to with great joy by the people of all ranks. On each occasion the liquefaction lasts for a week, which is always spent by the Neapolitans in festivities of every kind.

JANUARY, the opening month of the year, was introduced into the calendar by Numa, and by him consecrated to Janus, from whom it received its name. As the god Janus had two faces looking in opposite directions, so January, as the first month of the year, looked back upon the past and forward upon the future. The consecration of the month took place by an offering of meal, salt, frankincense, and wine, each of which was new. On the first of this month all enmities were suspended, presents were exchanged, consuls installed, &c. See CALENDAR.

JANUS AND JANA, in the *Ancient Mythology*, two deities held in especial honour by the Romans. The names themselves are derived from *dies*, light, or day; and their original form was Dianus and Diana. Dianus was soon corrupted into Janus, and the analogy holds in the feminine form, for though Diana remained unchanged, she was invoked by the rustics in their prayers and hymns to the new moon as "Jana novella." Janus, as her brother, seems to have been the same with Sol; and though special honours were at first paid to each as a distinct deity, their rites were finally merged into a common worship. It is probable that the Romans borrowed their idea of Janus from the Tuscans, among whom a similar god was worshipped from a very remote period. He presided over the beginnings of things, and hence Horace invokes him in the following strain:—

> "Matutine pater, seu Jane libentius audis,
> Unde homines operum primos vitæque labores
> Instituunt."

So much importance did the Romans attach to successful beginnings, that when any civil or military undertaking failed at the outset, they often began it anew. In honour of him Numa called the first month of the year Januarius; and as he both looked back upon the past, and forward to the new year, he was always represented with a two-faced head. As the presiding god of the seasons his statue had four heads, his temples were built with four equal sides but only one entrance, and his common designation was "quadrifrons." As the patron of gates (*januæ*), he is provided with a key in his left hand, and a staff in his right. These insignia symbolized his power as the janitor of heaven, whence he was called Patulcius, the opener, and Clusius, the closer. Indeed, all his attributes, numerous and varied as they seem, have reference to the idea of opening and shutting, and, regarding Janus as identical with Sol, symbolize the vivifying influences of his beams on the fruits of the soil and the operations of nature. The great

Japan. temple of this divinity at Rome was that of Janus Quirinus, of which the gates were kept open in times of war, and only closed when the state enjoyed universal peace. During the republic these gates were only once shut, at the end of the first Punic War, B.C. 241. In the reign of Augustus they were closed three times—first, after the battle of Actium, B.C. 29; a second time after the Cantabrian War, B.C. 24; about the third time authors are not agreed. Japan.

JAPAN.

Situation. THE empire of Japan consists of a chain of islands lying off the eastern coast of continental Asia, and extending S.E. and N.W. between N. Lat. 31. and 48., and E. Long. 129. and 150. Inclosed between this chain of islands and the opposite coasts of Corea and Manchu Tartary, is the Sea of Japan, which communicates by means of straits with the Chinese Sea on the S., the Pacific Ocean on the E., and the Sea of Okhotsk on the N. To the E. Japan has no nearer land than California, 5000 miles off; the nearest part of China is about 420 miles, and of Kamtschatka 270 miles distant.

Name. The term Japan is probably a corruption of the Chinese name, *Jih-pun-quo*,—*i.e.*, Kingdom of the Source of the Sun, or Eastern Kingdom. Marco Polo, who was the first to bring intelligence of this country to Europe, and who acquired his information in China, calls it *Zipangu*. The Japanese name is Nipon, or Nifon,—*i.e.*, Sun-source.

General description. The empire is divided into Japan proper,—consisting of the three large islands of Nipon, Kiu-siu, and Sitkokf, and the numerous small islands. Nipon, the largest and most important of the group, and that which gives name to the whole empire, has an estimated area of 100,000 square miles; its length being more than 900 miles, while its average breadth exceeds 100. It is thus about one-fifth part larger than Great Britain. Its form is that of a curve or crescent, with the concave side towards the mainland. S. of Nipon, and separated from it by a narrow channel, is the island of Kiu-siu, or Ximo, about 200 miles in length and about 80 in average breadth, thus containing an area of about 16,000 square miles. Lying N.E. of Kiu-siu, and eastward of the southern extremity of Nipon, is the island of Sitkokf, or Sikoko, about 150 miles in length by 70 in average breadth. It is separated from Nipon by a long strait in some parts not more than a mile in width; and from Kiu-siu by Bungo Channel, which is about 30 miles broad. N. of Nipon, and separated from it by the Sangar Straits, is the large island of Yesso, a conquest and colony of the empire. Its form is that of an irregular triangle, and its area is computed at 30,000 square miles. The southern portion of the island of Krafto, or Sagalien, which is separated from Yesso by the Strait of Perouse, and the three southernmost of the Kurile Islands—Kunashir, Iturup, and Ourop—belong to Japan.

The small islands which surround these are generally rocky and barren, but occasionally rich and fruitful. The entire number of islands composing the empire of Japan is estimated at above 1000, and the area of the whole empire at not less than 170,000 square miles. The coasts are difficult of access, not only from the multitude of rocks and islets which beset the passages, but also from the severe gales which, more than in any other part of the ocean, agitate these narrow seas. Several dangerous whirlpools also occur among the rocks. Kæmpfer remarks, that nature seems to have designed these islands to be a sort of little world, secluded and independent from the rest, as well by rendering it dangerous to approach their shores, as by endowing them plentifully with everything necessary for luxury and comfort, and thus enabling them to subsist without any commerce with other nations. The Japanese policy, which rigidly forbids all intercourse with strangers, in other circumstances impracticable, has been greatly facilitated by the interposition of these natural barriers.

Climate. The climate of Japan must vary considerably between its southern and northern extremities; but, except at a few points, we possess very little information on the subject. In the southern part of the empire, it is said in many respects to resemble that of England. At Nagasaki, in the island of Kiu-siu, Lat. 33., the average temperature in the month of January was 35°, and in August 98°, of Fahr. At this point the weather is very changeable. Rain is frequent at all seasons of the year, but especially in the months of July and August. In December and January the ground is covered with hoar frost, and occasionally with snow, except in very mild winters. In summer the land is cooled by the sea-breeze which blows from the S. during the day, and from the E. at night. At Simoda, on the island of Nipon, in N. Lat. 34. 39. 49., E. Long. 138. 57. 50., we learn, from the account of the American expedition (1852–54), that "the climate is more or less variable in the winter and spring. The presence of snow upon the lofty peaks, although there is seldom frost or snow at Simoda itself, and the not unfrequent rains, with the ever necessary fogs, give an occasional humidity and rareness to the atmosphere, which are chilling to the senses, and must be productive of occasional inflammatory diseases, such as are frequent in the spring and winter with us. The change of wind alternates often between the warm sea-breezes from the S., and the cold blasts from the snow-capped mountains inland, and produces the usual effects, doubtless, of such variations. In summer it is occasionally very hot in the day-time, but the nights are refreshed by the sea-breezes. From April 19 to May 13, a record of the thermometer gives 72° as the highest, and 58° as the lowest point; and of the barometer, 29°·38 and 30°. As the season advances the mercury rises, no doubt, much higher, reaching probably 85° of Fahr., or more." Golownin, a Russian naval officer, who was for two years a prisoner at Hakodadi in Yesso (N. Lat. 41. 49., E. Long. 140. 47.), describes its climate as follows:—"The ponds and lakes freeze, snow lies in the valleys and plains from November till April, and falls in as great abundance as at St Petersburg. Severe frosts are indeed uncommon, yet the temperature is often two degrees below the freezing point. In summer the rain pours in torrents at least twice a-week, the horizon is obscured by dark clouds, violent winds blow, and the fog is scarcely ever dispersed. Apples, pears, and peaches hardly attain ripeness, and the orange and lemon will not bear fruit." Of the climate of the still more northern part of the empire we have no precise account; but the same writer informs us that on the coast of Sagalien, which is but little farther N. than Paris, the sea is not clear of ice so early as the Gulf of Finland. Fogs are also, as might be expected, very prevalent in Japan, and thunder-storms are frequent.

Surface. The surface of the principal islands is in general very irregular, though in the interior some plains of considerable extent occur. In many places hills descend close to the sea shore, or leave only a narrow strip of land between the water and their bases. The highest mountain is said to be Fusi, an extinct volcano, on the island of Nipon, westward of the bay of Yeddo. Its summit is clad in perpetual snow, thus indicating a height of not less than 12,000 feet above the level of the sea. Several mountains of considerable elevation are seen to rise in the northern part of Nipon, in

Yesso, and in Sagalien, and some of them are active volcanoes. Besides the outbursts of frequent volcanic eruptions, no country is more frequently visited by destructive earthquakes. Kæmpfer enumerates six active volcanic mountains. "Earthquakes," says he, "are so frequent that the natives regard them no more than Europeans do ordinary storms." In 1586 a succession of earthquakes took place and lasted for forty days, causing the destruction of the best part of the city of Yeddo, and the death, it is alleged, of 200,000 of its inhabitants. In 1783 the eruption of a volcano in the island of Kiu-siu, accompanied by violent earthquakes, destroyed in a single province twenty-seven villages. Another volcanic eruption took place in the same island in 1793, accompanied by earthquakes which continued from March to June, and caused, according to official returns, the death of 53,000 persons, with a proportional destruction of property. On 23d December 1854, an earthquake occurred which was felt on the whole coast. Of the town of Simoda only a few temples and private edifices, that stood on elevated spots, escaped destruction. The fine city of Osaca, on the south-eastern side of Nipon, was completely destroyed, and the capital Yeddo did not escape without injury. On 10th November 1855, an earthquake at Yeddo is said to have caused the destruction of 100,000 dwellings and 54 temples, and the death of 30,000 persons.

Volcanoes and earthquakes.

Rivers.

The rivers are numerous, but short, shallow, and rapid. They are not navigable for vessels of burden, but some of them may be ascended by small boats for some miles from the sea. The principal lake of Japan is that of Oitz, in the southern part of the island of Nipon. It is about 60 miles in length, but of inconsiderable breadth.

Geology.

Little is at present known of the geological formation of the Japanese islands. The volcanic formation appears to prevail, but by no means to the exclusion of the plutonic and sedimentary. The useful mineral products, so far as yet known, are gold, silver, copper, quicksilver, tin, lead, iron, coal, sulphur, and salt. With the exception of tin and iron, these seem to be all very abundant. The gold is found in many parts of the empire, sometimes as ore, and sometimes from the washings of the earth or sand. Silver is equally plentiful with gold, and it is probable that the quantity of these metals annually exported from the country, when the trade was open, amounted in value to a million and a half sterling. Copper abounds through the whole group, and sometimes of a quality not to be surpassed by any in the world. The natives refine it, and cast it into cylinders about a foot long and an inch thick. A specimen analyzed by Dr Percy gave 0·13 per cent. of nickel, 0·03 per cent. of iron, and extremely minute traces of tin and gold. The coarser kinds they cast into round lumps or cakes. Iron ore rich enough for the purpose of smelting appears to be confined to three provinces, and the metal is consequently dear. "Iron," says Kæmpfer, "is much of a price with copper, iron tools being full as dear, or rather dearer, than those of copper or brass." The same is stated with respect to the proportional value of iron and copper by Golownin. Lead and quicksilver are said to be abundant, but they have never been articles of export. Tin has been discovered in small quantities, and of a quality so fine and white that it almost equals silver; but of the extent to which it may be procured little is known, as the Japanese do not attach much value to it. Zinc, according to Kæmpfer, is not produced in Japan, and in his time calamine used to be imported from Tonquin for the manufacture of brass wares. Zinc, however, is expressly stated by the governor-general Baron Van Imhoff to be an article of export as well as brass. This was fifty years after Kæmpfer's time. Sulphur, as might be expected in a region so volcanic, is very abundant. In some places it lies in broad deep beds, and may be dug up and removed with as much ease as sand. A considerable revenue is derived by the government from this source. Coal appears to be found in many parts of the country, and is used for fuel. Siebold speaks of it as being in common use throughout the country, and on visiting one of the mines he saw enough to convince him that it was skilfully worked. Being bituminous, it is for domestic purposes generally converted into coke. Rock-salt seems to exist in some parts of the country, but does not appear to be much used, the culinary salt in use being made from sea water by an unskilful and expensive process. By saturating masses of sand with sea water in the sun a strong lye is obtained, which is afterwards boiled in earthen vessels, and yields an expensive and impure muriate of soda. No diamonds have been found, but agates, carnelians, and jaspers are met with, some of them of great beauty. Pearls, frequently of great size and beauty, are fished up on nearly all parts of the coast.

Vegetable productions.

The vegetable productions of Japan are, for the most part, those common to temperate regions. Timber is, however, so scarce that no one is permitted to cut down a tree without permission from the magistrate, and only on condition of planting a young one in its stead. The most common forest trees are the fir and cedar—the latter growing to an immense size, being sometimes more than 18 feet in diameter. In the northern parts of the empire two species of oak are found which differ from those of Europe. The acorns of one kind are boiled and eaten for food and are said to be both palatable and nutritious. The mulberry grows wild in great abundance, and the varnish tree (*rhus vernix*) abounds in many districts. In the S. the bamboo cane, though a tropical plant, is found either in the wild or cultivated state, and is largely used in the manufactories. The camphor tree is of great value here, and lives to a great age. Siebold visited one which Kæmpfer had described as having been seen by him 135 years before. It was healthy, and covered with foliage, and had a circumference of 50 feet. The country people make the camphor from a decoction of the root and stems cut into small pieces. Chestnut and walnut trees are both found. Among the fruit trees are the orange, lemon, fig, plum, cherry, and apricot.

Animals.

Extensive cultivation leaves no room for wild animals; and tame animals not being used for food, are not multiplied beyond the felt necessity for their use. The horses are small, but hardy, active, and of good bottom. William Adams, an English mariner of the time of James I., describes them as "not tall, but of the size of our middling nags, short and well trust, small headed, and very full of metal, in my opinion far excelling the Spanish jennet in pride and stomach." Oxen and cows are only used in ploughing and carriage, milk or butter not being used as articles of food. Buffaloes of an extraordinary size, with hunches on their backs, like camels, are used to draw carts, and carry heavy goods on their backs. Sheep and goats were formerly kept at Firando by the Dutch and Portuguese, and might be bred in the country to great advantage if the natives were permitted to eat their flesh, or knew how to manufacture their wool. They have a few swine, kept chiefly for trading with the Chinese, among whom they are in great demand. Dogs are to be found in large numbers in the half domesticated state in which they generally exist in the East. This is not true, however, of one species, resembling somewhat an English spaniel, which is considered so valuable as to form part of every royal Japanese present. It is conjectured that the English variety may have sprung from some presented by the emperor to the king of England. The wild animals are bears, wild boars, foxes, monkeys, deer, and hares. Rats and mice are very common, as well as two small species of weasel or ichneumon, which live, half tame, under the eaves of houses.

Wild fowl are very abundant, consisting chiefly of geese and ducks, which migrate in great numbers to the shores

of Japan in winter. Numerous species of pigeons are to be found, and woodcocks, pheasants, snipes, larks, &c., are common. There are two species of pheasant, and one of peacock, peculiar to Japan. Domestic poultry are kept by the natives almost solely for ornament or amusement. Some of the reptilia are of large size, and, along with the insect tribes, are dreaded for their deadly and destructive powers.

The shallow bays and creeks around the islands swarm with shoals of fish, which, indeed, constitute nearly the whole animal food of the Japanese, and furnish them plentifully with oil for domestic purposes. In their coarse taste the intestines of the whale, and even the refuse of blubber, are considered good enough for food. The Japanese are the boldest and most expert of all Asiatic fishermen. Their fishing voyages extend to the rigorous seas of Sagalien and the Kuriles in pursuit of herring, with which they manure their cotton fields. They are the only Asiatic people that pursue the whale. The women are said to be expert divers for shell-fish, with which the shores of Japan abound.

Natives.

The Japanese are described as an active, vigorous people, of the middling size, and in their bodily and mental powers more closely assimilated to Europeans than Asiatics. The common people, according to Thunberg, are of a yellow colour, which sometimes borders on brown, and sometimes on white. The labouring classes, from the exposure of the upper parts of their bodies in summer, have their naturally fair complexion deepened into brown. Their dark brown eyes are oblong, small, and sunk deep in the head. The eye-lids forming a deep furrow gives them the appearance of being keen-sighted. Their heads are large, and their necks short, their hair black and glossy with oil. Their noses, without being flat, are yet rather thick and short. Dr Ainslie gives a somewhat different account of their complexion. He represents them as perfectly fair, and indeed blooming, though this seems to apply chiefly to the women. Thunberg also mentions that the descendants of the oldest and noblest families of the princes and lords of the empire are somewhat majestic in their shape and countenance, being more like Europeans; and that ladies of distinction, who seldom go out in the open air without being covered, are perfectly white. Siebold, speaking of the inhabitants of Kiu-siu, corroborates this view, and says that "the women who protected themselves from the influence of the atmosphere have generally a fine and white skin, and the cheeks of the young girls display a blooming carnation." The married women of Japan dye their teeth black, by means of a corrosive composition, so powerful that by mere touch it burns the flesh into a purple gangrenous spot, and in spite of the utmost care in its application, invariably taints the gums, destroying their ruddy colour and vitality. "The Japanese women, always excepting the disgusting black teeth of those who are married, are not ill-looking. The young girls are well formed, and rather pretty, and have much of that vivacity and self-reliance in manners which come from a consciousness of dignity, derived from the comparatively high regard in which they are held. In the ordinary mutual intercourse of friends and families the women have their share, and rounds of visiting and tea-parties are kept up as briskly in Japan as in the United States" (*American Expedition*).

Origin of race and language

Superficial observation led to the belief that Japan was colonized by the Chinese; but a more accurate knowledge of the physical characteristics and language of the people has rendered this opinion untenable. Indeed, the Japanese themselves consider it a high disgrace to be compared with the Chinese. Dr Ainslie states that the only occasion on which he saw a Japanese surprised into a passion, and, forgetting his habitual politeness, lay his hand on his sword, was on a comparison being made between the two nations. The structure of the languages of the two countries is essentially different, that of Japan being polysyllabic, while all the dialects of the Chinese are monosyllabic. It is true that, like the Latin in Europe during the middle ages, the Mandarin dialect of the Chinese is in use among the learned here, as in Corea, Tonquin, and elsewhere; and hence many Chinese words have been introduced into the Japanese; but the introduction of these only makes the structural difference the more strikingly apparent. The *Yomi*, or primitive language of Japan, is used in poetry and works of light literature. The *Koye*, or Chinese language, slightly varied in pronunciation, is employed by the *bonzes* or priests in their religious books. The vulgar language of the country is a mixture of the two. Close affinities have not been traced between the *Yomi* of Japan and any other Asiatic language. By some, at least, it is thought to be most analogous to the languages of the Tartar race, to which, in spite of diversity in physical characteristics, it is now most commonly believed that the Japanese belong.

Popula-tion.

In regard to the population of Japan, all our information rests merely on conjecture. Some authorities estimate it at not more than 10,000,000, while others make it more than four or five times that amount. All travellers who have visited the country bear testimony to the populousness of the parts visited by them. Thus, Kæmpfer, who passed four times over that part of the country between Nagasaki and Yeddo, says,—"The country is populous beyond expression, and one would scarce think it possible that, being not greater than it is, it should nevertheless maintain and support such a vast number of inhabitants. The highways are an almost continued row of villages and burghs. You scarce come out of one but you enter another; and you may travel many miles, as it were, in one street without knowing it to be composed of different villages but by the different names that were formerly given them, and which they afterwards retain though joined to one another. It has many towns, the chief whereof may vie with the most considerable in the world for largeness, magnificence, and the number of inhabitants." William Adams, writing eighty years before Kæmpfer, speaks in the same strain in reference to the same district. These accounts, however, refer chiefly to the island of Kiu-siu and the southern part of Nipon, and even of these only to the highway from Nagasaki to Yeddo, doubtless the most thickly peopled part of the empire. Of the island of Sitkokf, the northern part of Nipon, and of Yesso, we know little or nothing; but, as the two last are in many parts composed of rugged mountains, and have a less genial climate, we may conclude that they are less densely populated than Kiu-siu or the S. of Nipon. Sagalien and the Kuriles, with their rugged mountains and bleak climate, cannot be other than thinly peopled. Taking the average between the populations of Bengal and Madras, —countries which, in nearly the same latitudes, when taken together combine the principal features of the Japanese territory,—we obtain the datum of 225 persons to the square mile as an exceedingly probable basis for calculating the population of Japan. This, in round numbers, would give the population of the four principal Japanese islands as 39,900,000. Taking the average all over China, according to the last census of 1812, as the basis of calculation, which gives 268 to the square mile, we would have a Japanese population of 42,000,000. The checks to this exuberant population are infanticide (which, although prohibited by law, is openly practised), and public prostitution, which is legalized. Pestilences and occasional famines have periodically thinned a country wholly dependent on its own soil, which was populous two centuries and a half ago, and having enjoyed an uninterrupted peace for more than 200 years, cannot well be less populous now.

Classes of society.

The Japanese are divided into classes, which are all hereditary; a state of society that bears a close resemblance

Japan.

to that of the Hindus, while it differs widely from that of the Chinese. These classes, exclusive of the imperial families, are,—1*st*, The hereditary vassal princes of the empire; 2*d*, The hereditary nobility, who hold their lands as fiefs subject to render knight or military service to some one of the hereditary princes; 3*d*, The priests; 4*th*, The military or soldiers of the nobility; 5*th*, The professional class, including inferior officials, medical practitioners, and the like; 6*th*, The mercantile class, comprising all merchants and traders; 7*th*, The artizan class, including all crafts; and, 8*th*, Unskilled labourers, including peasants, fishermen, and sailors. To this last class belongs the great mass of the people, who are, in fact, in a condition of villeinage, and in so far as they are rural labourers, mere occupants, or at best metayers. To these may be added a pariah class, consisting of all persons dealing in leather, skins, and peltry, and who, from their constant contact with dead animal matter, are deemed in a state of perpetual pollution. They are not permitted to dwell among the rest of the people, but must live in villages by themselves. They dare not even enter an inn, teahouse, or any place of public entertainment; and no Japanese not of their own class would ever touch or use a vessel out of which they had taken food. From them are taken the jailors and executioners. The first four classes have the privilege of wearing two swords, the fifth of wearing one, and all the five of wearing a particular kind of trowsers forbidden to the rest. Although the ranks of each are closed against the others, it does not appear that the line of class-separation is always impassable. The most illustrious of all the secular emperors who reigned towards the end of the sixteenth century, rose to the throne from being a hewer and carrier of wood, by mere force of superior endowment.

Government.

The form of government in Japan resembles, in no small degree, the feudal system of mediæval Europe. The sovereign power is lodged in a supreme ruler, but the greater part of the country is subject to vassal princes, who pay tribute or render military service to the lord paramount. Not only every institution, but nearly every office is hereditary, descending from father to son. According to Japanese history, a single race of sovereigns, reputed to be descended from the gods, governed the empire for eighteen hundred years to A.D. 1195, when the then commander of the army, while engaged in suppressing a rebellion, usurped the greater part of the secular power, leaving to the lawful sovereign little more than the spiritual. Hence arose the singular government which still exists, consisting of two sovereigns, the one invested with the whole secular power, the other only with the ecclesiastical. The spiritual sovereign is known by the name of the *Mikado*, and his court by that of *Dairi*. The actual sovereign goes usually by the name of *Siogun*, but is also called the *Kubo Sama, i.e.*, Lord Kubo, the name or title of the original usurper. Both princes have their separate courts and capitals, the spiritual chief residing in Miako, the temporal in Yeddo. The Mikado, though nominally supreme, has not a particle of temporal power, being literally, from birth to death, shut up at Miako, in his little principality of Kioto, with the revenues of which, and the presents sent him by the Siogun, he must be content. Even the government in his own principality is in the hands of some grandee of his court, so that there never lived a sovereign having less of the attributes of sovereignty. He is visited with great pomp, once in seven years, by the Siogun. Whatever may have, at one time, been the power of the Siogun, it is certain that it is now very much circumscribed; indeed he is as much subject to laws as the meanest of his subjects. The real power of the empire is chiefly vested in the grand council of thirteen members, five belonging to the first class of society, the hereditary vassal princes, and the remaining eight to the second class, or the nobility below the rank of princes. The chief or president of this council has the title of "Governor of the Empire," and in him is vested the supreme power. He decides upon all affairs of moment, appoints to the various offices, and receives returns from all the authorities of the empire. His office appears to be hereditary. The grand council has even the power of dethroning the emperor. Important resolutions of the council are always laid before him, and he generally assents without investigation or delay; but, should he not at once grant his assent, or disapprove of a measure, it is immediately referred to the arbitration of the three princes of royal blood most nearly related to the Siogun, and their decision is final. If they differ in opinion from the monarch, he must instantly relinquish the throne to his son, or some other heir, without even the power to retract. If, on the contrary, they agree with him, the member of council who proposed the rejected measure must die, and not unfrequently all who supported him. It has thus sometimes happened that the whole council, with the governor of the empire at their head, have been obliged to atone by suicide for a mistake in national policy. The vassal princes still exercise a kind of sovereign power within their own territories. Formerly the kingdom was subdivided into sixty-six or sixty-eight principalities, which had previously formed independent kingdoms, and continued as principalities, under the rule of their respective princes, subject however to forfeiture in the case of rebellion or treason. This penalty of forfeiture having been incurred by many of the reigning princes, advantage was taken of the circumstance to split the forfeited principalities into fragments; so that, instead of the original number, there are now no less than six hundred and four distinct administrations, including principalities, lordships, imperial provinces, and imperial towns, of which last the Siogun himself is the ruling head. The chief danger to the empire lies in these princes, and, accordingly, strange and harassing means are employed to restrain their power. Their families are kept at court as hostages, and they themselves are obliged to pass half the year, or every alternate year there, while they are kept poor by the large contingents of troops which they are compelled to furnish. They are allowed to exercise scarcely any function of administration, that is not merely ceremonial, the real administration being conducted by deputies appointed by the imperial council, two for each province. To secure the fidelity even of these, their families must constantly reside at Yeddo the capital, while they themselves reside alternately at the capital and in the province. Besides these, the princes are continually surrounded by numerous private spies, who, unknown to them, watch their domestic as well as their public proceedings. In fact, the emperors, the governor of the empire, grand councillors, vassal princes, down even to the humblest citizens, all are under the eye of a secret police. Every city or town is divided into groups of five families, and every member is held personally responsible for the conduct of the whole. Everything, therefore, that occurs in one of these families, out of the usual course, is instantly reported to the authorities by the other four to save themselves from censure. Such are the means by which an extensive but essentially feeble empire is held together, and hence arises the unalterable character of the laws and customs. A governor, a lord, or prince knows that if he attempt any alteration whatever, he will be instantly denounced by his colleague or secretary as a violator of the established usages of the empire, and the punishment of his crime is death. The same fear of the same inevitable doom deters the common people from mooting the slightest degree of change.

Character of Japanese.

Thus a people, naturally frank, and possessed of a high sense of honour, have become in public life cunning, treacherous, and mean. "The men of all classes were exceedingly courteous, and although inquisitive about strangers,

Japan. never became offensively intrusive. The lower people were evidently in great dread of their superiors, and were more reserved in their presence than they would have been if they had been left to their natural instincts. The rigid exclusiveness in regard to foreigners is a law merely enacted by the government from motives of policy, and not a sentiment of the Japanese people. Their habits are social among themselves, and they frequently intermingle in friendly intercourse."[1] "The Japanese," says Kæmpfer, "are very industrious and inured to hardships. Very little will satisfy them. They generally live on plants and roots, tortoises, shell-fish, seaweeds, and the like. Water is their common drink. They go bare-headed and bare-legged. They wear no shirts; they have no soft pillows to lay their heads on, but sleep on the ground, laying their heads, instead of a pillow, on a piece of wood or on a wooden box somewhat depressed in the middle. They can pass whole nights without sleeping, and suffer all manner of hardships." The following apparently very correct picture of this people is given by an anonymous writer of the reign of Elizabeth. "The inhabitants show a notable wit and an incredible patience in suffering, labour, and sorrows. They take great and diligent care lest either in word or deed they should show their fear or dullness of mind, and lest they should make any man (whosoever he be) partaker of their troubles and wants. They covet exceedingly honour and praise; and poverty with them bringeth no damage to nobility of birth. They suffer not the least injury in the world to pass unrevenged. For gravity and courtesy they give not place to the Spaniards. They are generally affable and full of compliments. They are very punctual in the entertainment of strangers, of whom they will curiously inquire even trifles of foreign people, as of their manners, and such like things. They will as soon lose a limb as omit one ceremony in welcoming a friend. They use to give and receive the cup at one and the other's hands, and before the master of the house begins to drink, he will proffer the cup to every one of his guests, making show to have them begin. Fish, roots, and rice are their common junkets; and if they chance to kill a hen, duck, or pig, which is but seldom, they will not like churls eat it alone, but their friends will be partakers of it. Although essentially an abstemious and sober people, they are not averse occasionally to strong potations." "The common people," says Golownin, "are fond of them, and frequently drink to excess on holidays, but the vice of drunkenness is far less common than in Europe." Woman here occupies a higher position than in any other Asiatic country. "There is one feature in the society of Japan by which the superiority of the people to all other oriental nations is clearly manifest. Woman is recognised as a companion, and not merely treated as a slave. Her position is certainly not as elevated as in those countries under the influence of the Christian dispensation; but the mother, wife, and daughter of Japan are neither the chattels and household drudges of China, nor the purchased objects of the capricious lust of the harems of Turkey. The fact of the non-existence of polygamy is a distinctive feature which pre-eminently characterizes the Japanese as the most moral and refined of all eastern nations. The absence of this degrading practice shows itself not only in the superior character of the women, but in the natural consequence of the greater prevalence of the domestic virtues."[2] Concubinage, however, is common; and prostitution prevails to a very great extent. "Public bagnios," says Golownin, "are licenced and open from sun-set to sun-rise; their keepers ranking with merchants (entitled to wear one sword and the distinguishing trousers). One of the temples of Venus at Yeddo is as magnificent as a prince's palace, and contains six hundred priestesses." It would appear, however, that there is something like moral revenge on the keepers of these establishments at their death. "Although," continues Golownin "the keepers of bagnios are publicly licensed, they are held infamous, and when they die, denied any other funeral than a dunghill, to be devoured by dogs. A bridle of straw is put in their mouths, and their bodies dragged thus through the streets to be left on the dung-heaps." Capt. Saris had given the very same account two hundred years before. The women of the lower orders are frequently seen engaged in field labour, and employments which in other countries are considered to belong specially to the stronger sex, showing the general industry, and the necessity of keeping every hand employed in this populous empire. "All along this coast," says old Adams, "and up to Ozaca, we found women divers that lived with their household and family in boats, as in Holland they do the like. These women would catch fish by diving, which by net and lines they missed, and that in eight fathoms depth. Their eyes, by continual diving, do grow as red as blood, whereby you may know a diving woman from all other women."

Japan.

The Japanese are distinguished for their neat, clean, and orderly habits. "They are," says Kæmpfer, "very nice in keeping themselves, their cloths, and houses, clean and neat." The bath is in frequent use, their inns and houses of consideration being furnished with cold, hot, and vapour baths. Their highways are good, and swept with as much nicety as the street of a well-regulated European town. The distances are marked by posts, and where practicable the rivers crossed by bridges. Along the roads are numerous inns for the accommodation of travellers. Adams, on one occasion, accompanied the prince of Firando to the capital, who had with him a train of 3000 persons, and he thus describes the hospitalities of their march. "Such good order was taken for the passing and providing for of these 3000 soldiers, that no man either travelling or inhabiting upon the way where they lodged was any way injured by them, but chiefly entertained them as their other guests, because they paid for what they took, as all other men did. Every town and village upon the way being well fitted with cooks and victualling houses where they might at an instant have what they needed, and diet themselves from a penny English a meal to two shillings a meal."

The Japanese at one time enjoyed a high reputation among eastern nations for courage and military prowess. This, however, is no longer the case, and we suspect they will be found an essentially feeble and pusillanimous people. According to Golownin, they are deficient in courage, and in the art of war mere children. This can scarcely fail to be the case with a people who, by all accounts, have enjoyed peace external and internal for more than two centuries. A courageous and patient endurance of pain and suffering, and even a contempt of death, we know to be quite consistent with a lack of active aggressive courage.

Army.

Of the Japanese army little is known, except that it is very numerous, and that the military, like every other class, is hereditary. The officers and commanders, however, do not belong to the military order, but are princes and nobles, from which we may infer that the spirit and discipline of the Japanese army are not of a high order. The army consists of two classes, the soldiery of the emperor, and that of the vassal princes, the former being considered the better organized. Both consist of infantry and cavalry, armed with swords, lances, and the bow and arrow, and occasionally with the matchlock.

Laws.

The Japanese laws are very short and intelligible, and the proceedings under them are as simple as the laws themselves. There are no professional lawyers, every man being deemed competent to plead his own cause. If a party is aggrieved, he appeals to the magistrate, who summons the other party before him. The case is then stated by the complainant in his own way, and the accused is heard

[1] *Account of American Expedition to Japan.*

[2] Ibid.

Japan. in reply. The magistrate examines witnesses, and is said frequently to display great acuteness in the detection of falsehood. He passes sentence, from which there is no appeal, and it is carried into execution *instanter*. If the matter in dispute be of great importance, the magistrate may refer it to the emperor in council. Sometimes in trifling cases he orders the parties to go and settle the matter privately with the aid of their friends, and it is well understood that the matter must be so settled, or unpleasant consequences will result.

There is no country in which human life seems to be less valued than in Japan, whether by the government or the people themselves. Capital punishments extend even to the slightest offences, and suicide is not only frequent, but is considered meritorious. When an official has committed an offence, or even when there has been in his department a violation of law, although beyond his power of prevention, so sure is he of the punishment of death, that he anticipates it by disembowelling himself. By this act of self-destruction he saves his property from forfeiture, and his family from death. With many of the high officials it is a point of honour thus to kill themselves on any failure in their departments, and their sons are often promoted to high rank as a reward for the father's compliance with the established usage. Disembowelling is the usual manner of committing suicide, and is performed by making two incisions in the form of a cross over the abdomen, while a trusty follower stands behind to complete the work by decapitation. Public executions are usually performed by beheading, and crucifixion is also a mode in use. After execution, the bystanders amuse themselves by trying their own skill and the temper of their swords upon the corpse.

Revenue. The great source of revenue in Japan is the rent of land, with an impost on houses, in the manner of a ground rent. There appears to be no tax on articles of consumption, no capitation tax, and no transit duties. The cultivators of the soil appear to be mere villeins, simply occupants cultivating as metayers. In lands belonging to the crown, the proportion of the crop considered rent is four parts in ten, and in the rest six in ten, most commonly the latter. These proportions apply to every kind of crop—corn, pulses, and cotton. The land, in order to determine the rent, is surveyed by sworn appraisers twice a year, once before the seed is sown, and again immediately before harvest. Those that cultivate untilled ground have the whole crop for two or three years. Among their many excellent laws relating to agriculture, one is, that whosoever does not cultivate his ground for the term of one year forfeits his possession. It would appear from the proportion of crop taken as rent that the impost on the land does not materially differ from that assumed as land-tax under the Mohammedan government of Hindustan, and continued in some places by ourselves. This will enable us to make an approximate estimate of the rental of Japan,—that is, of the principal source of its public income. This, of course, will suppose a similar condition of society and rate of population in Japan and the country with which it is compared. Let us take, therefore, the same Indian territories by which we have attempted to estimate the population. These have, in round numbers, a population of 46,000,000, and yield a land-tax of L.10,000,000. This proportion would give to Japan, with its estimated population of 40,000,000, a rental of nearly L.8,700,000 to be divided between the imperial governments, feudatory princes, hereditary nobles, and the soldiery.

To the rent of land is to be added the ground rent of the houses, which is said to be at the rate of 1s. 8d. for each fathom of frontage, without regard to depth, unless it exceed fifteen fathoms, when the rate is doubled. Whether the impost applies to all houses, wherever situated, or only to those in towns, is not stated; but if the former be the case, estimating each house to have an average of five inhabitants, and also five fathoms of frontage, would give the income from this source at more than L.3,300,000, or, adding this to the land rent, would make the annual revenue of the empire about L.12,000,000. Japan.

Agriculture. The Japanese being chiefly dependent on the soil for subsistence, have arrived at a high state of perfection in the arts of agriculture. Though a great part of the country is hilly or mountainous, and the soil in general rather poor, yet almost every available foot of land is cultivated, and very abundant crops are raised. Where the land is inaccessible to the plough it is cultivated by manual labour. Like the Chinese, they pay great attention to manuring and irrigation. As animal food constitutes hardly any part of their subsistence, no pastures or meadows are to be seen. Rice constitutes the main object of agriculture, as it forms the bread corn of the people from one end of the empire to the other. Its cultivation extends to the island of Yesso, and as far N. as 45 degrees of Lat. The rice of Japan is known to excel every other in Asia, and this may not be owing exclusively to its skilful cultivation, but partly to the climate and the distance of Japan from the tropics. From it the inhabitants distil a drink called *saki* (a kind of rice beer), in very general use. Wheat and barley are grown, but the former is not in much use, and the latter is the chief provender of cattle. Rye, maize, panic, millet, and the *Cynosurus corocanus* are also raised. Beans and peas of different kinds are cultivated in great abundance, particularly the bean *Dolichos soja*, from which *soy*, a kind of sauce, prepared by boiling and fermentation, is made. Among esculent roots and pot-herbs the following are successfully cultivated—the batata, potato, carrot, turnip, cabbage, radish, lettuce, gourd, melon, and cucumber. The fruits are generally those of Europe, as the orange, lemon, peach, fig, pear, chestnut, walnut, and cherry.

The tea-plant in Japan, as in China, takes the place of the vine in the temperate regions of the west, and of the coffee in tropical countries. "The tea shrub, "says Kæmpfer, "is one of the most useful plants growing in Japan, and yet it is allowed no other room but round the borders of rice and corn fields, and in other barren places unfit for the culture of other things." In a few places the plant, according to Siebold, receives more attention; generally, however, hardly as much as our hawthorn hedges, and thus the leaves are unfit for the consumption of strangers. Its use, however, is universal among the natives. It was introduced into this country from China in the ninth century. Tobacco was first introduced by the Portuguese in the early part of the sixteenth century, about the same time that it was introduced into England, and it is remarkable that the Japanese emperor instituted a persecution against its growers and smokers at the same time that King James issued his *Counter-Blast*, and with as little effect in arresting its use.

The plants cultivated in Japan for textile purposes are cotton and hemp in the northern islands. The mulberry is grown for the silk-worm. In husbandry cotton ranks next in importance to rice, and furnishes materials for clothing the great mass of the people.

Manufactures. In the manufacture of cotton fabrics the Japanese display considerable skill, but in this respect they do not equal the Hindus. Their best silk is said to be superior to that of China. In the manufacture of porcelain, too, they are said by some to excel the Chinese. Specimens of great beauty and delicacy, at least, have been produced, though some assert that, owing to the exhaustion of the best clay, such articles can no longer be manufactured. Like the Chinese the Japanese have long practised the manufacture of paper and glass. Formerly they did not know how to make the flat pane for window glass, and probably what they do make is of an inferior quality, as they still purchase thick mirror glass from the Dutch, to grind into lenses. Paper they

Japan. manufacture in great abundance, as well for writing and printing as for tapestry, hankerchiefs, &c. It is made of very various qualities, and some of it is as soft and flexible as cotton cloth. Indeed, that used for handkerchiefs might be mistaken for cloth, so far as toughness and flexibility are concerned. This paper is made of the bark of the mulberry (*Morus papyrifera*) by means of the following process:—In December, after the tree has shed its leaves, they cut off the young shoots, about 3 feet in length, and tie them up in bundles. They are then boiled in a lye of ashes in a covered kettle, till the bark is so shrunk that half an inch of the wood may be seen projecting at either end of the branch. When cool, the bark is stripped off, and soaked in water for three or four hours until it becomes soft, when the exterior black cuticle is scraped off with a knife. The coarse bark, which is full a year old, is then separated from the fine, which covered the younger branches, and which makes the best paper. The bark is then boiled again in clear lye, continually stirred with a stick, and fresh lye from time to time added, to make up for the evaporation. It is then carefully washed at a running stream, by means of a sieve, and incessantly stirred until it becomes a fine pulp. For the finer kinds of paper this process is repeated, a piece of linen being substituted for the sieve. After being washed it is beaten with sticks of hard wood on a wooden table, till it is brought to a pulp, which is put into water and dissolved and dispersed like meal. This is put into a small vessel with a decoction of rice and a species of *Hibiscus*, and stirred until it has attained a tolerable consistence. It is then poured into a larger vessel, whence it is taken out, and put in the form of sheets in mats or layers of grass straw. These sheets are laid one upon another, with straw between, and pressure is applied to force the water out. After this they are spread upon boards in the sun, dried, cut, and gathered into bundles for sale and use. The well-known lacquer ware to which Japan has given name, is unequalled for beauty and durability by that of any other nation. We have ourselves of late years imitated, but certainly not equalled it. They display considerable skill in working the metals. In wood work, caskets, cabinets, and the like, they are unsurpassed. Some of their swords are said to be equal to the finest Damascus blades; and Golownin states that their carpenters' and cabinetmakers' tools are equal in temper to those of a similar kind in England. They are exceedingly quick in observing any improvement brought in among them by foreigners, and copy it with great skill and exactness. Clocks, watches, and astronomical instruments are made by them, copied from European models.

Arts. In certain branches of the fine arts the Japanese have attained no small skill. They are ignorant of anatomy and perspective, and therefore barbarous in their sculptures and landscapes; but in the representation of a single object they manifest great accuracy of detail, and a truthful adherence to nature. Architecture, as an art, can hardly be said to have any existence—their temples, palaces, and private houses being all low and temporary structures, generally of wood; and the frequency of earthquakes leads them to bestow less care on their buildings than in other circumstances they might do.

Sciences. The medical knowledge of the Japanese must necessarily be very imperfect, as their dread of pollution from contact with dead bodies prevents them from scientifically investigating the dead subject. The native physicians display great eagerness to acquire information on professional points from Europeans; and Dr Siebold speaks with high praise of the zeal with which they thronged around him from all parts of the empire, seeking to enlarge their stores of knowledge. He also bears testimony to their intelligence, as evinced by the questions they asked. Original medical works are constantly appearing, as well as translations of such Dutch medical works as they can best understand. Japan. Their drugs are mostly animal and vegetable; they are too little acquainted with chemistry to venture upon mineral remedies. They study medical botany with great attention, and display considerable knowledge of the virtues of plants. Acupunture and *moxa* burning are both in use in Japan, and are native inventions. In the science of astronomy they have made considerable proficiency. They understand the use of European instruments, and many of them are successfully made by native workmen. Meylan says that he saw good telescopes, chronometers, thermometers, and barometers made by Japanese mechanics. They calculate eclipses accurately; and yearly almanacs are prepared in the Yeddo and Dairi colleges. Lalande's *Treatises* and other astronomical works have been translated from the Dutch, and are studied with great ardour. Their year consists of twelve lunar months, but is converted into sidereal time by the introduction every third year of an intercalary month of the requisite length. The natural day of twenty-four hours is divided into twelve watches—six for the day, from sun-rise to sun-set, and six for the night, from sun-set to sun-rise. As this division is absolute, it follows that the watches are never of the same length, except at the equinoxes. Their length is regulated only four times in the year, the intervening watches being consequently left in uncertainty. The twelve watches go by the names of the signs of the zodiac. These signs are the same as ours, differing only in their names. The chronology of the Japanese, like that of the Chinese, is usually reckoned by the reigns of their monarchs, beginning with the first Mikado, the supposed founder of their empire, and who commenced his reign B.C. 660. They have also a cycle of sixty years, formed by multiplying the signs of the zodiac by the number of the elements, which they reckon to be five.

There are three religions, and numerous religious sects Religions. in Japan. The ancient religion of the country is called *Sinsyu, i.e.*, the gods' worship, and its followers are called *Sintoos*. In this worship the chief deity is the sun-goddess *Ten-sio-dai-zin*. She is considered too exalted to be herself addressed in prayer, and is therefore invoked through inferior deities called Kami, of whom there are reckoned 492 gods and 2640 deified men, making in all 3132 gods who have their temples, priests, and priestesses, the last being the wives of the priests, for celibacy forms no part of this worship. "The more immediate end," says Kæmpfer, "which its followers proposed is happiness in this world, and they have but an obscure notion of the immortality of the soul and of a future state of rewards and punishments. The temples," he continues, "are generally in a grove of trees or on the side of a green hill, and have avenues of cypresses leading to them, the buildings themselves, however, being small and mean. The five great duties enjoined in the Sintoo religion are,—1*st*, Preservation of pure fire as an emblem of purity and an instrument of purification; 2*d*, Purity of soul and body, the former by obeying the dictates of reason and the laws, the latter by abstaining from whatever defiles; 3*d*, Observance of festival days, which are numerous; 4*th*, Pilgrimages; and 5*th*, The worship of the *Kami*, both in the temples and in private dwellings. For pilgrimages there are twenty-two chief holy places, besides many smaller ones. Pre-eminent among these is the temple of Isye, in the island of Nipon, which is to the Japanese what Mecca is to the Mohammedans. One pilgrimage at least to this shrine is incumbent upon every professor of the Sintoo faith, and the very pious go annually. But the most remarkable feature in this religion is the doctrine of purity and pollution in regard to acts harmless or indifferent in themselves, in which respect it agrees with that of the Hindus, and differs entirely from any form of belief among the Chinese.

Japan. "External purity," says Kæmpfer, "is one of the most stringent parts of the Sintoo religion. This consists in abstaining from blood, from the eating of flesh, and from communication with dead bodies. Those who have rendered themselves impure by any of these things, are thereby disabled from going to the temples, from visiting the holy places, and in general, from appearing in the presence of the gods. Whoever is stained with his own or any other blood is impure for seven days. Whoever eats the flesh of any four-footed beast, deer only excepted, is impure for thirty days. On the contrary, whoever eats the flesh of a fowl, wild or tame—waterfowl, pheasants, and cranes excepted—is impure only for a Japanese hour, which is two of ours. Whoever kills a beast, or is present at a public execution, or attends a dying person, or comes into a house where a dead body lies, is impure for that day. But of all the things which are impure, none are reckoned so very contagious as the death of parents and near relations. The nearer you are related to the dead person, so much the greater the impurity. All ceremonies which are to be observed on this occasion, the time of mourning and the like, are determined by this rule." They have no idols in their temples; there are indeed images of their Kami, but these, it is alleged, are not for purposes of worship. The only decorations in their older temples were a mirror, the emblem of purity of soul, with several strips of white paper formed into what is called a *gohei*, also an emblem of purity. The festivals all begin with a visit to the temple. There the votary performs his ablutions at a reservoir provided for the purpose; he then kneels down in the verandah opposite to a grated window, through which he gazes at the mirror, and offers up his prayers, with a sacrifice of rice, fruit, tea, or the like. This done, he drops his coin in the money-box and retires. The money thus contributed is applied to the support of the *Kaminusi* or priests of the temple.

The religion of Buddha is said to have been first introduced into Japan A.D. 69, but to have made very little progress until the sixth century. It is now by far the most prevalent religion in the country, but is much mixed up with the ancient worship, and the ancient worship with it. The philosophy of Confucius was early introduced into Japan, but is confined to the higher and more educated classes. It is rather a system of philosophy than a religion; it inculcates no particular faith and can accommodate itself to any. It is compounded of most of the moral precepts of Confucius and some high mystic Buddhist notions. In some of its features it borders closely on Pantheism. It has no religious rites or ceremonies of its own. Of the two principal religions it would appear that there are many sects. Liberty of conscience, so far as it does not interfere with the interests of the government or affect the peace and tranquillity of the empire, has been at all times allowed. It was on political, and not on religious grounds, that Christianity was driven out. A curious illustration of this toleration is given in an account of the shipwreck on the coast of Japan of a governor-general of the Philippines in 1608 on his return to Spain, and of which an abstract was published in the *Asiatic Journal* for 1830. It is as follows:—"There are no less than thirty-five different sects or religions in Japan. Some deny the immortality of the soul, others acknowledge divers gods, and others adore the elements. All are tolerated. The bonzes of all the sects having concurred in a request to the emperor that he would expel our monks from Japan; the prince, troubled with their importunities, inquired how many different religions there were in Japan. Thirty-five, was the reply. 'Well,' said he, 'where thirty-five sects can be tolerated, we can easily bear with thirty-six; leave the strangers in peace.'" The testimony of Golownin is to the same effect in reference to religious toleration. "The difference of religion and sect," says he, "in Japan does not cause the smallest embarrassment to the government or to private persons. Every citizen has a right to profess what faith he pleases, and to change it as often as he thinks fit. No one cares whether he does so from conviction, or from regard to interest. It frequently happens that the members of one family follow different sects, yet this difference of faith never occasions ill-will or disputes. The making of proselytes, however, is prohibited by law." Japan. According to the same writer, not only is any belief tolerated, but even the absence of all belief; in short, every mood of mind that does not vex the political peace of the empire.

Education. Education, in so far as this consists in reading and writing, is universal even among the lowest ranks in Japan. There are colleges and academies throughout the empire in all the principal towns. There would seem also to be something like a national system of education, for Meylan states that the children of both sexes, and of all ranks, are invariably sent to rudimentary schools; but whether or not these are supported by the State he does not say. Here the pupils are all taught to read and write, and are initiated into some knowledge of the history of their own country. There are immense numbers of cheap easy books continually issuing from the Japan press, designed for the instruction of children or poor people. Books of a higher order are produced for the rich and better educated—reading being a favourite occupation with both sexes. The city of Mikado appears to be the great literary metropolis of Japan, and the residence of the literati. Printing from blocks after the Chinese fashion was introduced in the beginning of the thirteenth century. Books are profusely illustrated with wood-cuts engraved on the same block with the types, and the Japanese are not ignorant of the art of printing in colours.

Trade. The Japanese carry on a large internal traffic, which, from the peculiar characteristics of their country, is in a great measure by coasting. The numerous straits and creeks, with their shallow waters, though generally unfit for ships of burden, are sufficiently commodious for the small craft of the Japanese, which rarely exceed 60 tons burden. The inland transport is by horses, oxen, and porters, there being very little river or canal navigation. Kæmpfer, who, however, refers to the busiest parts of the country, that between the chief port Osaca and the two capitals, speaks of its commercial activity as follows;—"How much is carried on between the several provinces of the empire! How busy and industrious the merchants are everywhere! How full their ports of ships! How many rich and mercantile towns up and down the country! There are such multitudes of people along the coasts and near the seaports; such a noise of oars and sails and numbers of ships and boats, both for use and pleasure, that one would be apt to imagine the whole nation had settled there, and all the inland parts were left quite desert and empty." This was said 160 years ago, and it may be safely assumed that the uninterrupted peace which the country has since enjoyed has not impaired its commercial prosperity. That the Japanese are a commercial people may be inferred from the order, neatness, and propriety with which everything connected with their trade is conducted. They have gold, silver, and copper money, as well as bills of exchange. Their shops have signs, and their goods are packed and labelled with a truly mercantile care and neatness.

The foreign intercourse of Japan was, more than two centuries, and till within the last two years, solely confined to the Dutch and Chinese. Even with these the trade was limited, being with the Dutch for a considerable time restricted to a single ship annually, and with the Chinese to ten junks. The exports and imports were even limited as to value, and the sales and purchases fixed by a tariff of the Japanese government. The Dutch were confined to the

Japan. small island of Dezima, in the harbour of Nagasaki, which is only about 640 feet in length by 240 in extreme breadth. A small stone bridge connects the island with the town of Nagasaki, and a strong Japanese guard was always stationed here, no one being allowed to pass either to or from the island without license. The whole island is surrounded with a high fence, on the top of which are placed iron spikes. On the N. side are two water-gates which were kept always shut, except to admit or let out the Dutch vessels. When a ship arrived her guns and ammunition were first taken out, and she was afterwards searched in every part, and an exact list made of everything on board. The crew were then permitted to land on the island, where they were kept, as long as the ship remained, under the inspection of guards. Every Japanese official at the Dutch factory was bound twice or thrice a year to take a solemn oath of renunciation and hatred of the Christian religion, and was made to trample crosses and crucifixes under his feet. The Dutch were at all times surrounded by Japanese spies, whom they were obliged to employ as interpreters, clerks, servants, &c.

As the empire is again in some measure thrown open to foreign intercourse, it may not be unprofitable to speculate on the nature and value of a trade with it. The commodities which have been chiefly in demand in Japan, are iron, steel, lead, tin, quicksilver, cinnabar, sapan-wood, black pepper, cloves, nutmegs, sugar, putchuk, deer-skins, ivory, Chinese and Tonquin raw silk, Indian cotton goods, cotton yarn, mirrors and other glass ware, and English woollens. At one time or another all these articles found a market in Japan, and most of them are imported by the Dutch or Chinese at the present time. In a free trade, or any approach to it, with Japan, we may suppose that iron and steel, high-priced commodities there, would become staple imports. The climate would give rise to a consumption of woollens; and although the Japanese are clothed in their own cottons, judging from what has taken place in India where both the raw and wrought articles are cheaper than in Japan, we may infer that cotton fabrics might be imported with advantage. Cotton yarn or twist has long been one of the regular articles of import, although it was long the high-priced manufacture of Java spun with the distaff that was imported. Mirrors and glass ware would, no doubt, find a ready mart. Sugar would certainly be in demand as Japan produces none; and the same may be said of nearly all kinds of spiceries and dyewoods. Even cotton wool and rice might be occasionally imported, as they are regularly into China. According to M. Caron, whose information refers to 1636, or the period preceding the last persecution, the European nations imported annually into Japan from 540,000 to 675,000 lbs. of Chinese raw silk, 200,000 deer-skins, and 100,000 other kinds of peltry.

With respect to the exchangeable products from Japan, gold, silver, and copper were largely exported when the trade was open. While the Dutch were carrying on their trade at Firando, and still unrestricted, they exported annually gold to the value of L.470,000, and silver to from L.330,000 to L.385,000. But the Spanish and Portuguese trade was free at the same time, and these nations are stated to have exported more largely, so that we may conclude that a million and a half of the precious metals were, from near the beginning to near the middle of the seventeenth century, exported from Japan. Of copper, the Dutch exported in some years as much as 1800 tons. Most important, however, in this part of the world will be the supply of coal which the islands are said to furnish abundantly. It will also be seen from what we have already said of the productions of the country, that there are many things among them that may become valuable as exports, while a demand for other articles will no doubt lead to their introduction as subjects of trade.

After the expulsion of the Portuguese in 1639, and before the restrictions were so stringent as they afterwards became, the entire value of the foreign trade was estimated by the Dutch governor-general, the Baron Van Imhoff, at L.833,000; while in his own time (1744) it had declined to L.264,583, of which one-third only was Dutch, the rest being Chinese. In 1805 the cargoes of two ships laid in at Batavia, were sold in Japan for L.35,416, with which, or rather with the balance after deducting heavy local charges, copper and camphor were purchased, which in Batavia sold for L.195,773. The adventure of next year was neither so large nor so prosperous, for the outward cargo brought in Japan only L.24,325, and the return cargo of copper and camphor produced when sold in Batavia only L.101,644. These favourable speculations, however, arose entirely from the enormous war prices for copper and camphor. Since then the trade has become still smaller, and as already stated, is confined to a single ship. In the earlier period of its trade Japan was not only free to all the world, but was not even burdened with imposts on either ship or cargo: presents, however, required to be made to the emperor, the provincial governors, and one or two other parties. Japan.

Moneys. The ordinary modern gold coin of Japan is an oblong and thin piece rounded at the ends, and impressed with some symbolical Chinese characters. It is of no more than 16 carats, and contains 37·5 per cent. of copper. It weighs 180 grains, and is of the value of 21s. 3d. or nearly that of our guinea. It goes, among Europeans at least, under the name of a kupang. Previous to 1700, the gold money which had been coined was a piece weighing 275 English grains of 22 carats fine, and of the value of L.2, 4s. 7d.; but in that year, and continued to 1730, the government, perhaps actuated by a rise in the price of gold from the large quantities of it which had been exported, began to tamper with the coin, and insisted on the new coin, reduced in weight and standard, being received at the same value as the old, although of less than half its value. Besides the ordinary gold coin, there is another of three times its value, and a small coin of the value of about 3s. 6d. The principal silver coin, called by the Dutch a schuet, or boat, from its shape, is of the value of 16s. 3d. Notwithstanding the existence of these coins, mercantile transactions are conducted by silver ingots as in China, and these are usually of the fineness of $\frac{11}{12}$. The small change of Japan consists, like that of China, of small pieces of copper or brass with a hole in the middle, and of these 600 are reckoned to the tail weight of silver, itself of the value of about 5s. 6d. Accounts are kept in tails, divided into ten parts called mas, and these into 100 parts.

History. In history, the Japanese do not make the same pretence to extravagant antiquity as the Hindus and Chinese. They are content with going back to the commencement of the reign of their first spiritual monarch, whose name was Sinmu, or at full length Sinmu Tenu, meaning "the supreme of all men," and the "divine conqueror," a descendant of the gods. He was the first emperor, the supposed civilizer of the Japanese, and ascended the throne 660 B.C. From him to A.D. 71, there reigned only ten emperors, which gives an average of 73 years to each reign! The first of these emperors is reported to have lived 167 years, and to have reigned 79, and the last of them to have lived 139 years and to have reigned 98. From A.D. 71 to 1690, there reigned 104 emperors, which makes the average duration of a reign in this period only 15 years and 7 months, its shortness being in a good measure ascribable to the very frequent practice of abdication, sometimes voluntary, and sometimes compulsory. Borrowing from Kæmpfer, we may notice a few of the most remarkable events of this long period. In 693 the art of brewing saki was discovered. In 749, gold, which had heretofore been imported from China, was first discovered in Japan. In 788 a strange people, not Chinese, invaded Japan, and their final expul-

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sion involved a war of eighteen years. In 1147 was born Yoritomo, the first secular emperor. Placed in command of an army to suppress a rebellion, this personage used the power thus entrusted to him for his own aggrandizement, by usurping nearly the whole temporal power of his sovereign, leaving him little more than the spiritual, and thus establishing the form of government which has existed down to our times. In 1284 the Mogul Tartar conquerors of China invaded Japan with an armada of 4000 ships, carrying a force, according to the Japanese, of 240,000 men. This was the celebrated expedition of Kublai Khan (grandson of the renowned Jenghis), the patron of Marco Polo. This great armada, like the Spanish against our own country, was nearly destroyed by a storm. Had it effected a landing in sufficient force, it is probable that it would have made a conquest of Japan, as the people who fitted it out had just made of China.

Japan was first made known to Europe by Marco Polo, who was in China at the time of the Mogul expedition. This, however, did not lead to its discovery. A Chinese junk, manned by Portuguese, was driven upon its coasts by a storm in 1542, forty-four years after the arrival of the Portuguese in India. In 1549, seven years after the discovery, the Jesuits, headed by Francis Xavier, the famous apostle of the Indies, made their appearance in Japan, and forthwith the labour of converting the inhabitants went on prosperously until 1587, or for thirty-eight years, when it was partially arrested by the first persecution, which was of no great severity. That took place under the Emperor Taico Sama, the most illustrious of all the secular emperors of Japan—a man who, by mere force of character, had, from the condition of a hewer of wood, raised himself to the throne. "The heathen priesthood," says Kæmpfer, "took alarm at the rapid spread of Christianity; and, in 1587, the emperor issued a proclamation prohibiting his subjects, under pain of death, from embracing the new religion; and several persons were executed for disobedience." It does not appear, however, that more than six or seven and twenty suffered on this occasion. The son of Taico, himself an usurper, was dethroned by another usurper; and under him the persecution of Christianity became terrible, for, in 1590, it is stated that no fewer than 20,570 Christians were put to death. Another persecution followed in 1597, when among others that suffered were some European priests, who were crucified. After this, however, a lull of forty years took place, when the persecution was renewed in 1637; and in a single day of the ensuing year, the 12th of April, 37,000 Christians were put to death. The persecutions of Roman emperors were trifles to such wholesale butcheries. For the two following years the Spaniards and Portuguese were finally expelled the empire. The Romish priesthood boast that before the first persecution they had made 1,800,000 converts, and that in the year that followed it they had made 12,000; so that in all they had probably converted not fewer than two millions of the Japanese, reckoning among their proselytes several of the vassal princes.

The decree which isolated Japan from the rest of the world is as follows:—"No Japanese ship or boat whatsoever, nor any native of Japan, shall presume to go out of the country. Whoso acts contrary to this shall die, and the ship, with the crew and goods aboard, shall be sequestered, till further orders. All Japanese who return from abroad shall be put to death. Whoever discovers a Christian priest shall have a reward of from 400 to 500 schuets (from L.305 to L.381), and for every Christian in proportion. All persons who propagate the doctrine of the Christians (the worship of the fathers), or bear this scandalous name, shall be imprisoned in the Ombra or common jail of the town. The whole race of the Portuguese, with their mothers, nurses, and whoever belongs to them, shall be banished to Macao. Whoever presumes to bring a letter from abroad, or to return after he has been banished, shall die, with all his family; also whoever presumes to intercede for him shall be put to death. No nobleman nor any soldier shall be suffered to purchase anything of a foreigner."

Japan.

The Japanese government acted fully up to the letter of its bloody decree of prescription. In 1640, three years after its publication, and the year which immediately followed the practical expulsion of the Portuguese and Spaniards, the Portuguese government of Macao sent a mission to Japan, which, with its retinue, amounted in all to seventy-three persons. On their arrival at Nagasaki, the parties were arrested, and an order came in due time from the capital directing them to be beheaded, and it was carried into effect on all but twelve of the meanest persons, reserved for the purpose of carrying back a threatening message, to the effect that, "Should the king of Portugal, nay, the very God of the Christians, presume to enter his dominions, he would serve them in the very same manner."

The ceremony of trampling on the cross was instituted on the expulsion of the Christians, and seems still to be persevered in. It seems, however, always to have been confined to those parts in which the Christian religion had obtained the chief footing,—namely, the town of Nagasaki, and the provinces of Omura and Bungo, in the island of Kiu-siu. This is Kæmpfer's account of it:—"Another solemn and important act, in their opinion, is performed in the beginning of the year. This is the Jefume, that is, in the strictest sense, 'the figure-treading,' because they trample over the image of our blessed Saviour extended on the cross, and that of his holy mother, or some other saint, as a convincing and unquestionable proof that they for ever renounce Christ and his religion. This detestable solemnity begins in the second day of the first month."

The proscription of one particular form of worship, while so many other religions or sects were tolerated, or viewed with indifference, is easily explained. The new religion was propagated by an energetic race of men, and its votaries inspired with an active zeal unknown to all the old forms of worship. Christianity, in a word, was proscribed, not on account of its tenets, but on account of the danger apprehended from those who taught it. The persecution was not a religious, but a political one. Its ministers and followers threatened the subversion of the native government and institutions, and the substitution of a foreign yoke. They were deemed guilty of high treason, and punished according to the bloody code of Japan. According to Japanese notions, a dangerous insurrection was suppressed by the extermination of the insurgents. In this matter the Japanese acted with foresight; for there can be little doubt but that the Portuguese and Spaniards would, in due course, and through the instrumentality of the Catholic religion, have effected the conquest of Japan, unless we suppose them, which is highly improbable, to have acted with a forbearance which neither Spaniards, Dutch, nor English have exhibited in other parts of the East. The Japanese not only saw this, but very plainly expressed it. Thus, when the Spanish governor of the Philippines, in the year 1597, sent an envoy to the Emperor Taico Sama to remonstrate with him respecting his persecution of the Christians, he thus addressed the Spanish official,—"Conceive yourselves in my position, the ruler of a great empire, and suppose certain of my subjects should find their way into your possessions, on the pretence of teaching the doctrine of Sinto. If you should discover their assumed zeal in the cause of religion to be a mere mask for ambitious projects; that their real object was to make themselves masters of your dominions, would you not treat them as traitors to the state? I hold the Fathers to be traitors to my state, and as such I treat them."

The priests of the various ancient forms of worship, a numerous body,—for in the ecclesiastical capital alone they

Japan. amounted to 52,169, with 6020 temples,—were equally interested with the government in the suppression of the rival, and to them dangerous religion. The violence, insolence, and indiscretion of the Fathers, provoked the native priesthood beyond bearing. The Jesuits eulogise one of the converted tributary chiefs for his zeal, alleging that he had destroyed heathen temples and monasteries reckoned by some at no fewer than 3000. Some of these tributary princes even went the length of sending an embassy to the Pope, and king of Spain, which the emperor would not fail to consider as an act of high treason. About the time that the first edict against Christianity was published, the emperor, who was the celebrated Taico Sama, despatched two imperial commissioners to Father Cuello, the vice-provincial, demanding an answer and explanation to the following questions:—"Why he and his associates forced their creed on the subjects of the empire? Why they incited their disciples to destroy the national temples? Why they persecuted the Bonzes? Why they and the rest of their nation used for food animals useful to man, such as oxen and cows? And finally, why they permitted the merchants of their nation to traffic in his subjects, and carry them away as slaves to the Indies?" Evasive answers only were given to these demands, but the destruction of the temples and the traffic in slaves were not denied. With such provocations as these, we cannot wonder at persecution, although shocked at the ferocity and vindictiveness of its excesses. "Now," says Kæmpfer, "as to the fall of the Portuguese, I heard it often affirmed by people of great credit among Japanese themselves, that pride and covetousness in the first place,—pride amongst the great, and covetousness in the people of less note,—contributed very much to render the whole nation odious." In our time the persecution, with the murder of ambassadors, would certainly be avenged by an invasion, very probably ending in a conquest of Japan. Even in the seventeenth century, Spain would probably have engaged in such an enterprise from the Philippines, had she not about this time been separated from Portugal; and the naval superiority of the Dutch, in alliance with the Japanese, proved an insuperable obstacle.

The Dutch made their first appearance in Japan in 1600, fifty-eight years after its discovery by the Portuguese, and about half-a-century after the latter nation had been carrying on trade with it. In common with the Portuguese, and eventually with the Spaniards, they carried on with it an active and profitable intercourse, down to the time of the exclusion of these two nations. The seat of this commerce was Firando, in the island of Kiu-siu. When the last persecution of Catholic Christianity was in progress, the Dutch furnished information of the political intrigues of their commercial rivals to the Japanese. They were called upon to assist in destroying the last refuge of the Japanese Christians in Simabarra, in Kiu-siu, and effected with the cannon of their ships what had baffled the skill of the imperial forces. This last event happened in 1639, and two years after, imperial commissioners arrived in Firando to remonstrate with them respecting what appeared to be very venial proceedings. They were thus addressed: "In former times, it was well known to us, that you both served Christ, but on account of the bitter enmity you ever bore each other, we imagined there were two Christs. Now, however, the emperor is assured to the contrary. Now, he knows, you both serve one and the same Christ. From any indication of serving him, you must for the future forbear. Moreover, on certain buildings which you have newly erected, there is a date carved, which is reckoned from the birth of Christ. These buildings you must raze to the ground forthwith." The order was incontinently complied with, but their prompt obedience did not save the Dutch from being removed in 1641 from Firando and its comparative liberty to the virtual imprisonment on the island of Dezima in the harbour of Nagasaki.

In 1613 we have the first authentic information of the Englisn having attempted an intercourse with Japan, but it is certain, from the accurate information concerning it given by the Elizabethan writer whom we have more than once quoted, that they must have frequented it much earlier. William Adams, an Englishman, who acted as pilot to the first Dutch vessel that arrived at Japan, and had settled there, induced his countrymen to attempt to establish a trade. Accordingly, a ship called the Clove, commanded by Capt. John Saris, whose name we have had occasion to mention more than once already, was despatched for Japan, and reached Firando on the 11th of June 1613. Japan.

Adams, who stood high in favour, obtained for his countrymen a most favourable reception, and, in a letter to the King of England, the emperor desires "the continuance of friendship with your Highness—and that it may stand with your good liking to send your subjects to any part or port of our dominions, where they shall be most heartily welcome; applauding much their worthiness in the admirable knowledge of navigation, having with much facility discovered a country so remote, being no whit amazed with the distance of so mighty a gulf, nor greatness of such infinite clouds and storms, from prosecuting honourable enterprises of discoveries and merchandizing—wherein they shall find me to further them according to their desires." The English, however, did not succeed, and, after a ten year's trial, in which they expended L.40,000, they withdrew from the country.

In 1653 a fruitless attempt was made to renew our intercourse with Japan, said to have been defeated by the Dutch informing the Japanese that the Queen of England was a daughter of the King of Portugal. The failure is not to be regretted, since it is certain that under the blighting influence of a monopoly, trade could not have prospered in Japan, or anywhere else.

It is not necessary to advert to any of the subsequent small and futile attempts made to open an intercourse with the long-locked empire of Japan, since they are all superseded by the more successful attempts recently made.

To America undoubtedly belongs the credit of having been the first to re-establish commercial relations with Japan. The increased traffic in this part of the world, particularly between Eastern Asia and North-Western America, and the importance of the whale-fishery in the Japanese seas, had rendered it very desirable to have free access to at least some of the ports of Japan. Repeated attempts had been made by England, Russia, and the United States, but without success, when at length the United States government resolved to make an effort worthy of the object, and accordingly fitted out an expedition under the command of Commodore M. C. Perry. The commodore sailed from Norfolk in the Mississippi war-steamer, on 24th November 1852, to be followed as soon as possible by the other vessels of the expedition. He arrived in the Bay of Yeddo on 8th July 1853, with four vessels, two war-steamers and two sloops of war, and after some negotiations he delivered the letter of the President, promising to return for an answer in the spring. The rest of the year was spent at Loo Choo and China, and on 12th February 1854, the squadron reappeared in the Bay of Yeddo, having by this time been increased to nine vessels, three steam-frigates, four sloops of war, and two store-ships. A treaty was concluded on the 31st of March, in terms of which the ports of Simoda in the island of Nipon, and Hakodadi in Yesso, are opened for the reception of American ships, where they will be supplied with wood, water, provisions, coal, and other articles, so far as the Japanese possess them. Ships in distress, or from stress of weather, may enter other ports; and seamen shipwrecked on any part of the coast are to be aided and carried to either Simoda or Hakodadi. Shipwrecked seamen and others temporarily residing at these ports are, at Simoda, free to go anywhere

Japanning.

within the limits of 17 English miles from a small island in the harbour, and in like manner at Hakodadi within 12 miles. Ships of the United States are also permitted to trade under such regulations as shall be temporarily established by the Japanese government for that purpose. All the privileges that may hereafter be granted to any other nation are to be accorded to the United States. On the 7th of September following, an English squadron, consisting of a frigate and three steamers, under the command of Rear-Admiral Sir James Stirling, entered the harbour of Nagasaki. The primary object of this visit to Japan was to search for Russian vessels, but it was also intended to attempt to establish friendly relations between the two nations. A treaty was entered into, the effect of which is to open absolutely and at once to British ships of every description, for effecting repairs and obtaining fresh water, provisions and other supplies, two of the most convenient harbours in Japan—Nagasaki and Hakodadi;—to open inferentially to British ships in distress any other port in Japan it may be expedient for them to seek shelter in; to secure eventually to British ships and subjects in every port of Japan which may hereafter be open to foreigners, equal advantages with the ships and subjects of the most favoured nation, excepting only the advantages at present accorded to the Dutch and Chinese. It imposes, in return for these concessions, no other obligation on British ships and subjects than that of respecting the laws and ordinances of the ports they visit. More recently the Russians have succeeded in obtaining a similar footing in Japan. (J—N C.)

Jarnac ‖ Jaroslav.

JAPANNING, a species of lac-varnishing, in imitation of the lacquered ware of Japan, which, with that of China, is esteemed the best in the world. The ware may be lacquered upon wood, metal, or *papier-maché* grounds. A description of the process as practised in China may serve to explain the sources of superiority. The article, if of wood, being made very dry, light, and smooth, is primed with a mixture of ox gall and rottenstone, which is rubbed smooth before the varnish is applied. The varnish is composed of 605 grains of gum-lac in 1200 grains of water, to which are added 38 grains of oil of *Camellia sasanqua*, a pig's gall, and 19 grains of rice vinegar. The ingredients are well mixed in full daylight, when the varnish gradually deepens into a brilliant black. A very thin coat of this varnish is applied with a flat hair brush. The article is left in a steamy heat, and is then rubbed down in water with very fine pumice. A second coat of lac varnish is next applied, and the polishing is repeated, which two operations are continued until a perfectly even and brilliant surface is attained, a finer quality of lac being used for the later coats, of which there are never less than three, nor more than eighteen. The object is ornamented by an artist, who draws the design in white lead, engraves it, and fills up the details. The article is next painted with the camphorated lac of Kouang-si, which serves as a basis for the gilding. It is completed by varnishing.

In our method of japanning, the wood intended for the best works is thoroughly dried, since any warping or shrinking would be fatal to the finished surface; for which purpose well seasoned wood is cut nearly into the required forms, and exposed for several days to a gradually increasing heat in the japanner's stove. The articles are then finished as to form, and are again stoved, after which the cracks are stopped with putty or white lead. For black japanned works, a ground of ivory black mixed with dark-coloured animè varnish is applied. This is dried in the stove, and coated with varnish three or four times, the work being stoved between every two coats. For coloured grounds, the varnish mixed with the proper colour is laid on in one or two coats, and the work is completed by several successive varnishings and dryings. Ordinary painters' colours ground with linseed oil or turpentine and mixed with animè varnish are employed for various black or brown surfaces with gilt edges, imitations of marble, fine-grained woods, tortoise-shell, &c. The colours mostly used are flake-white or white lead, Prussian blue, vermilion, Indian red, king's yellow, verdigris, lamp-black, and the various tints produced by their admixture. The varnishes used are copal, seed-lac, animè, and mastic. The lac varnish is the best for hardness, but its colour prevents its use for delicate grounds, so that for such purposes it is either mixed with gum varnish, or copal varnish is used instead. Copal or animè varnish made without driers is applied, in from two to six coats, after the colour has been laid on. (See VARNISH.)

Japanners sometimes use a priming of size and whiting, which is laid on with a brush, and left for a day or two to dry; it is then made smooth by rubbing with rushes and a wet cloth. When this is quite dry, the grounds are laid on, and finished by varnishing and polishing with rottenstone, or in the case of a white ground, with putty or starch, and oil. It must, however, be remarked, that a priming, or artificially prepared ground, is objectionable, the japanning being more liable to crack than when executed on the actual surface of the object itself. A gold ground is formed by varnishing the work with japanner's gold size, and when nearly dry, but still clammy, covering it with gold dust applied on a piece of wash-leather; the effect of such a ground when highly varnished is very brilliant. Japan work is ornamented with drawings or engravings on the principle of transfer, for which purpose the engraving is printed, or the drawing executed on fine paper previously prepared with a coat of isinglass or gum water. When this is dry it is placed face downwards upon the japan ground, which is covered with a thin coat of copal varnish. A sponge dipped in warm water is then applied to the back of the paper, which dissolves the isinglass, loosens the paper, and leaves the print on the work. Another method is to execute the print on an elastic composition of glue, &c., which receives the impression well, and can be laid down at once on the japanned surface. The whole of the processes require so much drying, that stoves are requisite to hasten the work.

The great demand for japanning is for works in *papier maché*, to which article we must refer for further information on the subject. Common articles of furniture are sometimes said to be japanned, thereby implying that they are more durable than common painted articles. The term as thus used is, however, incorrect, since the colours employed on such common works are only mixed with turpentine instead of oil.

For japanning works in metal, they are cleaned with turpentine to get rid of grease or oil, unless the oil should be linseed, in which case the articles are stoved until the oil becomes quite hard. Japanning is then performed in the usual manner. See LAC, LACQUER. (C. T.)

JARNAC, a town and commune of France, department of Charente, 8 miles E. from Cognac, and 15 from Angoulême. The town stands on the N. side of the River Charente, which is here crossed by a suspension bridge. It was here that the Prince de Condé fell when fighting with but a handful of men against the forces of the Duc d'Anjou. Brandy is distilled at Jarnac in large quantities. Pop. 3360.

JAROSLAV, a government of European Russia, bounded N. by the government of Vologda, W. by those of Novgorod and Tver, S. by that of Vladimir, and E. by that of Kostroma, between N. Lat. 56. 40. and 59., and E. Long. 37. 40. and 41. 20. It is 155 miles in length from N. to S. by 140 in breadth, and contains an area of 14,000 square miles The surface of the country is regular, and in many

Jaroslavl.

parts even flat and marshy. The principal rivers are the Volga flowing from the N.W. to S.E., and its tributaries the Mologa and Sheksna. Several lakes occur in the S., the largest of which, called Nero, is 11 miles long and 5 miles in breadth. The soil in general is not very good, being in some places too dry, and in others too damp. Agriculture is consequently confined to the river sides, where the soil is subject to natural drainage, and the communication is rendered easy. Rye, flax, and potatoes form the chief products. The first, however, is not grown to an extent sufficient for the consumption of the province, and is imported down the Volga from the neighbouring governments. Extensive forests in the interior of Jaroslav at one time proved a source of revenue to a large portion of the inhabitants, but now from want of state protection they have been much destroyed, and fuel is consequently scarce. Some cargoes of fir deals, however, as well as tar and turpentine, are annually shipped to Archangel for exportation. The central position, however, which this government holds, affords greater scope for manufacture than agriculture. Linen, silk, calico, lead, and bell metal are fabricated in considerable quantities at Jaroslav, Mologa, and Rybinsk. The latter town enjoys an important transit trade; all the grain, flax, hemp, &c., brought up the river being either transhipped into lighters for navigating the narrower streams in the N., or unshipped there for manufacturing purposes. On an average 2000 vessels arrive annually at this river-port from the S., and about 8000 depart for the N. The trade of Rybinsk is rapidly on the increase. In habits the people of Jaroslav present the same general features as those of the other Russian provincials. The poorest of the peasantry leave their homes to work at the harvest in the neighbouring provinces, returning with a competency for the winter, which they spend in comparative idleness. Several of the villages are occupied solely by serfs, who work collectively at their respective trades, each village having its peculiar manufacture—one for shoemaking, another for tailoring, and so on. These serfs pay an annual fee to their masters, but are under no restrictions in their work. The gardeners of the province have long been noted for their skill in horticulture, and can always obtain high wages in other parts of the empire. The government of Jaroslav is divided into the five circles of Poschechon, Mologa, Rybinsk, Rostov, and Danilov. Pop. (1851) 943,426.

JAROSLAVL, a town of Russia, capital of the above government, situated in the angle formed by the confluence of the Rivers Volga and Katarosst, 480 miles distant from St Petersburg, and 163 miles from Moscow. It is one of the most ancient cities in the empire. Since the reign of Katherine II., who introduced German customs into the town, and otherwise took interest in its prosperity, Jaroslavl has steadily increased in importance and population. In appearance it resembles other Russian towns, the streets and squares being wide. The houses are built of wood and stone in about equal numbers, and the town is surrounded by a palisade. Five of its suburbs are on the right bank of the Katarosst, and one on the left side of the Volga. Handsome villas line the river sides in the neighbourhood. The town contains 6 government offices, all of stone, and 24 churches and religious houses, 13 of which are stone, the others wooden. In gratitude for a lyceum which Prince Demidoff founded and endowed, the inhabitants have raised a monument to him in the public square. Besides this institution there are 4 public seminaries, 2 theological and 2 secular, with about 1300 scholars each.

Jaroslavl, conjointly with Rostov, is the see of an archbishop. It is principally noted for its manufactures, which include linen, calico, silk, paper, leather, gold and silver ornaments, &c. The total number of manufactories in the town is 86. The artisans are generally of an intelligent class; they are freed from any tax on trade. The municipal government is in the hands of the citizens, according to certain qualifications, which, however, are possessed only by a few. The population of Jaroslavl in 1851 amounted to 29,332 persons.

Jaroslaw || Jassy.

JAROSLAW, a town of Austrian Gallicia, circle of Przemysl, on the San, a tributary of the Vistula, 17 miles N.N.W. of the town of Przemysl. It has a castle belonging to Prince Czartorysky, a cathedral, normal school, and manufactures of woollen and linen cloths. Pop. about 4000.

JASHER, THE BOOK OF, a work mentioned in Joshua x. 13, and 2 Sam. i. 18, and which, especially in recent times, has occasioned much controversy. The two passages connect the book with two poetical compositions, and from this circumstance Lowth has supposed that it was a collection of national songs; and that the name applied to it was the first word of the first poem, *Jasher—he sang,*—this being the common way in which the Hebrews gave names to books. A more general belief was that founded upon a different meaning of the word, according to which it was supposed to consist of a series of biographies of just men —*Jasher* meaning *just.* In early times Theodoret thought the whole book of Joshua to be a quotation from Jasher, while Jerome considered Genesis and Jasher to be the same. Some thought Jasher to be the Pentateuch; others, the book of Judges, and others again conjectured that it was a treatise on archery. This last opinion was founded on a mistaken notion of the passage in David's lamentation over Saul, where when he says that the children of Judah were taught the use of *the bow, the bow* is imagined to be the name of a poem so called from its initial word. In the thirteenth century, a book on Jewish laws, by Rabbi Tham, was called Jasher; and another, which was printed in 1625, professed to have been preserved by an old man at the destruction of Jerusalem. In 1751 an impudent forgery was palmed off upon the public, under the name of the *Book of Jasher*, by a type-founder of Bristol of the name of Jacob Hive. The preface to the book gave an account of the pretended discovery of the original in the city of Gazna in Persia by Alcuin, who is also said to be the author of the English translation. This forgery was revived in 1827, and would scarcely deserve so much notice were it not for the learned critiques to which it gave rise. (See HORNE'S *Introduction.*) The subject of Jasher has been again revived by the publication in 1854 of a work by Dr Donaldson, entitled *Jasher Fragmenta Archetypa Carminum Hebraicorum in Masorethico Veteris Testamenti textu passim tesselata*, &c. According to this author, the Old Testament is a new building consisting of materials taken from the dismembered book of Jasher, and these materials he restores to their primitive place. The present arrangement of the Old Testament, according to Donaldson, was effected by men thoroughly incompetent to the task; and amongst other discoveries which he has lived to make are these,—that Moses did not write the Pentateuch; that Shem, Ham, and Japhet were the three sons of Adam; that Abraham was the son of Abel; that the Song of Moses was written in the time of Solomon, and the Song of Hannah by David.

JASSY, the capital of Moldavia, situated on the left bank of the Baglui, a tributary of the Pruth, about 200 miles N.N.E. of Bucharest, and 130 miles N. of Galatz, in N. Lat. 47. 3., and E. Long. 27. 22. It stands partly on a plain and partly on a hillside, in the midst of a country rich in agricultural produce. The area of the town is very extensive, and quite out of proportion to the number of houses. All the public buildings, and most of the private dwellings, have pleasure-grounds attached to them which occupy at least one-sixth of the area comprised within the walls. The principal street is broad, and would be handsome were its appearance not disfigured by the booths which line its sides. The other streets are tortuous, narrow, and dirty, while

Jasz-Apathi || Jauts.

most of the houses are built of wood. The pavement consists of oaken planks thrown across the streets, which are so ill compacted that when the river is in flood, the drainage of the city is forced through them and spreads stench and disease around. Like all wooden-built towns it has suffered frequently from conflagrations. The fire of 1827, which was one of the most destructive, reduced half the town to ashes; but the houses destroyed were replaced by others of more substantial and elegant structure, and at present they are the best and cleanest in the city. The principal public buildings are the prince's palace, the church of the "Three Saints," and the monastery of Formosa. Besides these there are 42 Greek churches, 1 Roman Catholic, and 1 English chapel, with 25 religious houses, an hospital attached to the convent of Spiridion, a college, an academy, a scientific institution, and printing press, the only one in Moldavia. The manufactures are confined to the fabrication of canvas for the Turkish markets, and of carpentry; while the trade of the place, dependent as it is on the agricultural products of the country, fluctuates according to the season of the year.

Jassy is the residence of the hospodar, of the foreign consuls, and of most of the boyards of the principality. It is also the see of a Greek archbishopric. The history of the town dates as far back as the time of the Romans, when it bore the name of *Jassiorum municipium*. It was once occupied by a Roman legion. Perhaps there is no European town that has changed masters so often as Jassy; for, placed as it is on the great military highway of the East, and protected by no natural defence, it has become the prey and the camp of every invading host. Between the years 1853 and 1856 it was in the hands of Russians, Turks, and Austrians respectively; and, as always happens in such circumstances, the inhabitants were oppressed and trade extinguished. The population of this town fluctuates from the same cause. Before the Russo-Turkish war of 1853 to 1856 it was computed at 50,000, while in 1856 it was estimated at about 30,000, of whom one-eighth were Jews.

JASZ-APATHI, a town of Central Hungary, 54 miles E. of Pesth. The population, numbering about 8000, is chiefly agricultural; but hemp, silk, and vegetable dyes are manufactured.

JASZ-BERENY, a town of Central Hungary, situate on both sides of the River Zagyva, a tributary of the Theiss, 13 miles distant from Jazy-Apathi, and 41 miles E. of Pesth. It contains a large Roman Catholic besides several other churches, a Franciscan convent, a gymnasium, and council-hall. Tradition points out an old tomb on an island in the Zagyva as that which contains the bones of Attila the Hun, but there is not the slightest historical probability that this is really his sepulchre. Jasz-Bereny has markets for corn, cattle, and horses. Pop. (1851) 16,873.

JAUER, an ancient town of Prussian Silesia, in the government of Liegnitz. The town is situate on the Neisse, at the foot of the Riesengebirge, 38 miles W. of Breslau, and 10 miles S.E. of Liegnitz. It is surrounded by an old wall and contains a castle built by Henry III. in 1244, and now converted into a house of correction and asylum. The manufactures consist of gloves, woollen and linen goods, and tobacco. Its sausages and shoes are exported to great distances. From the rapid current of the Neisse, the town is subjected to frequent inundations. Pop. about 6000.

JAUTS, a people of Hindustan, who have at different times made some figure in its annals. The first historical mention of them occurs at the beginning of the eleventh century, on the invasion of India by Mahmoud the Gaznevide. That conqueror found them established on the eastern bank of the Indus, prepared to oppose his passage. For this purpose they had mustered a large fleet of boats, to the number, according to some accounts, of eight thousand. They were completely defeated, however, and driven into the mountainous districts in the interior of India.

Jauts.

From this time the Jauts remained in obscurity till the reign of Aurungzebe. Churamana, a Jaut of some distinction, collected then some troops of banditti, with whom he began to commit depredations on travellers. Popular and enterprising, he gradually rose from a captain of robbers to be a powerful chieftain; and availing himself of Aurungzebe's absence in the Deccan, became the terror of the country round. He had even the audacity, on one occasion, to plunder the rear of that monarch's army; and, when pursued, took refuge among the mountains of Narwar, where he eluded all attempts to extirpate his force. Under the growing imbecility of Aurungzebe's successors, the Jauts continually extended their power, till at length, during the weak reign of Mohammed Shah, and under their enterprising head, Sooraje Mull, it rose to its utmost height. That chief wrested continually new concessions from the weak emperor, till he was able almost to dictate the counsels of the Mogul Court. A reverse, however, took place on the invasion of Northern India by Ahmed Shah, the sovereign of Cabul. Sooraje Mull, having opposed that invader, saw his territory overrun, and was obliged to seek aid from the Mahratta power. When the Mahrattas, however, invaded Delhi, the Jaut chief went over to Ahmed Shah, and offered to atone for former hostility by his services on that critical occasion. The battle of Panniput followed, in which the Mahrattas were totally routed, and their power for the time entirely broken. Ahmed Shah rewarded the services rendered by his new ally in this hour of need by the important cession of Agra and its district. Sooraje Mull, and his son Jowalier Sing, made repeated attempts to obtain possession of Delhi, but were always baffled by untoward circumstances. Jowalier Sing was assassinated by an impostor, who had undertaken to initiate him in the secret of the philosopher's stone. He left his son an infant; a circumstance which, affording an open field to the dissensions of the chiefs, weakened the Jaut power, and rendered it unable to contend with the other fierce competitors for the spoils of the Mogul. In their contests, particularly with Nujeeph Khan, they were gradually stripped of all their possessions, and at length reduced to the fortress of Bhurtpore, with a small surrounding district. When the British power became predominant in this part of India, Runjeet Sing, rajah of the Jauts, sought security by concluding a treaty with Lord Lake, by which, on engaging to assist Britain against all enemies, he not only retained the internal government of his territories, but was even exempted from paying any tribute.

Yet, in 1805, after the defeat of Holkar, he received that chief, with his discomfited army, into Bhurtpore. The place sustained a most desperate siege, and cost the British army an immense number of lives. At length the rajah, despairing of effectual resistance, agreed to compel Holkar to quit the place, and to give it up to the British, on condition of retaining the government of his territories and the fortress of Deeg. He was obliged, however, to pay twenty lacs of rupees, and to give ample security for a more faithful observance of this treaty than of the former. At a later period, disputes regarding the succession to the throne of Bhurtpore led to the interference of the British. The place was invested by a large force under Lord Combermere; and, on the 18th January 1826, the hitherto impregnable fortress was stormed and taken after a desperate resistance on the part of the Jauts.

JAVA,

Java. THE first in importance, although only the third in magnitude of the islands in the Indian Archipelago, lies between E. Long. 105. 12. and 114. 4. and S. Lat. 5. 52. and 8. 40. In form it is long and narrow, being 666 miles in length from E. to W., by from 56 to 136 in breadth. Area 50,260 square miles. To the N.W., it is parted from Sumatra by a strait, at its narrowest part only 14 miles wide, and with islands between; and to the E. from Bali, by a strait of no more than two miles broad. On its low, and in some measure sheltered N. coast, Java has a good many islands, by far the largest and most important of which is Madura, separated from it by a strait at one part only about a mile wide. On the bold precipitous S. coast there are very few islands, and only two of any considerable size, Baron and Kambangan. The coast line of Java, which is about 1400 English miles in extent, has many bays on its northern coast, but it is not deeply penetrated by any one of them, so that it has properly no harbour but one, that of Surabaya, formed between the main island and Madura, where the strait that divides them is still narrow. The southern coast is still less indented. Here there are two harbours only, Pachitan—inconvenient and unsafe—and Chalachap, formed between the main island and Kambangan, both out of the way of intercourse, and little frequented. On other parts of the S. coast there is no safe anchorage, while dangerous surge rolls in on the shore in all seasons. With the single exception named, the ports of the northern coast are but open roadsteads, with good anchoring ground; but the want of land-locked harbours is not felt so near the equator, where hurricanes are never experienced, and where the weather is only occasionally tempestuous at the change of the monsoons.

The physical outline of Java may be divided into five different sections of various breadth. Beginning from the western end and following the line of the northern coast, the first section ends with the eastern side of the bay of Batavia. This is about 75 miles in average breadth. The second extends E. as far as Cheribon, in Long. 108. 36., and is about 95 miles broad. Both these divisions are mountainous, the mountains being of less elevation than in the other parts of the island, but more crowded, and with narrower valleys. They constitute the proper country of the Sundas, who speak a distinct language, and are less advanced in civilization than the Javanese, the nation which occupies all the rest of the island. The third section extends from Cheribon to the western side of the promontory of Japara, in about Long. 110. 30., and its breadth does not exceed 50 miles, the island being greatly narrowed by the bay which extends for 140 miles from the point of Indramaya to that of Japara. The fourth section extends from the promontory of Japara to that portion of the island which is opposite to the western end of Madura, and this has an average breadth of about 100 miles. The fifth section embraces the remainder of the island, and is no more than 50 miles in breadth. In the three last sections, the mountains are of greater elevation, the plains more spacious, and along their northern coasts there runs generally a belt of alluvial land, varying from 5 to 15 miles in depth.

Physical geography. The geological formation of Java is eminently volcanic. A range of mountains runs in a longitudinal direction through the centre of Java, the peaks of which vary from the height of near 4000 to near 12,000 feet above the level of the sea. No fewer than 46 of these peaks are volcanoes, 20 of which are in a state of greater or less activity. The craters are sometimes of great extent, and their walls illustrate the structure of the mountains, which is either vertical and irregularly columnar, or disposed in oblique or horizontal strata. Java.

Dr Horsfield gives the following account of the most remarkable crater in Java, that of the Tenger Mountain, in the eastern part of the island. "This mountain," says he, "constitutes one of the most remarkable volcanoes of the island. It rises from a very large base, in a gentle slope, with gradually extending ridges. The summit, seen from a distance, is less conical than most of the other principal volcanoes, varying in height at different points, from 7000 to 8000 feet. The crater is not at the summit, but more than 1000 feet below the highest point; and consists of a large excavation of an irregularly circular form, surrounded on all sides by a range of hills of different elevations. It is by far the largest crater in the island, and perhaps exceeds every other crater on the globe. It constitutes an immense gulf, the bottom of which is level, and denominated by the natives the dasar (the floor). This is naked, and covered with sand throughout; in one portion, near the middle, the sand is loose and blown by the wind into slight ridges, and to this the natives give the name of sâgara-wâdi, literally 'sea of sand.' The largest diameter of the crater is, according to my estimate, full 3 miles. From its interior, and towards the middle, there rise several conical peaks, or distinct volcanoes. The chief of these, the Mountain Brama (from the Hindu god Brama, whose emblem is fire), is a perfectly regular cone, and still in partial activity, with occasional eruptions. It is surrounded on one side by the 'sea of sand' above mentioned. Adjoining to it stands another conical peak, more than 1000 feet high, named Watangan (hall of audience), or Widadaren (abode of celestial nymphs), covered externally with sand, quite naked, and, on account of its steepness, its top has never been examined. At a small distance from the Brama rises a smaller cone, called Butak (the bald). The two last have not exhibited any volcanic activity in recent times."

"The range of hills surrounding the Dasar is very steep, and elevated to the N. At the opposite point it is lower, and affords a passage for men and horses; and, while I was occupied in examining the Brama, my assistants amused themselves by galloping over the extensive sandy plain, 6000 feet above the level of the ocean, much to the gratification of the attendant natives. The soil of the Tenger (wide or spacious) Hills is extremely fertile, consisting of a deep vegetable mould, accumulated for many ages on the sand and débris thrown up from the mountain."[1]

The volcanoes afford examples of every kind of volcanic product, as lava, tufa, obsidian, sulphur, and ashes in a high state of comminution.

South of the great central volcano is a range of low mountains skirting the southern shore of the island, and seldom exceeding 3000 feet high. In some places this chain comes into contact with the high central one, and covers its basis; but it is not stratified like the other, although consisting also of volcanic materials, chiefly basalt. Agates, chalcedony, flint, and petrified wood are found in it. The southern shore of the island is frequently bounded by steep and often precipitous piles of trap. Low ranges of limestone are seen in the low lands of the eastern parts of the island. In the western part of it, nearest to Sumatra, a few boulders of granite are occasionally found; but, as a general rule, this rock forms no part of the geological constitution of Java.

[1] *Map of the Island of Java; with the Geographical Preface, &c., of Plantæ Javanicæ Rariores*, by Thomas Horsfield, M.D.

Java.

Hot springs are frequent in many parts of the island, generally at the bases of the volcanic ranges, and several of them strongly impregnated with carbonic acid. Mud volcanoes exist in the low lands, yielding in some cases muriate of soda for culinary purposes.

The valleys of Java are numerous, but its extensive plains are not above six in number. In the first section of the island, or its western end, there is no considerable plain; in the second only one, that of Bandong. In the third and fourth sections there are four great plains, those of Surakarta, Madiyun, Kâdiri, and Malang; and in the fifth, constituting the eastern portion of the island, there are two, those of Bandawasa and Pugar. All these plains are bounded to the E. and W. by mountains varying from 8000 to above 11,000 feet high, which furnish them with a perennial supply of water for irrigation. Although the valleys of Java are frequently narrow, a few of them are spacious, and of equal fertility with the plains.

Java has no extensive collection of water, salt or fresh, and no large lagoons connected with the sea. There exist, however, a few beautiful mountain lakes. One of those lies within the mountain Wilis ("the green"), which parts the plains of Madiyun and Kadiri, and is known by the name of *Gâbal*. There is a second in the province of Cheribon, known by the Sanscrit name of Tàlaga, or the reservoir; and a third is in the province of Pasuruhan and called Bañunila, or the blue-water. In Java, however, there are several extensive marshes, which, in the season of the rains, become lakes, are navigated, and have fisheries.

The rivers of Java, especially on its northern side, are numerous; but, from the form of the island, they are of small size. None of them are navigable for vessels of burden, and few even for boats beyond the reach of the tide. They are all, more or less, obstructed by mud or sand-bars at their mouths. Though of little utility for trade, they are excellently adapted for irrigation. Few of the rivers of Java have specific names, but take their appellations generally from the places they pass by, and change them with every new one, a circumstance which may, perhaps, be owing to their small size and great number. There are, however, a few exceptions in some of the larger, as the Sàraya, a river of the province of Bañumas and the Praga, with its tributaries the Elos rivers of Kadu, all debouching on the southern coast.

The largest and most useful river of the island is that usually called Solo, from its passing the native capital, of which this is the popular name. It has its source in one of the low ranges of mountains towards the southern side of the island, and after a tortuous course of 350 miles, reckoning only from the native capital, it empties itself into the sea by two mouths in the narrow strait between Java and Madura. It is *par excellence* the "great river." Except for the three last months of the dry season, beginning with August, it is navigable for large boats, and for the whole year for small ones. The second river in magnitude is called by the natives the Brantas, but usually by Europeans the river of Surabaya. This also has its origin in one of the low mountain ranges towards the southern coast, receives many affluents, and dividing itself into two branches, enters the sea by two mouths, one in the province of Pasuruhan, and the other in the narrow part of the strait between Java and Madura, passing by the town of Surabaya and contributing to form its excellent harbour.

Climate.

The climate of Java is what may be expected in a narrow sea-girt country between five and eight degrees S. of the equator, having plains almost on a level with the sea, and inhabited land 5000 feet above it. The wet season begins with October and ends with March, and the dry with April, and ends with September. The monsoons are those of the southern hemisphere, the north-western corresponding with the wet season, and the south-eastern with the dry. The setting in of these monsoons is irregular, and, even during their prevalence, there is some dry weather in the wet and not unfrequently rain in the dry. At the equinoxes, when the monsoons change the weather is very unsettled, and most tempestuous at the commencement of the winter solstice in September and October. Thunder-storms are then frequent, and often destructive to life. Land and sea breezes are experienced within 15 miles of the northern and southern coasts, and in particular localities of its eastern and narrowest extremity the south-eastern monsoon blows with great force across the whole island. The temperature, so far as the seasons are concerned, is equable. Near the level of the sea, which is that of the great alluvial band, which runs along the northern side of the island, and of the wide plains of the interior, Fahrenheit's thermometer seldom falls below 70°, and seldom rises above 90°. According to the elevation of the land, every variety of temperature is experienced from this last to 5° below the freezing point. Snow never falls, even on the highest peaks; but on these at the height of the winter, in July and August, ice a few lines thick is formed, and hoar-frost is seen every morning, called by the natives, poison-dew (âmbun-upas), from its pernicious effect on vegetation. In the inhabited mountain valleys, at the height of 4000 feet, the thermometer is usually about 20° below what it is at the level of the sea. Here is experienced a climate agreeable and congenial to the European constitution; and here the corns, fruits, flowers, and esculent vegetables of temperate regions, have long been acclimated.

Java.

In point of salubrity, the climate of the high lands of Java is unexceptionable, and that of the low, containing the mass of the population, is generally equal to that of any other tropical country. In a few spots of the alluvial band of the northern coast, such as Batavia and Cheribon, deleterious malaria have occasionally prevailed, arising from the neglect of canals and water-courses, or from these being obstructed by volcanic débris; but these are exceptions, as are also a few forest tracts of the interior of the island. The extensive cultivation of rice by irrigation might have been expected to generate malaria, but such is not the case, nor has it ever been even alleged to have done so in the country itself.

Botany.

The botany of Java is rich and diversified. Few of the plants being deciduous, the island presents, at all times, the same appearance as the most fertile temperate regions at the height of summer. Its villages, and even its towns, are in a great measure concealed from view, by the luxuriant abundance and perpetual verdure of its vegetation. Patches of sandy shore and lava-covered mountain peaks are the few exceptions. The vegetation varies considerably with the soil, whether composed of the débris of volcanic matter, by far the most prevalent one, or of calcareous rock, or of sandstone. But it varies more according to the elevation of the land, which gives rise to at least six different botanical zones. Of these the learned Dr Bleeker gives the following succinct but spirited description: "It is more especially on the low coast lands that we find superb palms, bananas, aroids, amaranthaceæ, poisonous euphorbiaceæ, and papilionaceous legumens. Scarce have we reached the height of 1000 feet above the level of the sea when our eyes are struck by the quantity of ferns which already preponderate over the other plants. Here, too, we are surprised by magnificent forests of slender bamboos growing spontaneously. The further we ascend, the greater is the change in the aspect of vegetation. Palms and leguminous plants become rare, and bamboos are less abundant. In recompense, we find forests of fig trees with their tall trunks, spreading branches, and thick foliage, enveloping more lowly trees and humbler plants, and exhibiting a majesty which even surpasses the splendour of the palms of the coast. Here,

Java. too, the ferns increase in number and extent, often with trunks several yards in height. Orchideous plants also present themselves in considerable numbers. Sometimes these are found solitary and independent, but more generally as pseudo-parasites, forming, in this case, along with an infinite variety of other plants, an additional vegetation on old trees, hardly distinguishable on this account on first view." "At a height considerably higher, the vegetation still loses nothing of its imposing aspect. The figs here fraternize with gigantic rasimalas (*Liquidambar astingaria*), with white trunks. To the Orchideæ are added Nepenthes, with calyciform flowers (*Nepenthes gymnamphora*); while numerous species of ferns are accompanied by Loranthaceæ and elegant Melastomas. The region of figs and rasimalas is bordered above by that of oaks and laurels, and here the Melastomas and orchideous plants become still more abundant, while the vegetation receives a new ornament in numerous Pandans, particularly the Frecinatias, which are found as pseudo-parasites, rubiaceous plants being at the same time abundant, growing by themselves and flourishing in the shade. There is but one region higher than that of oaks and laurels, where the magnificence of the trees begins to decline. It would seem as if Nature, at the height of 5000 and 6000 feet, having accomplished her masterpiece, becomes powerless to maintain the tropical character of the vegetation. Therefore, rubiaceæ, heaths, coniferous and other plants familiar to countries beyond the tropics, present to us the flora of higher latitudes. Cryptogamous plants, especially, are infinitely multiplied; mushrooms are abundant, and mosses cover the ground and invest the trunks and branches of trees. The ferns are now smaller in size, but play an important part, being of an infinite variety of forms, and constituting the mass of the vegetation." Such is the botanical character of the western or Sunda portion of the island; and although there be several plants peculiar to each, that of the central and eastern or Javanese portion does not materially differ from it.

Zoology. The fauna of Java is proportionally as varied as its botany. Of mammiferous animals alone, it is thought to have no fewer than a hundred species, several of them peculiar to it. There are four species of monkey. Java has one species of sloth peculiar to itself, the *Kukang* or *Stenops Javanicus*. The species of bats are numerous. One of these, the *kalung* of the Javanese, or *Pteropus edulis*, is remarkable for its size and numbers. A flock of these is easily mistaken by a stranger for crows; they are chiefly to be distinguished by their larger size and heavier flight. They feed on fruit, in the course of a night devouring the produce of several trees, and their flesh is considered esculent. The dung of another species, together with that of swallows which dwell in caves and old buildings, affords the only supply of saltpetre in Java and the other islands.

In Java, although the most populous and cultivated island of the Archipelago, wild feline animals are still numerous. The tiger, the same as that of Sumatra, of the peninsula, and of continental India, abounds in all the forests of Java. The leopard is also common, the same litter sometimes producing a black variety of it, in which the spots can only be distinguished in a strong light. Two small species of leopard are also found, *Felis minuta*, and the *Linsanga gracilis*, the last an anomalous animal with some of the habits of a weasel. Of the weasel family, Java has five species, two of which yield musk, and a third is the *Viverra musanga*, an animal of the size of an ordinary cat, and of very wide distribution, being found also in the Philippine Islands. Of the dog, besides the half-domesticated race, there are two wild species; but the fox, the jackal, the wolf, and the hyena of the continent of India, are unknown. There is one species of otter, the *Aonyx leptonyx*.

The elephant is not found in Java, nor does there exist any evidence of its ever having been indigenous, and this is the more remarkable as it is abundant in Sumatra. The animal, however, was known to the Javanese for ages, and was probably imported occasionally for the use of its princes. Java has one rhinoceros peculiar to itself, and differing even from those of Sumatra. It is an animal easily tamed, and when so, gentle in its habits. Besides the domesticated hog, Java has two wild species, the *Sus verrucosus* and *Sus vittatus*. Both are very numerous, and their depredations are a serious impediment to agriculture. Java.

A wild ox is found in the forests of Java, the same as that found in the peninsula and Borneo, but which is wanting in Sumatra. It is the *Bos sondaicus* of naturalists. The Dutch naturalists inform us that all attempts to tame it have been vain, as in the case of the buffalo of the American prairies. According to the Javanese, however, it will pair with the domesticated cattle, producing a fertile offspring, to which they attribute the largest breed of their oxen. The buffalo, *Bos bubalus*, is found wild in many of the forests of Java, but considered by naturalists to be derived from individuals in the domestic state that had escaped from servitude. The horse nowhere exists in Java in the wild state, but the numbers of this animal and of horned cattle in the domestic state throughout the island are very large, the Dutch returns reckoning the first at 320,000, and the last at about 2,000,000.

No wild goats exist in Java, but the domestic has been immemorially known, although of small importance in rural economy. The sheep, usually called by its Sanscrit name *biri*, but sometimes "the European goat," is very little known to the natives. Six different species of deer exist, the most numerous of which are the *Cervus mantjac* and the *Cervus rusa*. These two will live and multiply in parks and paddocks, like our fallow and red deer, and are occasionally so kept. One species only of pigmy musk exists, the *Moschus kanchil* of naturalists. One species of hare is found in the neighbourhood of Batavia, and to the distance of about 50 miles E. of it, but in no other part of the island. It is a small animal, not exceeding a rabbit in size, and even of less speed. It had been generally believed that it was originally imported from the continent of India, but the Dutch naturalists have lately described it as a distinct species, under the name of *Lepus melanancha*, from being black over the nape instead of red, as the European hare.

Of birds the number of species is large, but of individuals generally small. Dr Horsfield has enumerated no fewer than 176 species. Of gallinaceous birds there is one species of peacock, the *Pavo spicifer*, equally handsome with the Indian. Two species of cock are found in the woods of Java, the *Gallus Bankiva* and the *Gallus furcatus* or *Javanicus*, a very beautiful bird, and peculiar to Java. This will pair with the common poultry, and the progeny is a hybrid, which for its beauty is sometimes kept by the natives. Two species of partridge are found in Java, the *Perdrix Sinensis* and *Perdrix Javanica*, and two small species of quail, the pugnacious propensities of the females of which, in the season of incubation, are availed of to produce a combat after the manner of fighting cocks. Of the pigeon tribe there are in Java no fewer than ten different species.

The family of birds most deficient in Java is that of web-footed water-fowl. There is but one species of duck, a teal, the *Dendrocygna arcuata*, and no species of goose, nor any migratory bird. There are, however, two indigenous species of pelican. The species of waders are numerous. The common snipe is abundant. Among the waders there are eleven species of stork or heron. Among smaller birds there are two species of cuckoo, one of which has a wild plaintive and monotonous note, not unpleasant to Europeans. With the Javanese, however, it is a bird of ill-omen. The mancho or *Gracula religiosa*, the speaking

Java. grackle, is common. The Java sparrow, *Fringilla oryzivora*, a great enemy of the rice crop, is but too common. The house sparrow is a stranger, introduced seemingly by Europeans. It is still, for the most part, confined to the European towns on the northern coast. Birds of prey are very numerous, but none of them of great size. There are eight species of eagle or falcon, and seven of owls, but no vulture. One species of black crow is abundant.

Fish are plentiful along the whole northern coast of Java, and a few species are of excellent quality, but, upon the whole, the abundance and the quality are not equal to those of the shores of the Straits of Malacca. The fresh-water fish are all of very inferior quality, and no migratory species frequent the rivers for spawning as they do on the rivers of the eastern side of Sumatra. Shell-fish are very abundant on the northern coast, especially oysters of excellent quality, and prawns, the last being much used by the people in the shape of the condiment called by the Javanese *trasi*. The fisheries of the exposed southern coast of the island are unimportant.

Inhabitants. Java, whether the inhabitants be of the Javanese or Sunda nation, is peopled by the same race, the Malayan. This is characterized by a short and squat person, the stature being about two inches less than that of the European, the Chinese, the Hindu, the Persian, or Arabian. The face is round, the mouth wide, the cheek-bones high, the nose short, small, never prominent as with the European, and never flat as with the African negro. The eyes are always black, small, and deep-seated. The complexion is brown, with a shade of yellow, not so dark as with the majority of Hindus, and never black as with some of them. Fairness is, indeed, in estimation with the Javanese and others of the same race. The hair of the head is abundant, always black, lank, and harsh, or at least never soft or silky. The hair on other parts of the body is either scanty or altogether wanting. The beard consists only of a few short straggling hairs, and there is none at all on the breast or limbs. The Javanese, personally, are not an agile people, and make very indifferent runners or wrestlers. As to moral character, the Javanese of the present day may be described as a peaceable, docile, sober, simple, and industrious people. The practice of running a muck, so frequent with the other cultivated nations of the Archipelago, is of very rare occurrence with them.

Java was populous, and to a considerable degree civilized for many ages before it was known to Europeans. De Barros describes the Javanese, at the arrival of the Portuguese, as what they still are, "the most civilized people of these parts" (*gentes de mais policia*). They were then found carrying on trade from Sumatra to the Moluccas; they furnished bread-corn and manufactures to the less advanced nations in return for their rude productions, and they had effected conquests or settlements in Malacca, Palembang in Sumatra, and in the two fertile islands of Bali and Lomboc. In fact, it is certain that the Javanese were, at this time, a far more civilized, probably even a more numerous people than either the Mexicans or Peruvians, who became known to Europe nearly at the same time. The essential part of Javanese civilization seems to be of native origin, and to have sprung up in the island itself, although it subsequently received considerable accessions by intercourse with Hindus.

Agriculture. With the exception of the people of Bali and Lomboc, the Javanese are the only nation of the Archipelago that can be said to be almost exclusively agricultural. With the exception of the fishermen of the northern coast, and a very small proportion of artisans, the computed ten millions of the population of the island is directly or indirectly engaged in agriculture, and have made a respectable progress in it. To regulate the processes of agriculture, the Javanese have a rural calendar still in use. This consists of a year of 360 days, beginning with the winter solstice of the southern hemisphere in the end of June, and divided into twelve seasons of unequal length, varying from 23 to 41 days each. It details the times for clearing and preparing the land, for sowing, for transplanting, and for reaping the different crops. The native terms by which the seasons are named, are, for the most part, the ordinal numbers of the vernacular language, while the adaptation of the seasons to the latitude of Java, sufficiently show that this calendar is a Javanese invention, and not borrowed from strangers. Java.

Irrigation, in so far as the rice crop is concerned, multiplies the productive powers of the soil from five to ten-fold, according to the abundance of water, and the facility of using it, and has been carried to such an extent in Java, that the majority of the arable land of the island consists of rice fields. The perennial streams and rivers, as they descend from the mountains, are, by means of embankments and trenches, diverted into small fields surrounded by low dikes, which can be flooded or drained at pleasure. The process of forming such lands is expensive and laborious, but when once formed, they are easily preserved. When the water for irrigated lands is sufficiently abundant and continuous, two crops of rice are raised within the year, and in some cases even three within fifteen months, the sun being hot enough to ripen rice in every season. The husbandman may follow his convenience as to the time of sowing, and in contiguous fields may be seen at once sowing and reaping rice, with every intermediate stage of the growth of the plant. When the water is not sufficiently copious for two crops, the rice is sown in the wet or hot season; and in the dry, or cold, crops considered of secondary value are produced, such as pulses, oil-giving plants, and cotton. No manure is ever applied to irrigated lands, nor are fallows practised.

Dry or upland arable is of small value compared to irrigated land. On the best dry lands rice is occasionally grown, but more generally these lands are used for such crops as pulses, oil-giving plants, cotton, sugar-cane, and tobacco, and on the mountain-slopes, at an elevation of 2000 and 3000 feet, for coffee.

In the most fertile parts of Java, which, from the neighbourhood of the high mountains, are usually also the most picturesque, the scenery is at once agreeable and magnificent, and certainly for grandeur and beauty excels all that may be seen, even in Italy, that country which in summer bears the nearest resemblance to Java. In such situations we have mountains 10,000 feet high, cultivated to half their height, the valleys below having all the appearance of a well-watered garden.

When Java first became known to Europeans, its principal agricultural products were rice, pulses, sesame, ground-pea, and other oil-giving plants, indigo and cotton, with palms and indigenous fruits. European intercourse has added to these maize, tobacco, and coffee. The quantity of its great staple, rice, which it produces, can only be estimated. With the exception of a small quantity of maize, rice is the only bread-corn of the Javanese; and, therefore, if we take the consumption per head at a quarter, or 448 lbs., this, on a computed population of ten millions, will make the total annual produce the same number of quarters. The export is, at present, too inconsiderable materially to affect this computation, for in 1848 it amounted to no more than 217,000 quarters.

From the first appearance of Europeans, and no doubt for many ages before, Java was the great granary of the other countries of the Archipelago. Recently the extensive culture by corvée labour of such products as sugar, coffee, and indigo, under an idle and pernicious hypothesis that some peculiar commercial advantage to the state belonged to their culture, has greatly interfered with the production of corn. The export of it has consequently dimi

Java.

nished, and the price materially risen; the consequence of which has been, that countries immemorially supplied by Java, now draw their corn from other places, such as Bali, Lomboc, Siam, and Arracan.

Mechanic arts.

The state of the mechanic arts among the Javanese is far below that of their agriculture, but still in advance of that of the other nations of the Archipelago; and with the exception of textile fabrics, not below that of the Hindus. About thirty different crafts may be enumerated as practised among them, the most important of which are the blacksmith or cutler, the carpenter, the kris-sheathmaker, the coppersmith, the goldsmith, and the potter. Both bricks and tiles are, at present, largely made; and excellent bricks are found in the remains of many ancient temples, proving that the art of manufacturing them has been known for many ages. Coarse unglazed pottery, similar to that of Hindustan, is also made; and the names of the different sorts all belong to the vernacular language. Beyond the manufacture of this coarse article, the Javanese have not advanced—all their better pottery having been for ages received from China.

Their skill in carpentry is displayed in house and boat building, in the fabrication of agricultural implements, and of the hilts, shafts, and scabbards of warlike weapons. The ordinary dwellings of the peasantry consist of a rough frame of timber, thatched on the coast with the leaves of the nipa palm, and in the interior with grass; having walls and partitions of split, flattened, and plaited bamboo work. They are always built on the ground. The dwellings of the upper classes differ, chiefly, in their greater size, with the exception of the palaces of the princes and higher nobility.

Boat-building is an art extensively practised all along the northern coast of Java. Their boats vary in form and size from mere fishing canoes to vessels of fifty tons. The building of ships is, at present, carried on under the direction of Europeans, the workmen, however, being all Javanese. When Europeans became first acquainted with the Javanese, they were possessed of vessels of large size, well entitled to the name of ships.

The agricultural implements of the Javanese are, like those of nearly every other Asiatic people, simple and rude.

The Javanese of the present day have no architecture that deserves the name, and apart from the temples of their ancient worship, no relics remain of any kind of domestic architecture, of bridges, of reservoirs, or of embankments of rivers, such as are found in the country of the Hindus. The remains of the remarkable edifices connected with the Hindu religion are abundant; but it is singular that an improved architecture ceased with that religion, and that no Mohammedan structure of solid materials or beauty has been constructed since the adoption of the Mohammedan religion towards the end of the fifteenth century.

It is in working the metals, however, that the Javanese have most excelled, and as they acquired this comparative excellence without possessing any of the metals themselves, but having all of them imported, the fact may be considered as evidence of comparatively advanced civilization. According to the Javanese, the first rank among artisans is to be ascribed to the blacksmith, or at least to the cutler. The most esteemed product of his skill is the dagger, the well known kris. Every man, and boy of fourteen, wears at least one kris as part of his ordinary dress, and men of rank two and sometimes four. Even ladies of high rank occasionally wear one. Swords are used only in native warfare, and are much less esteemed than the kris, the national weapon. The Javanese spear, a plain pike with an iron head, is a formidable weapon, from its long shaft of from 12 to 14 feet. Some of the Javanese krises, from their antiquity, are highly appreciated, and when sold bring enormous prices. The Javanese had also, before the arrival of the Portuguese, a knowledge of gunpowder and artillery. De Barros, in describing an expedition which invaded Malacca in 1513, says, "that it was furnished with much artillery, made in Java, for," adds he, "the Javanese are skilled in founding or casting, and in all work in iron, besides what they have from India."

Java.

The Javanese, although they manufacture gold and silver ornaments of considerable beauty, execute nothing equal to the filigree work of Sumatra. In works in brass, their chief excellence consists in the fabrication of musical instruments, a full band of which is known throughout the Archipelago by the Javanese name of *gamâlan*. The instruments consist chiefly of bars, constructed after the manner of the staocata, or of the gong, a word which has found its way into our dictionaries and is genuine Javanese. Some of these gongs have been made three feet in diameter. Musical instruments of this description are still manufactured in Java, and form an article of exportation, as, indeed, they are said to have done on the first arrival of the Portuguese.

The only textile material of native produce is cotton, rather a coarse article, and the only kind of cloth made from it is a stout durable calico, the muslins and other fine textures of Continental India being unknown as manufactures. The processes of cleaning and preparing the cotton, of spinning, weaving, and dyeing, are all carried on by women, and are purely domestic operations, as is the case with all the other nations of the Archipelago. The usual mode of giving variety of colours to the web is the simplest possible, consisting in weaving the previously coloured yarn in stripes, chequered or tartan patterns, so frequent with the other tribes, being against the taste of the Javanese. Another mode peculiar to this people consists in covering with melted wax the part of the cloth not intended to be dyed before putting it in the vat, the process necessarily requiring repetition in proportion to the number of colours intended to be given.

The only material, besides cotton, from which cloth is made by the Javanese is silk, and as the art of rearing the silk-worm has never been successfully introduced into Java, the raw material has always been imported. At present it is imported from China, an inferior silk, from which a coarse cloth is wrought with the same implements as that of cotton.

Paper is a manufacture peculiar to the Javanese. It is of the nature of the papyrus of the ancients, and not of the beautiful and ingenious fabric which the nations of Europe acquired from the Arabs of Spain, and so long known to the Chinese.

Higher branches of knowledge.

Of higher branches of knowledge, the Javanese know little. The Hindu system of noting numbers seems to have been introduced from India, and not by the Arabs, for we find it in ancient inscriptions, both on stone and brass. The Javanese, however, have little knowledge of arithmetic.

Music.

Music is, probably, of all others, the art in which the Javanese, compared with most of the other Asiatic races, have made the greatest progress. In common with all the other nations of the Archipelago, they are passionate lovers of music, and have generally fine musical ears. Javanese melodies are wild, plaintive, and beyond all other Asiatic music, not, perhaps, excepting that of the Persians, pleasing to the European ear. Most of their musical instruments, too, are superior to those of other Asiatic nations. They have wind and stringed instruments, both of them rude and imperfect however. Their best and most frequent are those of percussion. Some of these consist of a single gong, or of a series of them representing different notes, and others of bars of brass or sonorous wood placed over troughs, and representing so many keys, after the fashion of the harmonicon. The late Dr Crotch, a most competent judge, after inspecting the fine collection of instruments brought to England by Sir Stamford Raffles, favoured the writer with his opinion of them, as well as of the general character of

Java. Javanese music. With respect to the single gongs, he thus expressed himself: "A pair of gongs was suspended from the centre of a most superb wooden stand richly carved, painted, and gilt. The tone of those instruments exceeded in depth and in quality anything I had ever heard." Of the instrument consisting of a double series of small gongs, he thus spoke: "The tone of this instrument is at once powerful and sweet, and its intonation clear and perfect;" and of the instruments of percussion generally, he observed that he "was astonished and delighted with their ingenious fabrication, splendour, beauty, and accurate intonation." With respect to the character of Javanese music generally, he made the following observations: "The instruments are all in the same kind of scale as that produced by the black keys of the pianoforte, in which scale so many of the Scots and Irish, all the Chinese, and some of the best Indian and North American airs were composed. The result of my examination is a pretty strong conviction that all the real native music of Java is composed in a common enharmonic scale. Some of the cadences remind us of Scotch music for the bagpipe. Others in the minor key have the flat seventh instead of the leading note or sharp seventh, one of the indications of antiquity. In many of the airs, the recurrence of the same passages is artful and ingenious. The irregularity of the rhythm or measure, and the reiteration of the same sound, are characteristic of oriental music. The melodies are, in general, wild, plaintive, and interesting. A full band of Javanese musical instruments, which consists of flutes, drums, gongs, and staccatas, will cost from L.100 up to L.400.

Language. Two languages are spoken in Java, of the same general structure, belonging to the same class of tongues, and having many words in common, yet essentially differing from each other. These are the Javanese and Sunda.

The Javanese has been immemorially a written language, and its alphabet has extended to the Sunda language. Inscriptions on stone and brass carry us back in its history to the twelfth century. The written character is of two descriptions, that found in ancient inscriptions, and that at present current. They seem, however, to be essentially the same, and not to differ more than black letter from modern manuscript. The character is peculiar, essentially unlike that of the other alphabets of the Archipelago, and equally unlike any Hindu or other foreign character. It does not even, like several of the ruder alphabets of the Archipelago, follow the rhythmical arrangement of the Hindu alphabets. In fact, it has all the appearance of being an indigenous invention. The consonants alone are considered substantial letters, and the vowels mere adjunctive signs to modify them, or, as the Javanese designate them, their "clothing." The consonants are nineteen in number, but the initial vowel *a* is considered a substantive letter. This vowel, too, is inherent in, and follows every consonant, unless there be a contrivance to elide it. Independent of this letter, there are five other vowels. Javanese writing is neat and distinct, and, so far as concerns native sounds, perfect, for every sound in the language has its representative character, and the same character has invariably the one power and no other.

There are three dialects of the Javanese, the vulgar tongue, the polite dialect, and the ancient or recondite. All of them are marked by simplicity of grammatical structure, a simplicity which appears to be innate and original.

The foreign languages which we find mixed with the Javanese are Sanscrit, Arabic, and Tâlugu or Telinga. All these have found their way into it, not through foreign conquest and the intermixture and settlement of men of strange race, but through the influence of religion and commerce. Of these languages by far the largest infusion is of Sanscrit. Of the first conversion of the Javanese to Hinduism, and consequent influx of its sacred language into Javanese, there is no record whatever; but it seems probable, from the extent of the influence exercised, that the connection is of great antiquity,—probably little short of twenty centuries. In the ordinary language of Java, the proportion of Sanscrit words is about 11 in 100, but in the kawi or recondite, it is not less than 40 per cent. The proportion of Arabic words is comparatively small. The Tâlugu words introduced are very few in number. Java.

The Sunda language, as already stated, differs from the Javanese, and is a ruder and less cultivated tongue. To judge by ancient inscriptions, it had once a peculiar character of its own, but is now written in the Javanese, with the omission of two letters, a palatial *d* and a *t*. It has no recondite, like the Javanese, and no ceremonial dialect, except in so far as it has borrowed, in the last case, a few words from that of the Javanese. Its literature, also small in amount, is taken from the latter.

The literature of the Javanese is sufficiently abundant, and exists both in the ancient and modern languages. In both it is metrical throughout, the former being in different metres, borrowed from Sanscrit poetry, and the latter in native stanzas, of many kinds, and in a peculiar rhyme. The principal portion of Javanese literature consists of romances and of histories, partaking too much of the character of the romances. The romances are founded, some of them on Hindu legends, and others on ancient Javanese story. Of the Sanscrit poems, which describe the wars of the Pandus, and the adventures of the demi-god Rama, the Javanese possess abstracts both in the ancient and modern tongue. These two poems are to the Javanese what the poems of Homer were to the Greeks and Romans, and they have even transferred the scenes of them to their own island. The poem which describes the wars of the Pandus is known to the Javanese by the name of the *Bratayuda*, a title which is composed of two Sanscrit words, signifying "the war of the descendants of Barat." This, the most meritorious production of Javanese literature, is said to have been composed in the twelfth century (1195), by a Brahmin of the name of Ampusâdah, at the court of a Javanese prince. Litera- ture.

It cannot with truth be said of Javanese poetry that it possesses either vigour or fertility of imagination. On the contrary, although a few better passages now and then occur, its general character is that of inanity and childishness. At the same time, it is certainly of a higher order than that of any other people of the Archipelago, while it is much inferior to the literature of the Hindus.

The native government of Java is a pure despotism. The sovereign is the arbitrary lord of all, including, in theory at least, the religion and the property of his subjects. All titles are derived from him, and are annulled at his pleasure. He names his successor out of the members of his family; and there is nothing hereditary, save the royal family, for which there is a superstitious veneration, very like idolatry,—even here, however, scarcely extending beyond the first generation. Govern- ment.

The Javanese sovereign exercises his authority through a minister, having under him four assistants, who are his deputies, as he himself is of the sovereign. Two of these are charged with the administration of the royal household and capital, and two with the administration of the provinces, of which, in the Javanese portion of the island, when under native rule, there were not fewer than forty. These were under the administration of governors bearing the Sanscrit title of bopati. These had their deputies, so that a provincial government was a copy in miniature of the supreme administration. The province was divided into districts, administered by officers, and each district was composed of a certain number of villages, each having its head man and deputy.

The village community constitutes the most important part of the Javanese institutions. The Javanese village,

Java. like the Hindu, is an incorporation, in which the powers of self-government to a large extent are inherent. Its officers consist of the head man, his assistant or deputy, and the village priest, who are elected by the occupants of the land, and in a few cases by its proprietors. With these village officers rests the collection of the public taxes, and the whole care of the police.

In the structure of Javanese society there is no other distinction of classes, except that of nobles and commonalty. Slavery is at present unknown in Java, in so far as concerns its native inhabitants, nor is it known to have existed in any period of Javanese history, which is remarkable enough since it prevails more or less among all the less advanced nations of the Archipelago. That at a remote and early time it did exist in Java there can be no doubt. Its disappearance must be attributed to density of population, with its concomitant cheapness of labour, which made it more economical and convenient to employ free men than to breed and maintain slaves, and assuredly to no higher motive.

The main source of the revenue of a Javanese prince is derived from the rent of land, or a tax on rent; and Java is probably the only country of the Archipelago, with the exception of Bali and Lomboc, in which, from the relation between land and population, a real land rent can be said to exist. This rent is chiefly found in the irrigated land, that is, in the land of the highest fertility, and is composed of two elements—the difference in the quality of different lands, and the value which in the course of ages has been invested in such lands in converting them into water-fields.

In the ruder country of Sundas there are some remains of a private and heritable property in the land, but in the country of the Javanese the sovereign has gradually taken the whole rent as tax, reducing the cultivators to the condition of mere occupants or tenants at will, he himself having become the virtual proprietor.

All other sources of taxation than the land are, under the native government, comparatively trifling. In some cases a small capitation tax is levied, but this also is confined to the cultivators. A property in the nests of the esculent swallow, and in certain fish-ponds or stews, formed another branch of the native revenue. Taxes on consumption in the shape of customs, transit duties, and market dues formed a third, but probably most of these are of comparatively modern origin, and will be presently considered.

Discovery. Java was unknown even by name to the civilized nations of ancient Europe, and even to those of the middle ages. It is first named by Marco Polo, who, in his junk voyage from China to the Persian Gulf, passed through the northern part of the Archipelago about the close of the thirteenth century. He gives the name as Ciaua or Java, but his information being mere hearsay is in other respects erroneous. Thus, mistaking probably the products of its commerce for its indigenous productions, he enumerates among the latter cloves and nutmugs, and gold in quantity "exceeding all calculation and belief," although it produces none at all.

No sooner had the Portuguese reached India by the Cape of Good Hope than the name became familiar enough to Europeans. L. Barthema visited the island and remained fourteen days in it, but his account is obviously false or worthless, for he describes parents as selling their children to be eaten by the purchasers, and himself as quitting the island in haste for fear of being made a meal of. Edoardo Barbosa, although he had not visited it, describes its productions, its trade, its manufactures of arms, and the persons, dress, and manners of its inhabitants, with much accuracy. Pigafetta, although his information respecting it was derived, as he tells us himself, from the old pilot who accompanied him from the Moluccas, is even more correct than Barbosa.

How very little, however, was really known of Java by the early Portuguese of India, is to be seen from what De Barros, master of all the Indian archives, says of it in his Third Decade, published in 1663, no less than fifty-two years after the conquest of Malacca, and several years after his countrymen had visited China, discovered Java, and traded with both. He makes it to consist of two islands, Java and Sunda; and his work contains a rude map, in which a great river, or rather a strait of the sea, is represented as dividing them. This he calls the river Chiamo, which may possibly be the Chitando of the Sundas, a considerable stream at the eastern boundary of their country, and which, in their language, signifies, "boundary water or river." Java.

History. It is only from the time of the Javanese conversion to the Mohammedan religion, which all parties are agreed in asserting to have been consummated by the overthrow of the most potent Hindu state of the island in 1478, that their history begins to have some faint semblance of congruity. All that transpired previous to this date is more a matter of archæology than of history or chronology. They possess chronological tables, but in these the earlier period is palpably fabulous; the dates, after the manner of the Hindus, being expressed, not in numeral characters, or in words representing numbers, but in mystical terms, differently interpreted by different parties. It is a favourite notion with Javanese chronologists that the islands of Sumatra, Java, Bali, Lomboc, and Sumbawa, formed at one time a continuous land, and they assign precise dates preposterously modern, to the times in which they became so many different islands. Sumatra, according to these statements, was separated from Java in the year 1192, Bali from Java in 1282, and Lomboc from Sumbawa in 1350, that is above half a century after Marco Polo had passed through the Archipelago.

From the eleventh century the Javanese chronology assumes an air of at least some feasibility; but even from that time down to 1478, there is much discrepancy between different statements, according as the mystic words in which dates are expressed are interpreted. Thus, the "thousand temples" of Brambanan, the finest remains of Hinduism in the island, are said by one account to have been built in 1096, and by another in 1266.

The great events of Javanese history are the respective conversions of the people to Hinduism and Mohammedanism. Of the time when the first of these took place, or the manner in which it was brought about, we have no positive information. The evidence derived from language and ancient monuments, sufficiently attests the general prevalence, if not, indeed, the universality of some form or modification of the religion of the Hindus over the island; but anything beyond this is matter of inference or conjecture. Ancient states existed which had acquired a considerable amount of civilization and power, as is shown by the ruins of palaces and temples; but none of them had any durability,—none of them ruled over the whole island, while several of them, according to tradition, existed at one and the same time.

The Hindus, it is highly probable, migrated to Java and established their religion in it at a very early period, probably as early as the sixth century. That the Hindus and their religion, however, existed in Java from the end of the thirteenth to that of the fifteenth century, is a matter of certainty, proved by monumental dates entirely reliable.

The history of the conversion of the Javanese to the religion of Mohammed, even at this comparatively recent period, is much enveloped in fable. The parties who effected the conversion were the mixed descendants of Arabs, Persians, Malays, and Mohammedans of Hindustan,—parties who had settled on its northern coast for the purposes of trade; who were intimately acquainted with the natives of the country and their language; and who, in process of time, had acquired wealth and influence. Of such men were the real missionaries of Islam in Java composed, and the work of conversion was certainly a slow one. As early as the year of our time 1358, an unsuccessful attempt had been made by missionaries of this description to convert the Sunda nation. Another was made in 1391 to convert the proper Javanese; and the tomb of one of the reputed saints who made this attempt, one Maulana Ibrahim, still exists in Gressik, bearing the year of Salivana, 1334, or of our time 1412. In the year of Christ 1460, the Mohammedan converts assembled a force for the conquest of Majapait, the capital of the principal Hindu state, but were defeated; and it was not until 1478, eighteen years after, that they succeeded in capturing the capital, overthrowing the state, and establishing their own power and faith.

The Sunda nation appears to have been converted about the same time, the conquests proceeding from Cheribon, and ending with Bantam in 1480. The Mohammedan chiefs assumed the government

Java.

of the respective states which they had subjugated, under the title *Susunan*, abbreviated *Sunan*, a spiritual title, meaning "object of reverence," which one of the native princes still retains.

According to these statements, the work of conversion ran over a period of at least 130 years. Even at the lapse of this time, however, it does not appear to have been completed; for, according to De Barros, when Henrique Lemé visited the country of the Sundas 1522, forty-four years after the supposed final conversion of the Javanese, he found idolatrous temples, nunneries, and the practice of concremation still existing. For a century after the overthrow of Majapait, Java appears to have been split into many independent states. When first visited by the Portuguese, such was unquestionably its condition. "The island of Java," says De Barros, "is divided into many kingdoms;" and he enumerates no fewer than fourteen, most of which, notwithstanding much corruption of orthography, can be identified with the existing names of provinces. About the year 1578, however, a native chief, the governor of the province of Mataram, on behalf of the king of the neighbouring state of Pajang, raised himself to sovereign power, and founded the family from which has sprung the two existing native rulers. In the course of the first four reigns of this dynasty, most of the proper country of the Javanese, with the island of Madura, were subjugated, and the princes of the Sunda country made tributary.

It was in the reign of the second prince of this dynasty, that the Dutch made their first appearance in Java, under Houtman, in 1595. In 1610 they obtained permission from the Sunda prince of Jacatra, to build a fort near to the spot on which now stands the city of Batavia. In 1619 this fort was besieged by the joint forces of the princes of Jacatra and Bantam, aided and abetted by the English. It was relieved by a Dutch fleet under Admiral Koen, and the assailants defeated and driven off. It was after this event that the name of Batavia first given to the fortress was bestowed on the town. In 1628 Batavia was besieged by a numerous army sent against it by the reigning prince of Mataram, with the hope of expelling the Dutch from the island; but by the skill and courage of the European garrison, the rude and disorderly host was baffled and routed. From this time the history of Java is properly that of its European conquerors. No considerable territorial acquisition, however, was made until 1677, when the Dutch obtained a cession of the principality of Jacatra. From that time up to the year 1830, every war carried on by them with the native princes, whether as principals or auxiliaries, invariably ended in a cession of territory to the former; so that, at present, hardly one-fourteenth part of the island is in possession of native rulers, and even that is entirely tributary and dependent.

From the year 1674 to 1830, the Dutch, as principals or auxiliaries, have been engaged in no fewer than four great wars, all of long duration. One of which, begun in 1674, lasted for thirty-four years; one in 1718, lasted for five years; one in 1740, for fifteen years; and one in 1825, for five years; so that, of one-third part at least of a period of 156 years, civil war raged in the island.

The Dutch have divided their possessions in Java into twenty provinces or residencies, each of which is administered by a resident or prefect. Six of these belong to the country of the Sundas, and fourteen to that of the Javanese. The two remaining native states, although administered by their own princes, are virtually Dutch provinces, and placed under the control of an officer, with the same title as those of the provinces under direct Dutch rule.

Population.

Attempts have been made at various times to estimate the total population of Java. The first of these was by the historian Valentyn, who estimates the population in his time (1726) at 3,199,750; and including Madura, 3,591,500. This estimate was made shortly after a civil war of five years' duration. In 1755, immediately after the finest parts of the island had been the theatre of a civil war of fifteen years, an estimate was made which gave Java only 1,941,911, or including Madura, 2,001,911. This would seem to show that in less than thirty years a decrease had taken place exceeding a million and a quarter. At the close of the last century, estimates of the population were made, which raised the joint population of Java and Madura to 3,559,611. This was after a continued peace of forty-five years; and shows, compared to the last estimate, an increase exceeding a million and a half. In 1808 another estimate was made, and by this the number was made 3,730,000. In 1815 a census was attempted, during the temporary occupation of the English, which raised the population of Java to 4,390,661, or including Madura, to 4,615,270. In 1826 a census was taken which gave the population at 5,403,786. Ten years later, another was taken, and this raised the number to 7,861,551; and consequently gave a decennial increase at the rate of about 44 per cent. The census of 1845 made the joint population of Java and Madura 9,530,781, or of Java alone, 9,235,033. The last census is that of 1852, and this made the joint population of Java and Madura 9,943,075. The population was estimated as being, on 31st Dec. 1853, 10,290,000.

Java

The inhabitants of Java, besides Javanese and Sundas, consist also of Madurese; for these are not confined to their own island, but form the larger part of the population of that section of Java which fronts Madura. This portion having been depopulated by the civil wars of the end of the seventeenth and beginning of the eighteenth centuries, the Madurese began to emigrate to it from their own less fertile land; and this emigration still goes on, so that the Madurese in Java are probably at present more numerous than in their parent country. For the whole island, including Madura, the proportions of the three nations is supposed to be 66 in 100 of the Javanese; 26 of the Sundas; and 8 of the Madurese.

The most numerous class of stranger-settlers are the Chinese; the census of 1852 makes their numbers 125,407, the greater number consisting of a mixed race. The small proportion of Chinese in Java is, of course, in some measure attributable to the nature of the labour market, in so far as respects unskilled labour, that being already preoccupied by the native population; but it arises also from the restraints imposed by the policy of the Dutch government on their settlement. They are obliged to pay a mulct for leave to enter, and a larger one for permission to quit, besides a poll-tax—all of them imposts to which no other class of strangers is subjected. Jealousy of Chinese settlement is, indeed, a principle of long standing in the Dutch administration. In the early part of the last century their numbers alarmed the government, and their wealth and prosperity appear to have excited the envy of the Dutch colonists; and in 1723 the local government issued a decree against Chinese immigration, which, however, was never fully acted on. They were, however, prohibited from passing beyond the limits of the town of Batavia without a license; and all who could not render an account of themselves satisfactory to the European authorities were imprisoned or sent back to China. These severities drove the Chinese to revolt; and on the 26th of September 1740, the Chinese quarter of Batavia was attacked by a mob, consisting of soldiers, sailors, European settlers, and natives, and in the course of two days, 10,000 of the Chinese are stated to have been slaughtered, and their houses pillaged and burnt. Those who escaped the massacre retreated into the interior of the island, and the result was a civil war, which, in one form or another, lasted for fifteen years. The local government sent a letter full of excuses to the emperor of China, to which the emperor did not vouchsafe a reply. In justice to the Dutch nation it should be noticed, that the whole proceeding was condemned at home: and the weak and timorous governor, who was the cause of, or winked at the massacre, was duly punished.

The other Asiatic people settled in Java consists of Arabs, or rather, for the most part, of their mestizo descendants, and of natives of the other islands of the Archipelago. All these are grouped together in the census of 1852, and their total number, including slaves, is no more than 37,701. The number of slaves is but 9410. None of these are Javanese, but all natives of the other islands of the Archipelago, or their descendants, chiefly of Celebes, Sumatra, and Bali. All of them are domestics of Europeans or Chinese. The practice of employing free Javanese as domestic servants was first introduced by the English during their temporary occupation of the island, and has been followed by the Dutch.

Revenue

The revenue of the European government of Java is that of the whole island, including Madura; excepting as to some taxes on consumption, the territories are subject to the two remaining native princes, embracing an area of 2229 square miles, and a reputed population of 850,000. It is derived from multifarious sources, and may be briefly described, taking the figures from the public accounts of 1843, as given by Mr Temminck. These may be sufficient for a general view, as no material change has since been made in the fiscal system.

During the five years' temporary occupation of Java by the British government, from 1811 to 1816, nearly the whole ancient system of monopolies, forced deliveries, and corvée labour was overthrown, and free culture, open trade, and free labour substituted for them. The merit of this great revolution in the administration of the island belongs to the late Sir Stamford Raffles, the British lieutenant-governor of Java, under the supreme government of India; and he carried his bold and valuable innovations into effect with a courage, industry, and perseverance entitled to the greatest praise. The financial system which he adopted, however, was not so happy,—in so far as the land-tax was concerned, for it proceeded on the principle of the states entering directly into an arrangement with each individual occupant of a few acres, in the case of Java probably not fewer than half a million. Under this system, the tax was paid either in money or in kind, at the option of the occupant; and being generally paid in the latter, it followed that the government was converted at once into warehouse-keepers, and corn merchants. As in our own territories on the continent of India, the new system was found mischievous and impracticable. The land was over-assessed, and the hypothetical land-tax could not be realized.

Java. After a two years' trial, the Dutch commissioners who received charge of the island, judiciously abandoned the Ryotwarrie system of 1814, and arranged with the heads of the village corporations for the land-tax, leaving its distribution among the occupants to these corporations themselves. This natural and simple system, the only one suited to such a state of society as that of Java, after being in operation for 14 years, was partially relinquished in 1832, and the old system of forged deliveries of certain agricultural products, and of corvée labour in raising them, was to a large extent restored. The pretext for this was the hope of greater gain, and the assumption that, by the immemorial usage of the country, the state was entitled to take, at its option, its tax in money, in kind, or in corvée labour. Under this system a considerable portion of the tax on rent is remitted, and some of the best land with the labour of its peasantry has been appropriated to the cultivation of products deemed peculiarly fitted for the markets of Europe, such as coffee, sugar, and indigo, with tea, cinnamon, and cochineal, the last three expressly introduced into the island for this special purpose. By this impolitic measure, the Dutch government has become, once more, a cultivator, a trader, and necessarily, from its position to a certain extent, a monopolist trader. The evil effects of such a system on that wealth, which is the only source of public revenue, must be obvious to every enlightened statesman.

The actual amount of the tax on rent or land-tax remaining to the Dutch government, after deducting exemptions, was, in 1843, allowing 20 pence to the florin, L.835,551. To this, however, is to be added a sum of L.26,215 for the quit-rents of land sold at various times in fee simple to Europeans, with other items of the nature of a land-tax, as the rents of certain fish-ponds, or stews, amounting to L.27,302, making the total land-tax realized L.889,128. No account is rendered of remissions on account of land appropriated to the culture of produce for government, but a few facts are stated which will give a tolerable notion of the extent to which this very barbarous system is carried. The number of Javanese families from which corvée labour was exacted for the culture of coffee, in 1841, was 453,289, and for that of sugar, indigo, and cinnamon, 350,955, making the total number, exclusive of those employed in the cultivation of tea and cochineal, which is not stated, 704,244 families, equivalent to a population exceeding three millions and a half, or 40 parts in 100 of the entire population of the European portion of the island. The quantity of land set aside for the cultivation of sugar, indigo, and cinnamon, amounted in 1841 to 317,635 acres, and this consisted of the richest irrigated lands of the island, usually yielding two yearly harvests, and equal in value to ten times that of the average of all dry lands. The quantity of land, of an inferior description, appropriated to the culture of coffee and tea, all peculiarly fitted for the growth of maize, is not stated, but some notion of it may be formed from the number of families employed, as above given, and from the number of trees, which amounted in 1841 to 336,922,460.

The taxes on consumption are multifarious, consisting of monopolies, excises, customs, transit and market duties, taxes on fisheries, and on the slaughter of cattle. The chief monopolies are those of the vend of opium and salt. In 1843 the first of these amounted to L.796,630, and the last to L.384,159. The monopoly of opium is at once productive and unexceptionable in principle. That on salt is, of course, a poll-tax, which amounts to about 4s. on each family, and is only less onerous than our own in Bengal, from the salt of Java, the produce, chiefly by solar evaporation, of its northern coast, being better, cheaper, and more economically distributed to the consumers than that of Bengal. Another monopoly is that exercised in certain caves producing the esculent swallow nests, and this, as the birds are the chief manufacturers, and strangers the chief consumers, is an unexceptionable source of revenue. In 1843 its amount was L.24,271. The sale of timber from the teak forests, which are the exclusive property of the government, constitutes another monopoly, of which the produce in the same year was L.42,141. These different items make the total revenues arising from monopolies L.1,247,201. In the public accounts, the monopoly of the tin of Banca is set down as Javanese revenue, and stated at the sum of L.250,000. As the revenue of Java alone supplies the funds with which the mining and smelting is carried on, this branch is therefore correctly enough included in the financial resources of that island.

The export and import duties of Java in 1843, including port charges, amounted to L.460,840; and the market, transit, and ferry dues, came to L.262,672. The tax on the slaughter of cattle was L.39,341, and that on fish and fisheries L.27,911. It is not necessary to add that the two last, as taxes on necessaries of life, are injurious imposts. A strange want of attention to an obvious principle is evinced by the European government of Java, connected with the slaughter of cattle. The slaughter of the buffalo is expressly prohibited, with the avowed object of increasing the number of this animal for the benefit of agriculture. The certain effect of the prohibition, however, must of course be the very reverse of what is intended, for the rearing of these animals is surely discouraged, not promoted, by depriving the owners of a market for the old, imperfect, or superfluous ones. Java.

The excise on distilled and fermented liquors, and on tobacco, yielded between them, in 1843, only L.36,843. The taxes on consumption yielded, in all, monopolies included, a revenue of L.2,207,488.

The direct taxes, land-tax excepted, are of very trifling amount. Stamp duties yielded L.26,452, and taxes on transfers and successions L.19,470, plain proofs of the real poverty of the ten millions of people, and similar to those which are afforded from the same class of taxes in our own Indian possessions. The capitation tax paid by the Chinese yielded no more than L.3477, and that on slaves only L.2014. A tax on gaming was far more productive than either of these, for it produced L.37,101. A duty on auction sales gave L.24,173, and the profits on public pawnbrokers' shops L.27,905. The tax on carriages and horses kept for private use gave the small sum of L.5530 only, and the post-office and stage coaches no more than L.18,226. Printing is a monopoly in the hands of government, and is represented as yielding a profit of L.4833. The tribute paid by native princes amounted only to L.3287. To these items are to be added the sale of such articles as rice, packing sacks, gold dust, and sundries, amounting to L.78,483. The whole amount of these direct or miscellaneous taxes is L.166,938, or, including the sale of produce, probably not the productions of Java, L.245,421.

The account of receipts contains, in all, forty-five different heads, without, however, any logical arrangement. The sums, too, are for the most part gross receipts, not including charges of collection, which are not separately given. The total revenues of Java in 1843 were L.3,209,357, including the monopoly of tin, but exclusive of the profits of trade on commodities sold in Europe—if there should be any. The rate of taxation per head on the population of Java, subject to European rule, is about 7s. 5d., and would probably amount to at least 10s., had not the resources of the island been dissipated in idle and wasteful governmental speculations, agricultural and commercial. In the British settlement of Singapore, without land-tax, customs, port-dues, salt monopoly, poll taxes, gaming tax, or stamp duties, the rate of taxation per head is better than 18s., or 142 per cent. more than that of Java. The difference is evidently owing to the superior industrial strength of the population of Singapore; its superior freedom in the exercise of that strength, and its comparatively superior wealth.

The expenses of the government of Java in 1843 were given at the sum of L.6,291,606. Thus, then, the expenditure exceeded the amount of the taxes by the enormous sum of L.3,082,249, to be made good, by the contingency of profits on produce remitted to Europe. The civil charges came to L.827,825, the military to L.720,319, the naval to L.138,846, and the extraordinary expenditure, on account of Sumatra, to L.220,076. The expense of despatching government produce, exclusive of freight and charges, amounted to L.75,212, while the interest of the public debt, nearly all incurred in twenty-seven years' time, came to L.1,018,463, or about half of that of British India, with a hundred and twenty millions of inhabitants, and which it has taken a century to incur.

The internal trade of Java embraces that of all the Netherland possessions in India, as it is the entrepôt for the whole of it. It includes also a large remittance for the public revenue in the shape of produce, as coffee, sugar, indigo, tin, and spices. Java and the other Dutch possessions were delivered over by the English in 1816, with a considerably improved commerce, and certainly, at all events, with a clear field for the establishment of a liberal system. The opportunity has assuredly not been taken advantage of. Double duties have been imposed on all goods imported under a foreign flag, and other contrivances of the exploded mercantile system have been had recourse to, in order to give trade a direction to Holland, a costly expedient injurious to the colony and of no substantial value to the mother country. In 1824, and within eight years after the restoration, a new East India Company was set up as one of these contrivances, the Handel Maatschapij or trading association. This association is merchant, shipowner, agent, for the sale of the government produce in Europe, carrier of this produce, and farmer of some branches of the public revenue of Java. Originally, there was guaranteed to it, a fixed and certain interest on its capital stock, and even the sovereign of the Netherlands was a sleeping partner of it. The false hypothesis on which this retrograde policy was adopted, was a supposed necessity for encountering what was called the overgrown capitals and enterprise of England and America, as if the free capital and enterprise of Holland, which under greater difficulties had not achieved much greater things, was unequal to carry on the trade of its own colony without pillowing and bolstering. This company has been in existence for thirty years, and we may see by the result how little it has effected.

Jaxartes.

In 1851 the value of all the imports into the Dutch East India possessions, exclusive of government stores, was L.2,512,893, but that of the exports L.6,149,088. Of the exports, no less than L.3,996,750 consisted of government produce, chiefly sent to Europe through the Handel Maatschapij, or Commercial Association, leaving for the exports of private merchants no more than L.2,152,300, a large portion of it the property of the privileged society itself. From this statement it will appear that the exports, instead of being nearly the same as the imports, as they ought in all fair trade, exceed them by the enormous sum of L.3,636,195, or by 144 per cent. It is evident that the difference, whether it ever reaches the treasury of Holland or not, is mere tribute paid by Java, and this, too, in a form the most injurious. These figures will further show that of the export trade of the Dutch possessions in India, nearly two third parts are carried on by the government with the colonial revenue, while little more than one third of it is conducted by private capital and enterprise. This is assuredly the greatest violation of the sound principles of commercial policy, which has been perpetrated since the overthrow of Indian monopolies, and one which ought not to have been witnessed in our times.

In 1844 the total value of the imports of Java was L.2,339,971, which shows that in the seven years ending with 1851 they had fallen off by no less than L.172,922. In 1842 the value of the exports was L.5,034,529. In the nine years, therefore, between 1842 and 1851, these had increased by the sum of L.1,114,560.

European government.

The government of Java and the other Netherland possessions of India is vested in a governor-general, named by the king, and answerable for his acts only to him. He is commander-in-chief of the military and naval forces, and possesses absolute legislative and administrative power. The liberty of the press does not exist; indeed, there is no press at all except that of the government, the political literature of Java consisting of two newspapers, the government gazette, and another equally under a rigorous censorship. In the three small British settlements, in the same quarter of India, there are six, as free as the journals of England or America.

Jay, William.

For the administration of justice there is a supreme court sitting at Batavia, which has a primary jurisdiction in a few cases, but is generally a court of appeal and cassation for the whole Netherland possessions in India. There are three provincial courts at the three principal European towns—Batavia, Samarang, and Sarabaya—for the administration of civil and criminal justice, one of the judges of which goes on circuits. Justice to natives and Chinese is administered by the country courts in which the president or chief civil administrator presides, having native chiefs for assessors. In criminal cases, the jurisdiction of these courts is confined to offences not capital, and, in certain civil cases, appeals from them lie to the provincial courts.

The finances are under the management of a director-general, a director of receipts and domains, a director of produce and warehouses, and a director of cultivation—these officers constituting the finance board. For keeping and auditing the public accounts, there is a distinct department—the chamber of accounts. From the mixing up of cultivation and trade with governmental affairs, the duties of these two departments become sufficiently onerous, complex, and always greatly in arrears.

The tributary princes, of which the number of principal ones is no fewer than one-and-twenty, administer the civil governments of their own countries. Of these there are five in Java, two of them only considerable; three in Madura, two in the group of islands at the eastern end of the Straits of Malacca, three in Borneo, two in the Moluccas, four in Celebes, one in Sumbawa, and one in Sumatra. (J—N C.)

JAXARTES, the SIHON, or SYR DARIA (i.e., *Yellow River*), a river of Turkestan, rising in the high table-land that stretches westward from the N. side of the Lake Sir-i-kol, opposite Issar, and falling into the Sea of Aral. It springs from many sources in the great Mooshtah table-land where the lake of Sengirkool and the mountain torrents of the Terek and Karaboora ranges chiefly contribute to its origin. After leaving the mountains the Syr enters the Khokan Valley which it traverses, and where its volume is very much increased by the influx of streams on both sides. After a course of about 400 miles it enters the Khirjiz-steppe at the town of Rhodien. In its passage through this desert it receives tributaries from the N. alone, the country to the S. being too flat and dry for water to collect or flow. It is here that the Syr branches off into two, formerly three, separate rivers about 250 miles from the Aral. The most northern and largest branch being the proper continuance of the original river, keeps the name Syr, while the other is called Koovan-Daria. A third branch, the most southern, called Tanghi-Daria, is now dried up. This was caused by the Khokanians, about 1815, erecting a strong dyke at the point where this branch diverged from the main stream, to prevent the inhabitants of the Khanas of Khiva from planting colonies on its banks. The river enters the Aral at Fort Kos-Aral after a course of about 1000 miles. From the general flatness of the country traversed, the Syr is very tortuous, with low banks, and its waters, as the name denotes, have a lightish yellow appearance. Its depth varies according to the season of the year; in autumn, the water being very low, and in some places dried up, while in spring its banks are overflowed. It is the intention of the Russian government to form a line of small steamers for the navigation of the Syr, which will develope the resources of its fertile banks. This river was not unknown to the ancients. Its banks were peopled by the Massagetæ, with whom Cyrus the elder of Persia came into collision, about the year 530 B.C., in his attempt to extend his conquests beyond the Aral; and it was in battle with their queen Tomyris that the Persian lost his life. He founded a city on the left bank of the river called Cyreschata, the ruins of which are said to have been discovered by recent travellers. It was next visited by the Greeks under Alexander in 329 B.C., in their invasion of Sogdiana, and a city was founded and named Alexandreia Ultima. But the ancient and modern geography of this whole country is so obscure and often contradictory, that disputes have arisen on the most important points of the subject. These ambiguities and contradictions arise from two circumstances, the inaccessibility of the place, and more particularly the peculiar and remarkable changes of the surface which occur in these parts. The Jaxartes was believed by the ancients to flow into the Caspian. There is now little doubt that the present Sea of Aral formed, at no distant period, a part of the Caspian, as the geology of the district, as well as historical evidence, clearly proves; while, from the former source, it is evident that by plutonic action the position of the rivers, as well as of these great lakes, has been very materially changed, and still is transitory.

JAY, WILLIAM, D.D., the author of some of the best and most widely known manuals of domestic devotion that have appeared in England in this century, was born at Tisbury in Wiltshire, May 6, 1769. His father, a mason by trade, was unable to give him any but the poorest education; and at an early age he began active life as his father's apprentice. Near the village where he was born, the author of *Vathek* was at this time building his splendid mansion of Fonthill Abbey. Jay had been assisting his father for an entire year in the work as an ordinary stonecutter, when he attracted the notice of Cornelius Winter, a dissenting clergyman, who occasionally preached at Tisbury. Pleased with the young mason's intelligence and piety, this benefactor persuaded him to put himself in training for the church. He was himself at the head of an academy in Marlborough, where he prepared young men for the ministry. Though his own resources were small, he undertook that his new protégé should be put in the way of pursuing his theological studies without interruption. How he effected this is not exactly known. It is most likely that he interested some of his wealthier personal friends in his new pupil. To one of them, John Thornton, the friend of Cowper and Wilberforce, and a leading member of what is known in religious history as the "Clapham Sect," he appealed for aid, and that munificent benefactor contributed liberally to the support of the poor student as

St Jean D'Angely ‖ Jedburgh.

he passed through his academic course. Jay, in after life, acknowledged his obligations to Winter by writing his life; a work which became one of the most popular, as it is certainly one of the best, pieces of religious biography that this century has seen. Jay left the training school of Marlborough towards the close of 1788, after three years' and a half of unbroken study. His first call was to Christian Malford where he remained for a year, and was rewarded for his services with a stipend of L.35. He was then called to Hope Chapel in the Hot-Wells of Bristol, where also he remained for a year. At the end of that time he was translated to Bath, and in this town he taught, preached, and wrote, during the remainder of his life. He died December 27, 1853, in the eighty-fifth year of his age and sixty-third of his ministry.

Jay had been for some time an author before his works attracted any notice. The first work that made his name known, was his *Mutual Duties of Husbands and Wives;* and the fame which he gained by this publication was fixed and extended by the four volumes of his *Short Discourses for the Use of Families.* This work had a very large circulation in England, and a still larger in America, where the college of New Jersey honoured itself and him by sending him the diploma of D.D. Still greater, however, was the success of his morning and evening *Exercises for the Closet,* which, since it first appeared, has run through very many editions, and has found its way into nearly every English home. Like all Jay's works, these *Exercises* are earnest, homely, and strongly practical. Breathing a spirit of high and pure devotion, they are also marked by a concise neatness of diction, great aptness, and abundance of illustrations. They always keep in view the purpose they are intended to serve; and so well adapted are they to their end, that while they do not fall below the requirements of the most highly educated, they meet the wants of the least instructed minds.

JEAN D'ANGELY, St, a town of France, capital of a cognominal arrondissement, in the department of Charente Inferieure, on the River Boutonne, 33 miles E.S.E. of La Rochelle. It has two parish churches, an ancient abbey, communal college, hospital, theatre, and a handsome public hall. The chief manufactures are gunpowder and cognac brandy. By means of the river, which is navigable for vessels of from thirty to forty tons, a considerable trade is carried on in wine, brandy, and timber. Pop. (1851) 6187.

JEBAIL, a town of Syria. See Djebail.

JEDBURGH, a royal and parliamentary burgh of Scotland, capital of Roxburghshire, situate on the Jed Water, a tributary of the Teviot, 12 miles S.E. of Melrose, and 47 miles S.E. of Edinburgh, with both of which it is connected by rail. It is surrounded with orchards and fertile fields, and in the neighbourhood are the remains of numerous strongholds built to protect the Scottish border. The town owes its interest wholly to the past, associated as it is with many important events in the history of Scotland. In the oldest chronicles the name is spelt indifferently as Gedworde, Jedworth, Jedwood, and Jeddart. The last of these still lingers among the peasantry. It owed its origin to the erection of the abbey founded by David I. in the twelfth century, and to the castle built about the same time, doubtless as a protection for the sacred edifice. The latter was frequently honoured by the residence of royalty; and Alexander III. selected it for the festivities of his second marriage. Toward the close of the fifteenth and beginning of the sixteenth centuries, Jedburgh appears as a place famous in border warfare. In 1523 it was burned by the Earl of Surrey, and the abbey suffered so severely as to be rendered uninhabitable afterwards. The slogan or war-cry of the inhabitants was "Jeddart's here;" and their mode of first hanging and then trying prisoners has passed into the proverb of "Jeddart justice." After the Union, Jedburgh gradually fell in importance, and it was not till the recent introduction of wool manufactories that it showed any signs of progress. The modern town contains four principal streets, diverging from the great square where the markets are held. The chief buildings of interest are the old abbey and the gaol. The former, which is now little better than a ruin, exhibits in its architecture a very effective blending of the Norman and early English styles. The abbey was long used as a school and church after the Reformation. In the former Thomson the poet received his early education. The gaol, which is a modern building, stands on the site of the old castle not far from the abbey. The trade of Jedburgh chiefly consists in agricultural produce and woollen stuffs. The latter are manufactured in considerable quantities, as well as iron and brass goods. Markets are held in the town every Tuesday and Saturday. The municipal affairs are in the hands of a provost and fifteen councillors; and the burgh unites with Haddington, Dunbar, Lauder, and North Berwick in returning a member to parliament. There are seven churches in the town belonging to the Established, Free, United Presbyterian, Independent, and Episcopal denominations. Pop. (1851) of royal burgh, 2948; parliamentary burgh, 3615.

Jeddo ‖ Jefferson.

JEDDO, Jedo, or Yedo, the capital of Japan, and the largest city, in that empire, is situate on a gulf on the western side of the island of Nipon, in N. Lat. 35. 32., E. Long. 140. It stands on a large plain at the head of the gulf, which is here so shallow that vessels generally discharge their cargoes a league or two below the city. Jeddo is said to be 7 miles in length by 5 in breadth, and to have a circumference of 20 miles. It is not enclosed by walls, but is intersected by numerous broad canals and ditches, having on each side high embankments, on the top of which are planted rows of trees. A river of considerable size flows through the town into the harbour. The houses are small and low on account of the frequency of earthquakes. They are built of wood with thin clay walls, and are divided into rooms by paper screens. The floors are covered with mats, and the roofs with shavings of wood. Being thus entirely composed of combustible materials, fires are frequent and destructive. As the families of the princes, lords, and nobility of the empire are obliged to reside continually at Jeddo, there are numerous houses of a superior class. These, however, are only one storey in height, and have no towers. They are distinguished from the other houses by large courtyards, stately gates, and fine varnished steps leading up to the door. There are besides numerous temples, monasteries, and other religious buildings. The imperial palace is near the middle of the town, and is said to be more than 8 miles in circumference. It consists of several palaces or castles, with large gardens and orchards. Besides being the residence of the court, Jeddo contains flourishing manufactures, and carries on an extensive commerce. The population is variously estimated from 700,000 to 1,500,000, and even more. (See Japan.)

JEFFERSON, Thomas, one of the founders of American independence, and president of the United States, was born at Shadwell, in Albemarle county, Virginia, on the 2d of April 1743. His ancestors had at an early period emigrated to that province, and his father had been one of the commissioners for determining the boundary between Virginia and North Carolina. Having completed his education at William-and-Mary College, Williamsburg, he became a student of law under George Wythe, afterwards chancellor of the state of Virginia; and upon coming of age, he was admitted to the bar, appointed a justice of peace for the county in which he lived, and soon afterwards returned as one of its representatives in the provincial legislature.

The position of public affairs early led him to contem-

Jefferson. plate questions far more comprehensive and important than any of those connected with the administration of his native state. As early as the year 1763 a spirit of opposition to the British government had manifested itself in the province, and continued gradually to increase, until, in 1769, it assumed the shape of a determination not to import articles from the mother country. This resolution Mr Jefferson not only signed, but used all his influence to promote. In the beginning of 1773, a general system of resistance was first organized, by the formation of committees of correspondence in the different provinces. This plan, devised and matured by Jefferson, was eagerly adopted; and, when the measures of the British government in 1774 showed the increased necessity of opposing to them a united and resolute opposition, its benefits became strikingly apparent. The passing of the Boston port act, and the bills which immediately followed that measure, had, in the opinion of the colonists, filled up the measure of oppression and insult. The breach with the mother country daily became wider; and, as a crisis was evidently approaching, Jefferson's plan served not only to concentrate the general spirit of resistance, but also to give it a suitable direction. About this time he published a *Summary View of the Rights of British America*, which he intended as an exposition, to be laid before the sovereign, of the wrongs that country had suffered, and the sort of redress she was prepared to demand. For this publication, Lord Dunmore, the governor, threatened to prosecute him on a charge of high treason, and also dissolved the legislature, which by its resolutions had sanctioned similar doctrines. In the following year, when the legislature was again assembled to consider the conciliatory propositions which had been sent out by the British ministry, Jefferson was appointed a member of the committee to whom these were referred, and he drew up the reply which was presented by that body; a document of great importance in the history of the period to which it refers. But he had scarcely completed this task when he was called to perform a part on a wider field of action. The colonies resolved to unite and send delegates to a general congress, and Mr Jefferson took his seat as a member of that body, then assembled at Philadelphia, on the 21st of June 1775, and immediately became one of its most prominent members. In the following summer, when, from the tone of the debates in congress, and the general expression of public opinion, it appeared that the time had arrived for an entire and final separation from Great Britain, a committee was appointed to draw up a declaration to that effect. Of this committee Mr Jefferson was chairman, and, in conformity to the instructions of congress, he prepared the declaration of independence, which, after a few alterations, was adopted on the 4th of July 1776. This is by far the most memorable event in his life.

During the summer of this year, Mr Jefferson took an active part in the public business; but being obliged in the autumn to return to Virginia, he was, in his absence, appointed, in conjunction with Dr Franklin and Mr Deane, a commissioner to the court of France, for the purpose of arranging with the government of that country treaties of alliance and commerce. Owing to ill health, and other causes, however, he declined the appointment, and shortly afterwards resigned his seat in congress; but being elected to the first legislature assembled under the new constitution of Virginia, he applied himself to introduce various changes and amendments into the laws and institutions of that state, particularly enactments for preventing the importation of slaves, destroying entails, abolishing the right of primogeniture, overthrowing the church establishment, and remodelling the whole of the statutory law. In June 1779 he was elected governor of Virginia, and re-elected the following year. This was a season of imminent peril. The state, invaded on the north and the south, was ravaged by the troops of Tarleton and Arnold, and he himself was the object of especial pursuit. Jefferson. But amidst all the difficulties with which he was surrounded, Jefferson conducted the affairs of the state with so much prudence and energy, that, after the expiry of his term of service, the legislature passed an unanimous resolution, expressive at once of their gratitude, and of the high sense they entertained of his prudence, ability, and integrity. In June 1783, Mr Jefferson was again sent to congress as the delegate of Virginia, and as a leading member of that body, was intrusted with the preparation of the address made by congress to General Washington, when he resigned his commission and withdrew from public life. In May 1784, congress having decided that, in addition to Mr Adams and Dr Franklin, another minister plenipotentiary should be appointed, for the purpose of negotiating treaties of commerce with the French government, Mr Jefferson was immediately elected to this office, and in the month of July sailed for France, where he arrived on the 6th of August. He remained in Europe until the 23d of November 1789, and, during his stay, visited Holland, the N. of Italy, and the principal seaports on the southern and western coasts of France. He also crossed over to England, and, in concert with Mr Adams, endeavoured to negotiate a commercial treaty with the British government; but their efforts were unavailing, and, after a fruitless visit of seven weeks, he returned to Paris. During Mr Jefferson's residence in France, he was not only engaged in various diplomatic negotiations of importance to his own country, but was received with marked kindness by men of letters, science, and political distinction. He was likewise an eye-witness of the extraordinary occurrences in public affairs which took place in rapid succession towards the close of his sojourn in the French capital; he had become acquainted with many of the leading men of the National Assembly, who were disposed to seek his advice, and place confidence in his opinions; and, as the representative of a free nation, he was an object of interest and attention to the principal actors in the new scenes which had opened upon France.

But his stay was not protracted till that fatal period which was darkened by the sanguinary excesses of popular frenzy; and the interest which he took in the French Revolution was consequently warmed by the hope that a great people were about to shake off their fetters, and, by a peaceful but decisive effort, to establish rational liberty upon the solid foundation of improved institutions. In November 1789 he returned on leave of absence to the United States, and there accepted the office of secretary of state offered him by General Washington, instead of resuming his post as minister at the court of France. Whilst in the department of the state, Mr Jefferson laid down those general maxims relative to foreign intercourse, which have ever since been regarded with approbation by the American people, and developed those principles which, in his estimation, ought to govern the conduct of a neutral nation. He understood the true interests of his country: he felt that she required time to consolidate her new institutions, and to strengthen the foundations of the freedom she had conquered; and he laboured assiduously to impress his convictions on the minds of his countrymen. In December 1793, Mr Jefferson resigned his office, and having retired to private life, devoted himself to the education of his family, the cultivation of his estate, and the pursuit of those studies which he had long abandoned, but now resumed with fresh ardour. But he was not long permitted to enjoy the tranquillity of retirement. In September 1796, General Washington made known to the people his wish not again to be a candidate for the presidency; and the two parties which had gradually grown up in the republic found it impossible to unite, as in the case of Washington, in the choice of one individual to whom the administration of public affairs might by com-

Jefferson. mon consent be committed. Mr Adams was selected by the federalists, and Mr Jefferson by the democratic party, as their respective candidates; and upon counting the votes, the former, in whose favour there appeared the higher number, was declared president, and the latter vice-president. At the next election, however, when again put forward as the popular candidate, he proved successful in his opposition to Mr Adams; and, although an accidental equality of votes between him and the person simultaneously chosen as vice-president raised a question which had not been provided for by the constitution, and thus gave his opponents an opportunity of contesting the validity of his election, yet, after a severe struggle, he was declared duly elected, and, on the 4th of March 1801, entered upon his first presidential term. The administration of Mr Jefferson embraced a long and interesting period in the history of the United States, and was distinguished by important measures, which contributed, in no inconsiderable degree, to promote the prosperity and increase the happiness of the free nation at the head of which he was placed. Under it various aggressions were promptly chastised; the attempt made by the agents of the Spanish government to obstruct the free navigation of the Mississippi was repelled; and the vast territory of Louisiana, affording an independent outlet for the western states, was purchased, and placed under the republican institutions of America. During the same period the internal policy of the United States underwent important changes. Measures were adopted for liquidating the public debt; the judicial system was improved; a rigid economy controlled and regulated the public expenditure; all useless offices were abolished; and the president himself set the example of voluntarily relinquishing unnecessary power and patronage. The public approbation formed the best reward of these sacrifices; and hence, when Mr Jefferson's term of service had expired, he was again elected by a majority which had increased from eight votes to one hundred and forty-eight. In his inaugural address, delivered on the 4th of March 1805, he declared his firm determination to continue to act upon those principles on which he believed it to be his duty to administer the affairs of the commonwealth, and which had already been sanctioned by the unequivocal approbation of the country. But he had scarcely entered upon office when an event occurred which seemed calculated to disturb the domestic tranquillity of the United States, if not to endanger the stability of the union itself. This was the conspiracy of Colonel Burr, a man of an ardent and ambitious character, who, disappointed formerly in attaining the first office of the government when it seemed within his grasp, and afterwards superseded in the second by the election of Mr Clinton, now sought, by desperate means, either to establish a new republic in the Spanish provinces of the west, or to break up the federal union in his own country. But his scheme was discovered, and although, when apprehended and brought to trial on a charge of treason, he obtained a verdict of acquittal, yet enough came out in evidence to show the government the extent of its danger, and to indicate the measures necessary to prevent its recurrence. At this period, too, the foreign relations of the United States became greatly embarrassed in consequence of the war which raged in Europe. Nearly the whole of their revenue depended on commerce, and on this serious aggressions had been made by both the belligerent powers, France and Britain; whilst the right of search claimed by the latter was resented as at once contrary to the public law of nations, insulting to the American flag, and inconsistent with free navigation. In this view, the natural and obvious remedy was a declaration of war. But, as it was conceived that the interests and situation of America required the previous trial and failure of all other means of obtaining justice, an embargo was resorted to, and a measure for establishing one passed congress on the 22d of December 1807, in consequence of the recommendation of the president. After this Jefferson. embargo had existed a year, however, overtures were made by the British government, indicating a disposition to abate somewhat of its pretensions; and as these had been preceded by the recall of some of those orders in council to which the Americans most strongly objected, an accommodation was effected without difficulty, because, in fact, the non-intercourse system had proved more prejudicial to the commercial interests of the United States than to those of Great Britain.

Affairs were in this situation when, on the 3d of March 1809, Mr Jefferson's second term of office expired, and with it also terminated his political career. He had now attained the sixty-fifth year of his age, and had for forty years been, almost without interruption, engaged in the most arduous public duties. He had passed with honour and credit through the various stations to which the service of his country had called him, and he now resolved to quit the scene where he had so long acted a prominent part while still unoppressed by the infirmities of age, and to pass the evening of a busy life in the calmness of domestic retirement. From this time until his death, which took place on the 4th of July 1826, he resided chiefly at his favourite retreat, Monticello; sometimes occupying his time with publications of his private correspondence, and at others connecting himself with rising institutions formed to promote the advancement of science, literature, or taste. He was sought out in his retirement by strangers of all nations who visited America, and also by the natives of every part of his own country, who regarded him as "their guide, philosopher, and friend." His residence was the abode of dignified ease and unostentatious hospitality; in the calm enjoyments of Monticello he forgot both the toils and the dangers of his long political career; he took the deepest interest in everything which seemed calculated to advance the improvement or increase the happiness of his country. Amongst his labours of this kind the most prominent consisted in the exertions he made for the improvement of education in Virginia, by the establishment of an university at Charlottesville, a town at the foot of the mountain where he resided. This institution, commenced by his own private donations and those which he succeeded in obtaining from his friends, received the sanction of the legislature. His plans, having for their object to combine elegant learning with strictly useful knowledge, were approved of; he himself was appointed rector of the new university; and from this time forward he devoted himself to consolidate the establishment which he had founded. Indeed, all his thoughts and means were employed to insure its success.

"Thus," says an American biographer, "glided on the evening of Mr Jefferson's patriotic and benevolent life; as age wore gradually away the energies of his body, his mind shone with intelligence undiminished; and his efforts and desires for the progress of human happiness and knowledge knew no change. Years, however, had crowded upon him; and when the increase of infirmities at length prevented him leaving his chamber, he remarked to the physician who sought to assist him by the aid of his art, that 'the machine had worn out, and could go on no longer.' During the spring of 1826 he had suffered from increasing debility, but it was not until the 26th of June that he was obliged to confine himself to his bed. The strength of his constitution and freedom from bodily pain for a short time encouraged the hope that this confinement would be only temporary, but his own conversation showed that he did not himself so regard it. 'Do not imagine,' he said to those around him, 'that I feel the smallest solicitude as to the result. I do not, indeed, wish to die; but I do not fear to die.' His temper retained all its usual cheerfulness and equanimity; his only anxiety seemed to be for the pros-

Jefferson.

perity of the university, and he expressed strongly his hopes that the state would not abandon it; he declared that if he could see that child of his old age fairly flourishing, he was ready to depart,—to say 'nunc dimittis, domine,' a favourite quotation with him. On the 2d of July he appeared free from disease, but his weakness was such that his physicians expressed a doubt whether his strength would prove sufficient to restore him. Conscious himself that he could not recover, and without any bodily or apparently mental pain, he calmly gave directions relative to his interment, which he requested might be at Monticello, without parade or pomp. He then called his family around him, and conversed separately with each of them. To his beloved daughter, Mrs Randolph, he presented a small morocco case, which he requested her not to open till after his death. When the sad limitation had expired it was found to contain an affectionate poetical tribute to the virtues of her from whom he was thus torn away. He desired, if any inscription were placed on his tomb, he should be described only as 'the author of the declaration of independence, of the statutes of Virginia for religious freedom, and the father of the university.' On Monday, the following day, he inquired of those around him with much solicitude what was the day of the month; they told him it was the 3d of July. He then eagerly expressed his desire that he might be permitted to live to another day, to breathe the air of the fiftieth anniversary of the declaration of independence. His wish was granted; the morning of the 4th of July 1826 found him still living; and after declaring himself gratified by the affectionate solicitude of his family and servants, and having distinctly articulated these words, 'I resign myself to my God, and my child to my country,' he gradually expired without a murmur or a groan."

At the time of his death Mr Jefferson had just entered the eighty-fourth year of his age. In person he was above six feet in height, and, though thin, erect and well formed. His complexion was fair, his forehead broad, and his face of a square form, with a thoughtful expression. His address was cordial, and his manner simple, cheerful, and unassuming, yet mingled with a certain degree of native dignity; in his disposition he was full of liberality and benevolence; in his temper he displayed the greatest equanimity, never being known to give way to passion, nor, even during the excitement of political contentions, to indulge in angry or vindictive feelings. His attachment to his personal friends was warm and stedfast; to them he communicated without reserve all that he thought or felt; in regard to them he exercised no diplomatic caution, nor entertained any ungenerous distrust; and he had his reward in that unflinching support which he received from them on every emergency. His application was constant and severe; and his habits were so exact, that in a cabinet abounding with papers, all were arranged in such a manner that any one might be instantly found. Considered intellectually, however, Mr Jefferson does not appear to us to occupy the distinguished rank which has been generally assigned to him by his countrymen, particularly by his eloquent eulogist Mr Webster. On the contrary, he seems to have been one of those men of plain, practical good sense, calm temperament, methodical habits, and persevering application, who make the most of their faculties, and are, upon the whole, much better fitted to excel in the conduct of business than to obtain distinction in pursuits of a higher order, or to stamp the impression of their genius upon the science, the literature, the philosophy, or the legislation of their time. Jefferson was perhaps at the head of the class to which he belonged, but that class was not a high one; and, in truth, he had always been more remarkable for the share which he took in the early formation of the American republic, than for any very predominant superiority of understanding. (*American National Portrait Gallery*, part xxiii.; Jefferson's *Memoirs*, vol. i.; *Edinburgh Review*, vol. xxxi., p. 139; *North American Review*, No. 86.) (J. B—E.)

Jefferson City ‖ Jeffrey.

JEFFERSON CITY, a town of the United States of North America, capital of the state of Missouri, situate on the right bank of the Missouri River, opposite the mouth of Cedar Creek, 100 miles W. of St Louis, with which it has communication by river and rail. It stands on elevated ground overlooking the river, and commands a beautiful prospect. The principal buildings are the state hall, the governor's house, and the penitentiary. The town though thriving has not made such rapid progress as most of the cities in the Union. Pop. (1853) about 3000.

JEFFREY, Francis, Lord Jeffrey, a distinguished critic and Scottish judge, was born in Edinburgh on the 23d of October 1773. His father was one of the depute-clerks of the Court of Session, "not a high but a very respectable situation," as Lord Cockburn describes it, and which enabled its possessor to give his children—two sons and two daughters—a good education. The mother, Henrietta Loudon, a Lanarkshire lady, appears to have been a very amiable and excellent person. She died in 1786, and her family revered her memory. Francis, the eldest son, in his eighth year was sent to the High School of Edinburgh, where he remained till he was fourteen. He was then removed to Glasgow University, and attended college for two sessions. He made considerable progress in the Greek and Logic classes, then taught by Professors Young and Jardine, both able and popular instructors, and regarded with affectionate veneration by Jeffrey, as they were afterwards, by another eminent student, Thomas Campbell. The second session Jeffrey seems to have devoted entirely to the moral philosophy class, taught by Professor Arthur; and upon this slender basis of scholarship he proceeded to Oxford. He was entered of Queen's College, and remained there from October 17, 1791, till June 5, 1792. The young Scottish student was by no means prepossessed in favour of Oxford. He was more inclined towards metaphysical than classical studies; and he seems to have thought with Gibbon that little else than port and prejudice were to be imbibed in the college halls. His opinions already leaned to the popular side; and the stately Toryism of Oxford, which had recommended the university to the father, failed to attract or change the son. Separated from his early friends and relatives, in a scene so totally new and alien to all his feelings he was lonely, dispirited, and helpless. He expected to learn nothing, he said, but the English language! This accomplishment, however, he never attained, for he only grafted some high English tones on his native Scotch, which, even with his fine rich voice, had an effect far from being graceful or musical. Lord Holland happily said, that "though Jeffrey had lost his broad Scotch at Oxford, he had only gained the narrow English." This peculiarity of pronunciation, joined to his *petit* figure and volubility of speech, formed an obstacle to Jeffrey's success at the bar. It gave him an air of superficial smartness and affectation which was only overcome in his highest moods, when the mature lawyer or eager politician, earnest in his cause, and impelled by strong feeling, carried all before him by his rapid eloquence and moral vehemence.

Restored once more to his friends and to Edinburgh society,—and in no one could the home affections or local attachment be more strongly implanted, though little seen on the surface,—Francis Jeffrey applied himself zealously to study. The law was not his favourite pursuit, but it was necessary that he should choose a profession, and this seemed to lie before him. He may be said to have breathed the atmosphere of the Court of Session from his infancy, and his father had held it up as the great object of his family ambition. The usual preparatory training was gone through, and he was called to the bar in December 1794. Previous to this Jeffrey had distinguished himself at the Speculative

Jeffrey. Society, an institution connected with the University, or at least sanctioned by the Senatus Academicus—a sort of intellectual gymnasium of a high character, at which essays were read, and public questions debated. The society had existed in great repute for about thirty years, and had enrolled many eminent men among its members—as Playfair, Dugald Stewart, Mackintosh, Dr Gregory, &c. When Jeffrey joined it in 1792, he found Walter Scott officiating as secretary. In a few years Henry Brougham, Francis Horner, John Archibald Murray, James Moncrieff, and Henry Cockburn became members; and an institution boasting such an array of varied and commanding talent, and enriched with historical associations, might well breathe an invigorating spirit and generous emulation into the youths who crowded to its intellectual contests. Jeffrey was never absent from the meetings, and never present without taking a part in the discussions. He there earned his first laurels, and felt his native strength freed from scholastic restraints, and revelling, as he said, "in the bright and boundless realms of literature and science." At this time he was attached to scientific pursuits, attended chemical lectures, and delighted in every department of natural philosophy.

His progress at the bar was slow, and long doubtful. He laboured under two disadvantages. His sentiments on all public questions were (to the great grief of his father), decidedly at variance with those in whose hands the patronage of Scotland was then vested, and his love of literature was more active and predominant than his love of law. Like most of his associates in the Speculative, he was a Whig in politics; and, in those days to be a Whig in Scotland, was to be proscribed from most of the higher circles in society, to be shut out from most offices of trust, and debarred from nearly all hope of advancement. The bench was filled with judges of high Tory principles—men of resolute character and dominant will, who crushed or discouraged every young aspirant at the bar supposed to be tainted with liberalism; and clients and agents held aloof from counsel, on whom the suspicion or displeasure of the Court rested. Within a period of nine years, from 1794 to 1803, Jeffrey's professional income never, in any one year, exceeded L.100. The unsuccessful advocate, however, was not idle. He continued his studies with unabated ardour, and at one time entertained the ambition of becoming a popular poet. He completed a poem on *Dreaming*, consisting of 1800 lines, in blank verse; he translated the *Argonauticon* of Appollonius Rhodius, extending to above 6000 lines in blank verse; he wrote two plays, one a tragedy, conceived apparently in the spirit of Lillo's domestic dramas; and he threw off copies of occasional verses, descriptive, amatory, and serious,—none personal or satirical. All this was done for the solitary student's own gratification and improvement. He was generally dissatisfied with what he wrote, and seems never, except in the case of the translation, to have contemplated publication. When worshipping the muse in secret, he was, like Chaucer's *Prioress*, "all conscience and tender heart." Had he come forward and challenged public criticism as a poet, he would probably never have been a reviewer. His works would have risen up in judgment against him; and his dread of ridicule, no less than his sense of justice, would have deterred him from condemning others in points where he had himself offended, and from assuming the tone and style of the Dictator. As it was, he was benefited by the exercise. "Many who are not able to reach the Parnassian heights may yet," as his friend Henry Mackenzie has said, "approach so near as to be bettered by the air of the climate." He could not have expatiated so long in verse, or courted the tragic muse, without extending the range of his moral emotions and sensibilities; felicities of expression, metaphors, analogies, and imagery, would be sought after; comparisons would be instituted; and command of language, acuteness of perception, and refinement of taste would follow. We have no doubt that some of the happiest flights of the eloquent pleader and brilliant essayist, might have been traced to the silent and abortive studies of the poetical enthusiast. One distinguishing feature of the poetical temperament he always possessed—he was keenly alive to the beauties of external nature. His letters overflow with expressions of delight when he visited the wild scenery of the Highlands, or reposed for a season amidst the cultivated pomp and beauty of the English parks and woodlands. His residence at Craigcrook commands extensive and noble views—the sea, the distant Highland mountains, and his "own romantic town," seated on its throne of crags;—and to wander at will on those heights contemplating the summer sunsets, or the varied aspects of the sky and surrounding landscape, continued with Jeffrey, till he was upwards of three score and ten, to form one of the most exquisite and indestructible of his enjoyments. Nay, the passion increased with his years, as it does with all men who have not sold themselves to the hollow vanities and traffic of the world. Time that steals away so many of our pleasures seems to leave this, the purest of them all, as the peculiar solace and delight of age. Jeffrey.

The year 1802 may be termed the grand era and turning-point in Jeffrey's life. He had the previous winter married—the marriage having "all the recommendations of poverty," as Lord Cockburn characterizes it. But Jeffrey doubted whether he should get above the L.100 a-year before he was too old to marry at all, and he felt the desolation of being in solitude as something worse than any of the inconveniences of poverty. He was an epicurean philosopher on a low platform. The lady of his affections was his second cousin, a daughter of Dr Wilson, professor of Church History in the University of St Andrews. She survived the marriage only about four years; but happy in his choice, with no impending cloud, Jeffrey set up his household deities in a flat or floor of Buccleuch Place. It was not in the fabulous *eighth* or *ninth* flat, named by Sydney Smith, but in the third flat of the house, now No. 18; and there—in the little parlour, furnished at a cost of just L.13, 8s., as Jeffrey with manly and honourable feeling recorded with his own hand, *and preserved the record*, or in the drawing-room, made ornate at an expense of L.22, 19s.—there assembled a more remarkable body of young men, and was organized a more memorable project than any other room of similar pretensions in Britain ever witnessed. The men were the host himself, Sydney Smith, Francis Horner, Dr Thomas Brown, John Archibald Murray, Dr John Thomson, and Thomas Thomson. As yet Henry Brougham, soon to be the most active of the band, was not admitted to the consultations; for Sydney Smith, stout-hearted as he was, dreaded discovery of their scheme, and feared the rashness of the future Chancellor. The project was the establishment of the *Edinburgh Review*. "I proposed that we should set up a Review," says the witty Sydney, "and it was acceded to with acclamation. I was appointed editor, and remained long enough to edit the first number of the *Edinburgh Review*." In reality three numbers were issued before he left Scotland; and though he was the projector and most active manager, there was no regular editor to the first three numbers. "The motto I proposed for the *Review*," continued Sydney, "was,—

Tenui musam meditamur avena.
('We cultivate literature upon a little oatmeal.')

But this was too near the truth to be admitted, and so we took our present grave motto from Publius Syrus." The motto, as Scott said, was as if the adventurers had hung out the bloody flag on their title page,—*Judex damnatur cum nocens absolvitur*; "The judge is condemned when the guilty

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is acquitted." No quarter was to be given to the public enemy—the critics were not to withhold their arm from battle for pity, need, or respect of persons,—*and they kept their word!* Of this powerful journal a short detail will not be inappropriate. The first number appeared on the 10th of October 1802. The impression of 750 copies was soon exhausted, a second followed, and other and larger editions were called for. Before the *Review* had reached the third number, the regular sale was 2500 copies, and ultimately it rose to about 12,000. Sydney Smith opened a negotiation with the publishers, Archibald Constable of Edinburgh (the Tonson or Lintot of Scotland) and the Messrs Longman of London, which resulted in Jeffrey being appointed editor with an allowance of L.50 for each number, and L.10 a sheet, or 16 pages, for all contributions. "The terms are without precedent," said Mr Longman; "but the success of the work is not less so," added Jeffrey, and in fact in a few years the *minimum* allowance to the authors was raised to sixteen guineas a sheet, and the editor's allowance was more than doubled. The *Review* was an "argosy with portly sail," against which the "petty traffickers" of the monthly and critical reviews had no chance of competition. It bore down all rivalry till Scott took the field.

During the long period of twenty-six years Francis Jeffrey conducted the *Edinburgh Review*. His best contributors were Smith, Horner, Brougham, and Mackintosh. Hallam and Scott lent occasional assistance, and at a comparatively late period Mr Macaulay imparted fresh vigour and brilliancy to its pages. From the first, however, Jeffrey was the most popular and effective writer; besides inciting his coadjutors, and giving consistency and stability to the work, he selected as his peculiar and chosen field the departments of poetry, romance, and biography. Politics he took up occasionally, though in this he was inferior to Brougham, and metaphysical speculation he divided with Mackintosh. He had no theory of his own, but he set himself to disentangle metaphysics from what he deemed doubtful and obscure, and to exhibit what is satisfactory to reason or what bears in any degree on practical purposes. The happiest of all his critiques of this description is his review of Alison's *Essays on Taste*, which he afterwards expanded into the article BEAUTY for this Encyclopædia. He cut off from Alison's theory of association the notion of long trains of ideas and sensations, which he held to be superfluous, and he enforced his views with a clearness and vivacity of style, and richness of illustration, which are perhaps not exceeded even by the finest of Dugald Stewart's disquisitions. In the few essays which he contributed on the old English masters he did good service to literature. His reviews of the Elizabethan writers, and of the wits, poets, and essayists of the Anne and Georgian periods, are generally marked by correct taste and acute discrimination. He did injustice to Swift, whose moral obliquities blinded the critic to the vast intellectual resources of that giant of his age, but he dwelt with cordial delight on the milder charms of Addison, the noble sweep of Dryden's versification, and the pointed brilliancy and antithesis of Pope. He may be said to have revelled among the creations of Shakspeare, Beaumont and Fletcher, Ford and Massinger. The same poetical susceptibility led him to hail Keats as a true poet, and to devote some of his most eloquent pages to Crabbe, Campbell, and Moore. The only defect of these genial essays is, that the style is often loose and careless. The critic's essays, like his speeches, sometimes wanted simplicity and condensation.

In dealing with living authors, Jeffrey had to encounter dulness and conceit, and he was startled by novelties not recognized in his school. Flushed with youthful power and success, he was at times harsh and petulant. He wrote to show his wit, and he failed occasionally to appreciate the higher traits of original genius. Political feeling also warped his judgment. The works of Wordsworth, Southey, and Coleridge were treated with unjustifiable severity. His war with the Lake poets lasted longer than the war of Troy, and he did not come off conqueror. Even the critic's personal friend Scott was schooled with a sort of pedagogical superiority, and his small errors dwelt upon as inexpiable offences. In all these unfavourable critiques, however, the best passages were uniformly quoted; whatever was picturesque, solemn, or figurative, in the work reviewed, found its way into the review. These extracts rendered Jeffrey's criticism's highly interesting; and the reviewer was not wholly to be condemned for his depreciatory criticism. If he dwelt more on faults than on beauties, he conceived it to be his duty to punish sins of carelessness and irregularity with an unsparing hand, in order that he might at once preserve the public taste from corruption, and reform the offender. He sent proof sheets of his most sarcastic articles to friendly parties whom he attacked—to Scott among others—which certainly evinced his courage as well as his conscientiousness. "I let them know," he used to remark, "what I say of them *before they are led out to execution.* When I take up my reviewing pen, I consider myself as entering the temple of truth, and bound to say what I think." He used jocularly to term the table in his study his *dissecting table;* and it bore many remains of mangled authors and fragments of works that he had dismissed to contempt if not oblivion; but there also were gathered many choice and beautiful flowers of fancy, with much solid and valuable fruit, the offspring of rich culture and a teeming soil. One of the bold and slashing articles in the *Review* (1806) led, as is well known, to a duel with Thomas Moore, but the poet and critic afterwards became warm friends, and Moore contributed to the work which had made such an onslaught on his reputation. The hostile criticism on Byron's juvenile poems was another blunder of the *Review;* it was absurdly severe. The offence was not committed by the editor, and Jeffrey amply atoned for his editorial indiscretion by his eloquent criticism on the noble poet's subsequent productions. Byron, in turn, did justice to the worth and generosity of his critic. In one of the later cantos of *Don Juan*, he warmly apostrophises Jeffrey, and makes touching and beautiful allusion to "auld langsyne," Scotch plaids, Scotch hills, and streams,—the visions of youth that floated past him in Italy, like Banquo's offspring, clothed in their own pall—a pall that now covers both poet and critic.

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The political strictures of the *Review* were no less warmly resented by the friends of government. The war in Spain ranged the nation into two decided parties,—one, like Scott, animated with a strong anti-Gallic spirit, and another, like Jeffrey, Brougham, and their friends, predicting that we should reap nothing but disaster and disgrace from the struggle. A review of Don Cevallos on the *French Usurpation in Spain* (1808) by Brougham, was the signal for the secession of Walter Scott and many persons of influence from the *Review*, and led to the establishment of its great rival, the *Quarterly Review*, in London. A class of religious objectors also swelled the cry of opposition. Sydney Smith's attacks on cant and methodism were held up to reprobation. In ridiculing the writings of authors of this class, and endeavouring to root out as he said, "the nests of consecrated cobblers," Sydney's wit sometimes bordered upon profanity, and a hue and cry of heresy was raised against the *Review* which was not extinct for years afterwards. Jeffrey's leading object was more general and enlarged; he wished to combine ethical precepts with literary criticism, "earnestly seeking," as he said, "to impress his readers with a sense of the close connection between sound intellectual attainments and the higher elements of duty and enjoyment, and of the just and ultimate subordination of the latter to the former." This was aiming at a high standard, and the attempt was not unsuccessful. All Jeffrey's writings bore the recommendation of a moral purpose. Since

Jeffrey. his day criticism has become more æsthetic and profound, and accordingly his essays in a collected shape have not been very popular; they had done their work in the original periodical form, and much of their value perished in the using. He was the great pioneer; he achieved much himself; but he had led the way to brighter conquests by others; and in politics this was more strikingly evident than in literature. Time has reversed many of his literary judgments; but to the *Edinburgh Review* may be mainly ascribed the formation and continued growth of that public opinion on which, as Hume has remarked, all governments ultimately rest, and which in England, carried the abolition of slavery, the repeal of the test acts, the emancipation of the Roman Catholics, and the reform of the parliamentary representation and municipal institutions of the country.

Mr Jeffrey's practice at the bar increased with his popularity as a reviewer. He was a careful and conscientious counsel; and when the Jury Court for the trial of civil cases was established in Scotland, he rose to the highest eminence and most extensive practice as a pleader. His professional talents and integrity had borne down all political opposition; and in 1829 his brethren of the bar elected him to the honorary office of Dean of the Faculty of Advocates. He had previously received honours of another description in his election in 1820 and 1822, as Lord Rector of the University of Glasgow.

But we have now to view him in a new and higher scene —in Parliament. The great political change which he had in no small degree helped to bring about, was accomplished. The old idols to which so many had bowed, had been thrown down and dashed on the floor of the sanctuary; the Whigs were in office, and Mr Jeffrey was the Lord Advocate of Earl Grey's administration. In February 1831 he took his seat in the House of Commons as member for the Perth district of burghs. He was unseated by an election committee, in consequence of some irregularity in the return, but through Lord Fitzwilliam's influence he was elected for Malton in Yorkshire. The House of Lords rejected the Reform Bill, Parliament was dissolved, and the Lord Advocate solicited the suffrages of his native city. No less than 17,400 of the inhabitants petitioned the Town Council in his favour, but that self-elected and irresponsible body, sealed against all popular sympathies, rejected him by three votes, thirteen being in favour of Mr Jeffrey, and seventeen supporting his opponent Mr R. A. Dundas. He again tried the Perth burghs, and by a valid election, was returned. In parliament he assisted in carrying the Reform Bill, and when that bill became law, and the new constituency was formed, he was triumphantly returned, along with his friend Mr Abercromby, now Lord Dunfermline, as representative of the city of Edinburgh. He retained his seat until May 1834, when he was elevated to the bench on the retirement of an aged judge, Lord Craigie. His parliamentary experience had extended over three years, and had cost him, in election contests, about L.10,000!

Jeffrey, like Erskine, though pre-eminently eloquent at the bar, is generally considered to have failed as a parliamentary speaker. His career was short, and his health was shattered and precarious. He was fifty-seven ere he entered the House of Commons—a period of life too late to acquire distinction in that difficult arena. His failure was less marked than that of Scarlett, Follett, and other eminent barristers; but it may be conceded that his style of oratory was not adapted for the House of Commons. It was too ornate and refined, and sometimes too prolonged. There was too much leaf for the fruit. The speeches wanted breadth and heartiness, which are essential in a popular assembly. The physical defects of the speaker, to which we have already alluded,—the rapid utterance, and weak, high-toned voice—rendered it difficult for his hearers to follow him; but his speech on the Reform Bill was one of the ablest addresses which that crisis called forth, and there were other occasions on which he spoke with great effect. He was also, as Lord Cockburn has observed, "a regular attender, a good voter, a wise adviser, and a popular gentleman" in the House of Commons. Jeffrey.

As a judge, Lord Jeffrey earned high distinction and implicit confidence. The most plodding and prosaic lawyer could not have been more industrious, though few could rival him in the clearness and vivacity with which he stated his legal decisions. The rapidity of his intellect sometimes led him to interrupt counsel, in order to elicit the truth, or detect sophistry; but this, as his friendly biographer states, was done with great urbanity, and solely from an anxiety to reach justice. He was, in fact, as popular with the counsel as he was with the public. In his periods of leisure, Lord Jeffrey still devoted attention to literature. He read much; carried on a considerable correspondence; and took a lively interest in the *Edinburgh Review*, to which, after his becoming a judge, he contributed one or two articles,—tributes to the memory of Wilberforce and Mackintosh. So late as 1848, he wrote a paper on the claims of Watt and Cavendish as the discoverers of the composition of water. His health had been long weak, but his death was sudden and unlooked-for. On Tuesday, January 22d, he discharged his usual official duties in the Court of Session; on the Saturday evening following he was no more. He died January 26, 1850, aged seventy-seven, and was interred in the Dean Cemetery His death was deeply mourned in his native city, with which he seemed to be peculiarly and indissolubly identified. To Walter Scott belongs the honour of creating a new and splendid epoch in our national poetry and in historical romance, which, while it embraced all the civilized world in its effects, shone with a peculiar and renovating lustre on his native country. Francis Jeffrey was the founder of a school of philosophical criticism and independent thought that has exercised greater influence on public opinion and contemporary literature than all the universities in the kingdom. His merits were high and various. In literature, he was long the prince of critics. In law, he was the most eloquent of advocates, and the most upright and discriminating of judges. As a politician, he was the enemy of all oppression, intolerance, and wrong, and the friend of every institution and measure that tended to enlighten and benefit society. In private life he displayed all the social virtues, and specially he was one of the most brilliant conversationists of his age; full of wit, "that loved to play, not wound," and of fancy that seemed inexhaustible in its combinations and imagery; the man of genius, and the patriot; kind, hospitable, generous, and disinterested. The rashness and precipitancy that marked some of his early judgments and opinions had disappeared long before his death. The youthful asperities and crudities had been removed or mellowed down by time and reflection, and the nobler qualities of his heart and mind became only more active and transparent with his years. He had gained all the prizes of honest ambition; he enjoyed wealth and honours without detraction or envy; he had survived all political and literary animosities; and he died before his intellectual powers or the fine humanity of his nature had suffered diminution or decay. For one who had toiled so incessantly, who had mingled in the stormy contentions of the world, and was as courageous as he was gentle and courteous, who had attacked established prejudices, and promulgated his canons of criticism and party denunciations with a sort of defiant power, this was a rare and enviable felicity. It could only be the reward of solid virtues and substantial services. It has been the lot of few, but all seemed willing and happy that it should be the lot of Francis Jeffrey.

Lord Jeffrey was twice married; the second time, in 1813, to an American lady, daughter of Charles Wilkes, Esq.,

Jeffreys ‖ Jelalabad.

New York. He left one child, a daughter, married to Professor Empson, Haileybury, lately deceased. Mrs Jeffrey survived her husband only about four months, dying May 18, 1850. (R. C—S.)

JEFFREYS, GEORGE, LORD, better known as "Judge Jeffreys," an English lawyer, whose name has become a proverb of infamy, was born in 1648 at Acton in Denbighshire. His father was a country squire of means so small that he was unable to do more for his son than give him a good legal education. That son, however, soon showed himself possessed of qualities that made him quite independent of aid from without. Charles II. described him as a man who "had no learning, no sense, no manners, and more impudence than ten carted street-walkers." The first half of this character is hardly fair to Jeffreys; the second, true so far as it goes, falls far short of the whole truth. "His legal knowledge," says Macaulay, "was merely such as he had picked up in practice of no very high kind. But he had one of those happily constituted intellects which, across labyrinths of sophistry, and through masses of immaterial facts, go straight to the true point." His manners were marked by a wild and brutal ferocity which was never matched or even approached by the worst of the bullies and prostitutes that he himself ever condemned to be flogged at the cart's-tail. To describe his impudence in brief compass is quite beyond the powers of language. In his wilder moods it ceased to be impudence, or even impudicity, and rose into paroxysms of a terrific and half maniacal frenzy. When to these qualities are added the cunning of a wild beast, the cruelty of an inquisitor, and a malignity that gloated and revelled in the shrieks and groans of its unhappy victims, it will be easily seen why the name of Jeffreys is even now hardly ever pronounced by the Englishman without a curse. Jeffreys first rose into notice by attending the assizes at Kingston when every other member of the profession was frightened away by the plague, then raging there. This act would seem to indicate that, until his swinish habits of drunkenness and debauchery had ruined his nerves and sapped his strength, he was not without a certain amount of courage. He worked himself into practice at the Old Bailey, and early became common serjeant, and then Recorder of London. Having in this capacity shown himself a willing tool of the court, he gradually rose till, in 1683, he became chief-justice of the King's Bench. After the failure of Monmouth's mad attempt on his uncle's crown, it was Jeffreys' duty to traverse the western counties and punish all who had been taken in revolt. In this tour, characteristically called "the Bloody Assizes," or Jeffrey's campaign, the chief-justice made it his boast that he had hanged more traitors than all his predecessors together since the Conquest. Lord Lonsdale says that his victims numbered 700; Burnet, 600. The list sent by the judges to the Treasury gives 320, which is probably far short of the truth. For these important services he was rewarded by James with the office of Lord High Chancellor, and he continued to serve his patron with his whole soul till the Revolution. When that event deprived him of his only friend, Jeffreys, conscious of danger if not of guilt, tried to fly the kingdom. Disguising himself as a sailor, he lurked at Wapping, watching for a vessel to carry him to the continent. An attorney whom he had browbeaten and bullied from the bench some time before, recognised him by the ferocious glare of his eyes as he was staring out of a tavern window. The alarm was given, and Jeffreys was only saved from being lynched by the mob by the arrival of a strong guard. He was carried to the Tower of London, where he died April 19, 1689.

JELALABAD or DOOSHAK, an ancient city of Seistan, in Afghanistan, about 250 miles W. of Kandahar, situate 4 miles from the right bank of the Helmoon River, and about 10 miles E. of the Lake Hamoon. This town was once large and flourishing, and is said to have been almost as populous as Ispahan. At present it only contains about 10,000 inhabitants, and covers not more than a fourth of its ancient area, which is now strewn with broken fragments of its former greatness. There is a good bazaar in the town, and the streets are better laid out than in the generality of eastern cities. Jelalabad ‖ Jena.

JELALABAD, a town of Afghanistan, in the province of Cabool, situate in the rich plain of Jelalabad. Though advantageously built on the main road from the Punjaub to Cabool, it has neither trade nor manufactures. It will, nevertheless, be ever celebrated in history in consequence of the heroic and successful defence made during the winter of 1841 by a handful of British troops, under Sir Robert Sale, against a numerous army of Afghans. The fortifications were destroyed by order of General Pollock, on his final evacuation of Afghanistan in 1842. Lat. 34. 25. Long. 70. 28.

JELATMA, a town of Russia, government of Tambov, and 150 miles N. of the town of that name. It stands on the River Oka, and, by the facility of river communication, carries on a trade in corn, tallow, wax, &c. The manufactures comprise linen, sailcloth, and vitriol. Pop. (1851) 5953.

JELETZ, a manufacturing town of Russia, in the government of Orel or Orlov, situate on the left bank of the River Sosna, 256 miles S.S.E. of Moscow, and about 100 miles from the town of Orel. Its trade has increased very much of late, and the manufacture of iron, which abounds in the neighbourhood, is gaining importance. Grain and cattle are staple articles, while iron, leather, and soap form the principal manufactures. Pop. (1851) 24,340.

JEMAULABAD, a town and fortress in the S. of India, province of Canara, which was originally called Narasingha Augady. The first, which was built by Tippoo, stands on the summit of an immense rock, which may be deemed impregnable, as it is wholly inaccessible except by one narrow way. The nature of the access to it, however, renders the approach to it in the face of an enemy nearly as difficult as the ascent; so that a very small body of men with artillery are adequate to blockade a strong garrison, which renders the place of little use, excepting as a safeguard for treasure or records. After the fort was built by Tippoo, he placed in it a khiladar or commandant, with a garrison of 400 men; and the town at that time contained 1000 houses, and carried on a considerable trade. On the invasion of Mysore, the Coorg rajah destroyed the town, and carried away half the inhabitants; the remainder made their escape into the woods, and only about twenty houses have since been rebuilt. After the fall of Seringapatam, it sustained a siege of six weeks from the British, when, being bombarded, it was taken, and, the commander having poisoned himself, his principal officers were hanged. It was afterwards surprised and taken by a band of insurgents or plunderers, when it was reduced, after a blockade of three months, and all that did not escape were summarily executed. The surrounding country is woody. E. Long. 75. 22., N. Lat. 13. 2.

JEMMAPES, a large village and commune of Belgium, province of Hainault, and arrondissement of Mons, 3 miles W. of the town of that name. It stands on the River Haine, and on the canal between Mons and Conde. In the vicinity are limestone quarries and coal-mines. Here, in 1792, the French, under Dumouriez, gained a decisive victory over the Austrians. Under French rule Jemmapes gave name to a department which was nearly co-extensive with the present province of Hainault. Pop. of commune (1851) 8387.

JENA, a fortified town, the capital of a cognominal circle in the grand duchy of Saxe-Weimar, is situate in a valley on the River Salle, here crossed by a handsome stone

Jenner. bridge. It is 12 miles E. of Weimar, and 45 miles S.W. of Leipzig. It has long been famous as a seat of learning, and is also celebrated for the great battles fought in its neighbourhood. The university of Jena was founded in 1547 by the elector John Frederic, and was opened in 1558, under the joint patronage of the ducal houses of Weimar, Altenburg, Coburg, and Meiningen. Its halls and lecture-rooms were soon filled with students from all parts of Germany; and the fame of the prelections delivered in its theatres made the attendance yearly increase. The largest number of matriculated students was in 1813, when it amounted to nearly 3000. From that date, however, the numbers have been gradually diminishing, partly from a want of proper academic discipline, but chiefly from the erection of several new colleges in other parts of the country. In 1850 there were about 400 students and 75 teachers, including professors and tutors. The great names which are associated with this university are numerous, and justly celebrated in the departments of philosophy and theology. Gerhard, Buddeus, Dantz, Fichte, Schelling, Hegel, Griesbach, Gabler, and Schiller, have all taught within the walls of the college. The garden in which the observatory stands was long the favourite resort of the last, who is said to have composed many of his works there. In connection with the university there is a library containing 70,000 volumes and many valuable MSS., an hospital, a lunatic asylum, botanic garden, and observatory. The students have also admittance to the museums of natural history and archæology in the ducal castle. Besides the above-mentioned buildings Jena contains a Roman Catholic and three Protestant churches. The courts of appeal for the Saxon duchies and Reuss princedoms are held in the castle. The trade of the town is unimportant; and the manufactures consist only of coarse linen, tobacco pipes, and hats. The famous battle of Jena, fought in October 1806 between the Prussians, under Prince Hohenlohe, and the French, under Napoleon, when the former were defeated, took place in the neighbourhood of the town. This battle, however, must be carefully distinguished from that of Auerstadt, which happened after the defeat of the Prussians by Bonaparte, but which is apt to be confounded with it from the proximity of the places and time of the two events. Pop. (1852) 6502.

JENNER, EDWARD, an English surgeon and physician, and the discoverer of *vaccination*, was born in the vicarage house of Berkeley in Gloucestershire, on the 17th May 1749. He was the third son of the Reverend Stephen Jenner, A.M., Oxon. rector of Rockhampton and vicar of Berkeley. His mother was the daughter of an English clergyman, the Reverend Henry Head, of an ancient Berkshire family, who also at one time held the living of Berkeley, and was a prebend of Bristol.

The family of Jenner was of some standing and antiquity in the counties of Gloucester and Worcester. It has produced several eminent men besides Jenner. Among these may be mentioned, Dr Thomas Jenner, president of Magdalen College, Oxford. Jenner's father possessed considerable estates in Gloucestershire in addition to his church preferments. He was also tutor to the late Earl of Berkeley, and was highly esteemed by the whole of that noble house, which equally gave its friendship to the son.

Jenner's father died when Jenner was only five years old; his elder brother Stephen, a beneficed clergyman and fellow of Magdalen College, Oxford, took charge of his education. At about the age of eight, when at school at Wotton-under-Edge, Jenner first displayed that taste for natural history which was so prominent and eventually so important a point in his character.

His education for the medical profession commenced, as was then usual, with an apprenticeship to a medical practitioner. Mr Ludlow, an eminent surgeon of Sodbury (or Sudbury), near Bristol, was Jenner's master. In his twenty-first year he went to London and became a private pupil of John Hunter, with whom he resided for two years. The community of their tastes and the mutual esteem and regard which arose out of this connexion laid the foundation for a lasting friendship between these two great men, which was broken only by Hunter's death. In after life Jenner never failed to speak in the warmest terms of Hunter. Jenner.

Under so distinguished an anatomist, Jenner acquired an almost unrivalled skill in minute dissections and delicate injections of parts. When in 1771, Cook, the great oceanic explorer, returned from his first voyage of discovery, Jenner was recommended to Sir Joseph Banks as a fit person to assist in putting up and arranging the valuable specimens of natural history which were collected during that voyage. This task he accomplished, and exhibited at the same time so much dexterity and knowledge, that he was offered the appointment of naturalist to the next expedition, which sailed in 1772. Jenner refused the offer, preferring to return to Berkeley where he commenced practice as a country surgeon. His first attempts were very successful, for although so young his practice rapidly increased. Adding to professional skill the manners of a thorough gentleman, and the information of a scholar, he was a welcome guest in the most distinguished families.

A mind so genial as Jenner's, and with so quick a perception of the Beautiful, could not fail to have a tinge of the Ideal. It is not remarkable, therefore, that he cultivated occasionally the art of poetry. He would read his compositions at convivial meetings, or send them to friends in the ordinary interchange of literary correspondence. One of these has long been popular, and has been read by many without a suspicion that the author of them was the discoverer of vaccination. *The Signs of Rain*, in metrical verse, commencing—

> "The hollow winds begin to blow,
> The clouds look black, the glass is low,"

was sent by Jenner as an excuse for not accepting the invitation of a friend to make a country excursion. It is remarkable for its combination of the minute accuracy of the naturalist with an easy versification not unworthy Crabbe. He was a good hand too at an epigram or a ballad, and he could sing his own verses in good taste. He was particularly fond of music, and could play on the violin and flute, as well as sing.

It was not until the year 1795, at the age of fifty, that he published to the world the results of his researches into vaccination, and announced the discovery that has immortalized his name. But previously to this date he laboured much at various scientific subjects as well as at experiments on the cowpox. He corresponded regularly with John Hunter on questions of natural history, comparative anatomy, physiology, and pathology, sending him specimens of all kinds, giving him hints and facts, and instituting and carrying out observations and experiments suggested by Hunter. The results of some of these latter were published in Hunter's paper on the Heat of Animals and Vegetables, printed in the *Philosophical Transactions* for 1778, and of others in Hunter's *Observations on some Parts of the Animal Economy*, published in 1792. He dissected many "freemartins," as he himself states in a letter to Dr Worthington, dated 1810; adding that he was the first (some thirty years ago) who made known to John Hunter the condition of the sexual organs in these animals; and so laid the foundation for Hunter's paper on the subject published in the *Philosophical Transactions*. He first communicated the results of his researches in pathology to two small medical societies of the district. His essay on *Angina pectoris* which forms the ground-work of his friend Dr Parry's work, was one of these. Another communication contained

Jenner. observations on a disease of the heart, which frequently comes on during attacks of rheumatism, and leads to enlargement and disorganization of the viscus. This (like others) fell into the hands of members of those societies, and was lost. It would have constituted a most important contribution to the literature of practical medicine, as it was doubtless an anticipation of the subsequent researches of Watson and Bouillaud on the same subject. He also wrote an essay on *Ophthalmia*.

At a later period (1790) he inquired very carefully into the nature of tubercular deposits, which he believed to be allied or analogous to hydatid formations. He also investigated the anatomy and pathology of the lymphatic system. In reference to this subject, and further to elucidate it, he had recourse to comparative anatomy and pathology. Some of his earliest views on the formation of tubercles in the lungs, were communicated to Dr Beddoes, and were published by the latter in his work on *Factitious Airs*. They were also made public in a more mature form by Dr Baron, his intimate friend and biographer, in his two works, the one *On the nature of Tubercular Accretions on Serous Membranes* (1819), and the other, *Illustrations of the Inquiry respecting Tuberculous Diseases*, published in 1822.

Perhaps this is the best place to mention another question in practical medicine which occupied Jenner's attention, although at a later period. A curious custom, apparently indigenous, has been noticed in various districts of Great Britain and Ireland—namely, the dipping or immersion in water, by a regular "professor," of a person attacked with hydrophobia, with a view to cure. The vale of Gloucester was a "dipping country;" and, as Jenner remarks in one of his letters, Pyrton Passage, four miles from Berkeley, has been noted for the practice for time immemorial. His thoughts, therefore, had not been idle, and he wished to see how far the practice could be supported by analogy, by getting some vaccinated person dipped within a few days after the insertion of the lymph.

It was at the medical societies just referred to that Jenner was accustomed to bring forward the reported prophylactic virtues of cow-pox, and to strenuously recommend the subject as one well deserving inquiry. Although he received no encouragement from his medical friends, he often recurred to the subject, until at last he was threatened with expulsion as an insufferable bore.

The vale of Gloucester was favourable to geological research, and Jenner was not the man to neglect the advantages it offered. His correspondence with John Hunter often refers to organic remains. He was within reach of the principal oolitic series and the lias formation, both rich in fossils. Of these he made a large collection. But he was also busy at the same time with pharmaceutical chemistry, and in particular he instituted experiments with the view of producing tartar emetic more uniform in its composition, and, therefore, in its medicinal action, than that which commerce supplied. The description of his process is published in the first volume (1793) of the *Transactions* of a Society for the Improvement of Medical Knowledge, having been communicated to that society by John Hunter.

In 1783 Montgolfier made public the result of his first experiment in aërostation. Jenner was much interested in it, and having constructed a balloon, had it filled with hydrogen gas in the hall of Berkeley Castle.

This was not the only instance of the versatility of his studies, for, in 1787, we find him writing to Sir Joseph Banks a letter in which, amongst other matters, he gives a detailed account of his experiments with artificial manures. Agricultural pursuits occupied his attention from time to time during the rest of his life.

His paper on the Cuckoo was one of his most carefully elaborated essays, and was finally read to the Royal Society 10th March 1788, and printed in the *Philosophical Transactions* of that year. Jenner had spent portions of several years and much labour in the collection of the facts contained in it. It explained the habits of the cuckoo very satisfactorily, and has always been considered as a model of accurate investigation. His *Observations on the Migrations of Birds*, read to the Royal Society, Nov. 27, 1823, may be classed with this paper on the cuckoo. Jenner.

The domestic incidents of Jenner's life at this period were important to him and to his future career; but not otherwise remarkable. In 1778 he experienced a disappointment in his affections. For several years after he still felt mortified and miserable on account of it, for, in one of his letters dated 1783, he complains that still the same dead weight hangs upon his heart, and expresses the pleasure with which he could "see an end of this silly dream of life." On the 6th March 1788, ten years after his disappointment, he was married to Catherine Kingscote, of an ancient Gloucestershire family.

In 1793 Jenner was deeply affected by the death of John Hunter. Already in 1777 Hunter had had an attack of the disease that was ultimately to destroy him; but it was Jenner's affectionate and anxious attention to his symptoms which at that time enabled him to detect its true nature. In 1778 he wrote out, but did not send, a letter to Dr Heberden, giving his opinion as to the nature of John Hunter's illness (*Angina pectoris*) and his reasons for entertaining it. The examination after death fully established the correctness of Jenner's views.

In 1792 Jenner determined to give up the general practice of his profession, and practise as a physician only. With this view he obtained the degree of Doctor of Medicine from St Andrew's.

In 1795 he commenced his professional visits to Cheltenham (which he continued for many years), it being obvious that Berkeley could never support a physician. In the spring of this year he had performed his first vaccination, and was preparing to bring the results of his investigation before the public. In the year 1798 he published the *Inquiry*, being his first work on the subject. Henceforth the immortal name of Jenner was to be identified with vaccination. It will be necessary, however, to return to the earlier years of Jenner's life if we would trace the gradual development of the idea which was ultimately to confer such incalculable benefits upon the whole human race for so long as *variola*, or small-pox, shall infest it.

It was while Jenner was yet an apprentice at Sudbury that his mind was first directed to the study of cow-pox. A young countrywoman came one day to his master's house to seek advice; small-pox happened to be mentioned in her hearing, and she remarked, "I cannot take that disease, for I have had cow-pox." It was the first time that the popular notion had been fairly brought before Jenner's mind, and it rivetted his attention. He resolved to let no opportunity of acquiring knowledge on so interesting a subject escape him. When, in 1770, he went to London, he repeatedly mentioned the circumstance to John Hunter, who made Jenner's opinions, and the popular notions of Gloucestershire, known both to his class and in conversation. Other lecturers made mention of them also.

About 1775 Jenner began to examine more particularly into the truth of the popular notions; but it was not until 1780 that he could report satisfactory progress. He had first to get at the natural history of the various forms of varioloid eruptions, such as swine-pox, chicken-pox, and spurious cow-pox, and to determine the distinguishing characteristics of each. Both numerous experiments and extended observations were required, with few opportunities for either; he did not, therefore, hesitate to experiment on his own and only son. When the child was a year and a half old he inoculated him for swine-pox successfully, and at six different periods shortly after he inocu-

Jenner. lated him with variola, without the slightest inflammation resulting. It was only after repeated experiments that he ascertained it was only in a certain state of the pustule that the virus of the cow-pox imparted a protecting condition; taken otherwise, there might be local inflammation of a peculiar character induced, but it gave no protection. In 1787 he had already come to the conclusion that the vesicular inflammation of the horse's heel, termed "grease," was varioloid. In 1788 he took with him to London a drawing of the casual vaccination as seen on the hands of the milker, and showed it to Sir Everard Home, Mr Clive, and others. Hitherto, however, he had only observed the casual disease, and the various epizootic forms; he had not communicated it from human being to human being.

The 14th of May 1796 is the date given by Jenner as that on which he vaccinated James Phipps, a healthy boy about eight years old, with lymph taken from the hand of Sarah Nelmes, a maid-servant who had been infected by her master's cow. On July 19th following, he announced the success of the experiment to his friend Gardner, adding, "But now listen to the most delightful part of my story,—the boy has since been inoculated for the small-pox, which, as I ventured to predict, produced no effect." Phipps lived to be inoculated twenty times for small-pox, and equally at each time without effect. In October 1818 Dr Baron found Jenner planning a cottage for Phipps (whose health was much impaired), which was built, and its little garden laid out and stocked with roses from his own shrubbery, under his personal superintendence.

It was not until the spring of 1790 that the opportunity was again afforded him of resuming his researches, for the cow-pox disappeared from the dairies. In the meanwhile (1787) he made many efforts to generate the virus from the heel of the horse, but in vain. He had also completed his *Inquiry into the Causes and Effects of the Variolæ Vaccinæ*, which was published in the summer of 1798. The second edition came out in 1800, and the third in 1801.

Before he published his *Inquiry*, Jenner thought it prudent to go to London, and there demonstrate the truth of his delineations and assertions by performing vaccination himself. With all his efforts and the efforts of his friends, not one individual could be persuaded to submit to the operation; and, after a fruitless stay of three months in London, Jenner left it for Berkeley, his patience exhausted.

Jenner's announcement of his discovery was received as such announcements usually are. The sanguine and benevolent set no bound to their anticipations; the envious and narrow-minded did not fail to deride and condemn the practice. But, upon the whole, it had a favourable reception, and researches were instituted in various directions to confirm and develope it.

From the date of the publication of his *Inquiry*, Jenner may be said to have become a public character; for he was mixed up, more or less, with all the proceedings instituted in his own country to apply the discovery to practical uses, and had at the same time a world-wide correspondence with foreign lands. The history of vaccination will have a separate consideration (see VACCINATION), so that the incidents in the life of Jenner need only be mentioned here.

Jenner soon had to meet his opponents in controversy. The earliest of these was Ingenhousz, a distinguished German physician, and the confidential adviser of the royal family of Austria. Jenner tried to meet his objections, but an imperial physician felt it rather humiliating to retract an error; so that, finding him altogether intractable, Jenner published, on April 5, 1799, the explanations he had given to him under the title of *Further Observations on the Variolæ Vaccinæ*.

Jenner's worst opponents were not, however, the avowed antagonists. Like all men in his position, he had secret foes acting the part of candid friends, or invidious men, covetous of his probable fame, and scheming to appropriate it to themselves. Such an one was Dr Pearson, who, so early as Nov. 8, 1798, published a pamphlet in defence of vaccination; in which, however, he undertook to set Jenner right by his "own reasoning," while, diplomatically, he hinted to Jenner privately that the principal facts (which he acknowledged) would be better established by his not uniformly acceding to all Jenner's doctrine. Pearson co-operated with Dr Woodville, physician to the Small-pox Hospital; and when Jenner went to London, in March 1799, he found that they had already vaccinated 200 persons; but, unfortunately, they were ignorantly using a contaminated varioloid virus, and sending it about the country as the true vaccine lymph. These proceedings greatly discouraged Jenner. He therefore published, in this year (1800), a *Continuation of Facts and Observations relative to the Variolæ Vaccinæ;* in which, with much moderation and accuracy, he investigated the facts and arguments of Woodville and Pearson. Jenner.

Pearson had soon thrown off the mask, for, hardly had Jenner left London (in the summer of 1799), than, without a word to the latter, he began to scheme the establishment of a Vaccine Institution, in which he, and not Jenner, was to occupy the most conspicuous position.

It was very obvious that the time had arrived for the establishment of some system of co-operation and mutual support amongst the true friends of vaccination. The whole weight of defending and extending the practice could no longer, with any propriety, be left wholly to Jenner, as hitherto. But Jenner felt that his experience was all important and ought to have a predominant influence in any public vaccine institution. We therefore find him in London in March 1800, communicating proposals to Lord Egremont for an institution of the kind. He at the same time secured the warm support of the Duke of York (who at first leaned to Pearson), in the first instance, and next of the Duke of Clarence, the King and Queen, the Prince of Wales, and other members of the royal family. Indeed, all his best friends rallied round him on this occasion. His scheme was not, however, carried into effect by the establishment of the Royal Jennerian Society until three years afterwards.

During this year the Count de la Roque translated the *Inquiry* into the French language, three editions of which translation were exhausted in less than seven months. On the 3d May 1801 the *Madrid Gazette* announced a translation into Spanish, and about the same time there appeared another by Dr Davids into the Dutch. Jenner's time was now wholly occupied with the correspondence which poured in upon him from all quarters, and with the arrangements necessary for transmitting lymph to the various countries from which he had applications for it. As he himself said, he was the *vaccine clerk* of the world. In five years from the date of his first public announcement of his discovery, vaccination had made its way into every civilized country, and was everywhere hailed as an inestimable blessing. Medals, diplomas, and complimentary verses and addresses poured in upon him from every side. He did not, however, neglect home duties, but offered gratuitous vaccination to all the poor who might think right to apply to him on certain fixed days. This practice he continued for the rest of his life. It proved to be particularly laborious whenever an alarm of small-pox took place; on such occasions he would have three hundred persons waiting at his door.

Early in 1801 Jenner published his *Account of the Origin of the Vaccine Inoculation*. About this time he began to investigate other diseases of animals, and in particular that of dogs known as "the distemper." He believed that vaccination rendered them less susceptible of the disease. In June 1801 he and his nephew, George Jenner, vaccinated about twenty of His Majesty's stag-hounds; and in consequence of this step it became a common practice (as it is

still) to vaccinate valuable sporting dogs. A paper by Jenner on the distemper, together with an account of two cases of small-pox communicated to the fœtus in utero, was published in vol. i. of the *Medico-Chirurgical Transactions* (1809).

In October of this year (1801) vaccine lymph reached Moscow at the time of the coronation of the Emperor Alexander. On the 10th August 1802, the Empress Dowager sent Jenner a most gracious and complimentary letter signed by herself, accompanying it with a valuable diamond ring. Towards the close of this year his friends in his native county of Gloucester, presented Jenner, in gratitude for his services, with a small service of plate bearing appropriate devices and inscription.

In the year 1802 the first parliamentary grant was made to Jenner. It was amply merited. He had spent much time as well as toil on his discovery; he had sacrificed great professional advantages; and he had disbursed largely and liberally from his own private fortune, in order to assist in conveying the vaccine lymph and the knowledge of its uses to the most distant countries. He was by no means in independent circumstances, and he had a family and many relatives who looked to him for support. His friends, therefore, warmly urged upon him the propriety of his petitioning Parliament for some remuneration for his services, which he accordingly did on 17th March. It was referred to a committee of which Admiral Berkeley was chairman.

Although Jenner's friends were active, his enemies were not idle. The opportunity now afforded to injure him was seized by Pearson, who endeavoured to lessen the weight of his claims to remuneration by insidiously attempting to show to the committee that vaccine inoculation had been practised before Jenner took it up; and that, although Jenner was the first to promulgate the practice, his opinions were erroneous, and had to be corrected by others, but especially by himself (Pearson) and Woodville. The grant was opposed in the House on very frivolous grounds. Mr Bankes of Corfe Castle thought its first duty was to guard the national purse, and that Jenner ought to have remunerated himself by making a secret of his discovery. The Chancellor of the Exchequer thought the "approbation" of the House was the highest reward that could be given him, inasmuch as it would lead to an extended and very lucrative practice. The proposition for the grant of L.10,000 was carried, but only by the narrow majority of three.

Jenner's feelings were deeply wounded by the mode in which the grant was made. He would gladly have repudiated the whole affair. Nor did it add either to his wealth or professional success. It was still unpaid at the end of two years; he was loaded with additional taxation in consequence of it to the amount of L.400 a-year; the expenses of his "petition" amounted to nearly L.1000; and when at last the money was paid to him, about L.1000 was withheld on the pretence of fees due. He had, therefore, no pecuniary remuneration for his labours, for the balance left hardly met his expenses out of pocket.

Jenner now thought, however, that he might venture to grapple with the risks and costs of practice in London. Elated and allured (as he himself states) by the speech of the Chancellor of the Exchequer, he took a house in Hertford Street, Mayfair, for ten years, at a high rent; but the result of his first year's practice sufficed to show the falsity of the minister's prediction.

His emoluments at this time from vaccination, were not more than L.350 per annum. The year 1804 therefore finds Jenner at his own happy home at Berkeley and amongst his old friends at Cheltenham, a poorer man in pocket, but a richer man in this world's wisdom, although somewhat saddened by his disappointments.

It must not be concluded, however, that all was darkness while in London. Early in the year 1803 the Royal Jennerian Society was established, according to his own plan, under the most favourable circumstances, and in a way as flattering to himself as possible.

On the 3d February Jenner took his seat for the first time as president of the society, and on the 2d March headed a deputation to the King, to return thanks to his majesty for his patronage of the institution. In order to render due honour to the man whose name it bore, the members resolved to celebrate the anniversary of the Royal Jennerian Society on Jenner's birth-day, May 17; and, accordingly, the first festival took place this year on that day,—Lord Egremont in the chair.

At the close of 1803 Jenner had the first opportunity of exercising that influence with foreign governments which his discoveries and character had secured him. The sudden breaking out of the war, after the peace of America, found many of our countrymen in France, who, as is well known, were most unjustly prevented leaving that country. Jenner applied to General Andreossi in favour of some of these, but he also tried his influence with the National Institute of France (with which he had already corresponded) on behalf of Lord Yarmouth as well as others. In February 1805 he addressed a letter to Napoleon himself, requesting permission for "two men of science and literature" (Dr Wickham, one of the Ratcliffe travelling Fellows of Oxford, and Mr Williams) to return to England. It was on this or some similar occasion that Napoleon, being about to reject the petition, heard Josephine utter the name of Jenner. The Emperor paused for an instant, and exclaimed, "Jenner! ah, we can refuse nothing to that man." He subsequently made other applications to Napoleon, each with the like success. In 1808 he interfered in a similar way, and as successfully, with the Spanish government for the release of an English gentleman from ten years' confinement in a Mexican fortress. By direct application to the Emperor of Austria, he served the son of Sir John Sinclair. In fact, about this time his name was so potent and his influence so well known, that persons left England with certificates signed by him, which had all the force and value of real passports. The document stated the objects of their travels, whether in pursuit of health, science, or other affairs not connected with war, and seems to have availed the bearer.

Jenner once or twice applied to the British government on behalf of French prisoners in England, but unhappily all his efforts were fruitless. He was not allowed to exercise any influence in that quarter. Nor was he permitted to share in the least degree in the vast patronage at the disposal of the government. He never succeeded in procuring an appointment for any of his relatives or friends. All his attempts to get a living for his nephew George had failed, although he applied where he was quite justified in thinking he should meet with attention and success. He felt this neglect acutely.

Jenner had derived little, if any, pecuniary benefit from the parliamentary grant of L.10,000, and his friends became anxious about his private affairs, for he was not remarkable for worldly wisdom. At their instance, a subscription was set on foot in India, where the benefit of Jenner's discovery had been largely experienced and gratefully acknowledged. In 1806 he received L.3000 from Calcutta as the result of this movement, with an intimation that L.1000 more would shortly follow; but the full amount of the Eastern acknowledgment did not reach him until 1812. Bengal sent L.4000, Bombay L.2000, Madras L.1383.

The Marquis of Lansdowne (then Lord Henry Petty), was a principal mover in Jenner's second parliamentary grant. Happily for Jenner, and the credit of Great Britain, that enlightened nobleman was appointed Chancellor of the Exchequer at this juncture; and in the session of 1806 he brought the question of vaccination before the House of

Jenner. Commons. In the first instance, however, it was referred to the College of Physicians of London, who, having inquired into it, reported that a body of evidence so large, so temperate, and so consistent, such as was that collected in support of vaccination, was never before advanced in support of any medical question. In the following year (29th July 1807), Jenner's claims were brought forward in parliament by Mr Spencer Percival. The report of the College of Physicians afforded the grounds on which he moved that a sum not exceeding L.10,000 be voted to Jenner, free of all fees and charges. Lord Henry Petty, Mr Windham, and Mr Whitbread, warmly advocated Jenner's claims; and Mr Edward Morris, member for Newport (Cornwall), influenced entirely by the weight of the evidence, moved that L.20,000 be granted instead of L.10,000. On a division, there were 60 for, and 43 against, the motion.

It could hardly be expected that no opposition whatever would be offered, and, accordingly, the dissentients found a mouth-piece in Mr Shaw Lefevre, who adopted the usual line of argument on occasions of the kind. He first attempted to depreciate the value of vaccination and the merit of the discovery, and next to depreciate Jenner's merit as the discoverer, arguing, in fact, that he was not the discoverer. Happily for the credit of the nation, these arguments failed in their intended effect.

Jenner did not cease his researches during this long period. In 1804 he published in the *Medical and Physical Journal* (vol. xii.), a paper on the Varieties and Modifications of the Vaccine Pustule; and, in 1808, his Facts on the Variolous Contagion. The progress of vaccination abroad was uninterrupted; at home, prejudices were active. Sir Isaac Pennington, the Reader in Physic at Cambridge, opposed it, and thus countenanced the unprincipled, rancorous, and ignorant opposition of practitioners like Moseley, Rowley, Squirrel, &c. These men pandered to and excited the popular feeling so much, that the question was seriously discussed in a popular debating society of the day, "Which has proved a more striking instance of public credulity—the Gas-lights of James Windsor, or the Cow-pox Inoculation?"

But petty feelings were operative also in higher quarters. The Royal Jennerian Society having failed to accomplish the objects for which it was founded, Jenner laboured hard to secure the national support to vaccination; and, in 1808, the National Vaccine Establishment was determined on. Its organization was entrusted to the College of Physicians of London; and, in the first instance, the propriety of Jenner exercising a predominant influence in the working of the institution was fully acknowledged by that corporation. After remaining in London for five months, with no other object than the efficient organization of the institution, family affairs obliged Jenner to go into Gloucestershire. Hardly had he departed when Sir Lucas Pepys, the president, formed the board out of officials of the Colleges of Physicians and Surgeons. Jenner was altogether excluded. This was a hard trial to him.

The Royal College of Physicians of London has never been distinguished for its magnanimity. It could enter into the fruits of Jenner's labours without compunction; and, consistently with itself, it afterwards refused him the compliment of its honorary Fellowship. In 1813 Jenner was presented by the University of Oxford with the honorary degree of M.D., and his friends thought it a favourable occasion to confer upon him the title of Fellow of the College of Physicians. The Fellowship at that time could only be conferred on graduates of Oxford and Cambridge, while hitherto the only British diploma held by Jenner was the then not very distinguished diploma of M.D. of St Andrews, for at that time it was one of the most venal of the Scottish universities. Now, however, Oxford nobly did her duty, and, in conferring the degree of M.D. on Jenner, enhanced the greatness of the compliment by assuring him that it was an honour which had not been conferred on any man for nearly seventy years before. Jenner replied, that he was the first of a long line of ancestors who was not educated there. But he added, "It is better perhaps as it is, especially as I have arrived at your highest honours without complying with your ordinary rules and discipline." He then reluctantly put on the accustomed academic gown and cap. Jenner.

The example of Oxford was wholly lost, however, upon the College of Physicians of London. Jenner was at this time a fellow or member of twenty-six medical or scientific societies, including the Royal Societies of London and Göttingen, the French Institute, the Royal Academies of Munich, Madrid, Stockholm, the University of Cambridge (Massachusetts), and of Wilna, the Royal College of Physicians of Edinburgh, and the like. He had been formally presented with the freedom of London, Edinburgh, and Dublin, and of various other towns and burghs; and the most distant nations and peoples venerated his name. He had, in short, won for himself the highest position ever attained in the medical profession, in any age or nation. But all this was of no account to the few individuals who constituted the governing body of the Royal College of Physicians of London. Edward Jenner could only be admitted into their body on undergoing the usual examination. This, however, was essentially classical; the examination, as to professional knowledge, was conducted in the Latin tongue, and was of a simply formal character; but, as a further test of sound knowledge, the candidate translated portions of Hippocrates and Aretæus out of the original Greek. It is doubtful whether half-a-dozen of the Fellows of the same age as Jenner, now sixty-four years old, could have passed this mere classical examination without going back to the studies of their boyhood; yet this was what, in effect, they required Jenner at that age to do. He, on his part, expressed his opinion very characteristically, "I would not do it for a diadem," he said,—"that would be a bauble—I would not do it for John Hunter's museum!"

In April 1814 Jenner paid his last visit to London. He had several interviews with the Duchess of Oldenberg, who delighted him exceedingly. She was also present at his interview with her brother the Emperor of Russia. Most of the distinguished foreigners wished to know him personally. The King of Prussia was the first crowned head who adopted the practice of vaccination in his own family, Jenner having sent the lymph for that purpose in 1799; he sent a respectful intimation of the time he would see Jenner. He had interviews also with Blucher, Platoff, and most of the distinguished foreigners then in London.

In September 1815 his faithful and beloved wife died. This loss he felt most acutely. He retired immediately to Berkeley, and never again quitted it, except for a day or two. From 1815, the remaining years of Jenner's life were passed in such occupations as befitted a physician, a naturalist, a magistrate, and a man whose life was rapidly drawing to a close. Acknowledgments of his great services still, however, reached him from time to time. He was elected a member of the Royal Academy of Sciences of Bavaria late in 1814. In 1818 it was proposed that a medal of him should be struck at Paris, as one of the series "*Des hommes illustres de tous les Pays;*" and in 1821 he was appointed physician-extraordinary to the king. During these later years he followed up the thoughts and views of his earlier lifetime. In 1817 he traced the *equine* virus experimentally for the last time, and demonstrated its prophylactic power against variola. In 1818, and following years, his thoughts were much occupied with an extensive epidemic of small-pox, often assuming a spurious or imperfect form. Numerous were the reported failures of vaccination in that and subsequent years, so that Jenner's attention was directed anew to the subject. For some time

Jenner. before his death he was employed in reviewing his opinions and comparing them with the numerous facts he had collected from all parts of the world, and it was his intention to have published a digest of the whole. It was probably with a view to the fulfilment of this plan that he sent out a *Circular Letter* early in 1821 to the most respectable practitioners in the kingdom, with questions as to the progress of the vaccine vesicle, the influence of herpetic and other eruptions upon it, and the number of cases of small-pox after vaccination. This circular was followed in 1822 by his last published essay, *A Letter to Charles H. Parry, M.D., on the Influence of Artificial Eruptions in certain Diseases.* His last scientific researches were read to the Royal Society 27th November 1823, being *Observations on the Migrations of Birds.*

During his later years, when resident at Berkeley, Jenner acted constantly as a magistrate. He could not but see that the peasantry were not fairly treated. They were oppressed by the poor-laws, and they were taught nothing—neither the laws of their country, nor of their God. The nature of his magisterial duties are shown in one of his letters written to Mr Moore (the brother of General Moore) of the date of 1813. He remarks,—"How you would enjoy seeing me in the exercise of my magisterial powers, dealing out lessons of morality to the poor unfortunate daughters of *vaccina*, when exhibiting their untimely *prominences*. I bring them all to the altar with their swains if I can."

Jenner had had several attacks of illness during his life, but he attained to a good old age. On the 6th August 1820, when in his seventy-second year, while walking in his garden, he became suddenly faint and giddy, and appears to have lost his consciousness. It was a premonition of the disease that was to terminate his life; for, although there was no paralysis, and not much indication of serious mischief in the brain, the latter organ had evidently been the seat of the attack. On the 24th January 1823, he was busily engaged in his professional avocations and his customary acts of kindness and charity. On the 25th January he arose as usual, and went into his library. Not appearing at breakfast, the servant went to ascertain the cause of his delay, and found that his master had sunk from his couch and was lying on the floor insensible. The right side was paralysed, and he was in a state of apoplectic coma, in which he continued until his death, a few hours after, on January 26, 1823, at 3 o'clock in the morning.

A public subscription for a monument to Jenner was set on foot shortly after his death, but only two public bodies subscribed; the College of Physicians of Edinburgh gave L.50, and the College of Surgeons of Edinburgh, L.10. After considerable difficulty there was raised sufficient to place a statue of Jenner by Sievier in the nave of the cathedral at Gloucester. Another attempt was made in the year 1850 to erect a monument by public subscription, but that seems to have failed also. The warmest interest was on this occasion shown by the United States.

The character of Edward Jenner is soon delineated. He was an English gentleman, with a liberal and professional education. Rural scenes and domestic life he loved best, and for these he repeatedly sacrificed wider fields of energy than a village in England afforded. And even when a world-wide fame became his, he wished that fame had been the lot of another man, because it deprived him of "his peace and quietness." The delight of his heart was ever his own village home, and the routine of his rural life. With a genial temper, high moral tone, cultivated tastes, a turn for poetry, and access to the best society, it was not surprising that he was likened to such English worthies, as honest Isaak Walton, the pious Evelyn, and the melancholy Cowper. But, perhaps, these qualities were not favourable to the full evolution of his intellectual powers or to grand labours. The discovery of vaccination was due, in the first instance, rather to an impulse of his youth than an effort of his intellect. Afterwards his large benevolence sustained his efforts, for he fully appreciated the great and enduring benefits that discovery would confer upon the whole human race. If he finally felt a pride and deep personal interest in its promulgation, as his own discovery, the feelings were just. Jenner.

His large benevolence was constantly shown in various ways, and has been already illustrated in the preceding pages. He loved to gratify the lowly in rank by his personal attention, and especially by his grace and condescension; to seek out and help genius struggling with poverty; to set on foot or support any plan for advancing science; or any institution having *good* for its object. His affections were of the warmest; his sensibilities acute. Hence his ardent love of wife and child, and his sympathies with the suffering, the gentle, and the lowly. Hence, also, the peculiar delicacy of his perceptions in all that regarded the grace and dignity of the female character.

Jenner's intellect was hardly inferior in power to the intellect of his master, John Hunter. But there was this difference between the men, that Hunter had few of those graces of character which made Jenner so pleasing in society. Hunter devoted, therefore, less time to the pleasures of social intercourse, and became more and more an enthusiast in the study of life and organization. Jenner's position in a country village, and his pursuits as a country surgeon, did not favour this entire devotion; but, on the contrary, prevented it, inasmuch as it threw the temptation of social enjoyment in his way. As a naturalist, Jenner took a high rank, and he would have shone as a pathologist had a proper sphere of action been open to him. He had large powers of observation, but a peculiar horror of arithmetic, and no taste for any of the branches of pure science. The descendant of a line of English clergymen, a tinge of piety would seem to be almost of necessity a part of Jenner's character. But he had evidently more than this; a spirit of religion seemed to be infused into all he did. Piety was so much a part of his nature, that it was habitual with him—yet, unostentatiously, and especially without that loud and suspicious profession of religion so frequently associated with an imperfect manifestation of the Christian grace of charity. Jenner appears to have habitually and constantly felt that he was always in the presence of God.

Although Jenner's temper was genial and gay in society, he was subject through life to fits of melancholy; in this respect resembling men of similar organization. He seems, too, to have been somewhat sensitive as to his claims to distinction, and to have had an excessive love of approbation. Among the last words he addressed to Dr Baron, his biographer, were these, "I am not surprised that men are not thankful to me." And when at an earlier date the Emperor Alexander of Russia said to him, "I am happy to think that you have received the thanks, the applause, and the gratitude of the world;" Jenner said, "he had received the thanks and the applause, but not the gratitude." Undoubtedly, the practice of vaccination was opposed in the time of Jenner (as it is yet) by the perverse, the ignorant, and the prejudiced; equally certain is it, that the opposition to it was conducted as now in the vulgar and brutal manner which such a class of opponents would necessarily manifest. But, on the other hand, few of the good and great throughout the world withheld their support. No large work of humanity was indeed ever more universally appreciated and welcomed. The parliamentary grants were, certainly, by no means commensurate with the benefits the discovery of vaccination had conferred and would confer. Jenner ought to have had a larger professional recompense; and if he had aimed at wealth, he might undoubtedly have acquired it by his discovery. But then to this end he should have made the promulgation of it a commercial, and not a philanthro-

Jenyns.

pic, enterprize. Rarely does the world give both wealth and honours to the philanthropist. Jenner was as successful as any man in this respect. Honours and fame he had, such as never fell before to the lot of a physician.

Jenner was a devoted smoker of tobacco, and it was probably a community of taste in this respect which led the Duke of Sussex to present him with a beautiful hookah.

Jenner's manners and personal appearance were not striking at first sight; further observation showed, however, that he was a remarkable man. He was simple and unreserved, but at the same time dignified. He was rather below the middle size, had a pleasant cheerful expression, full lips, well-formed nose. None of his direct descendants survive to inherit his name. (T. L.)

JENYNS, SOAME, author of the *Free Inquiry into the Nature and Origin of Sin*, was born at London in 1704. He was born of a good family, and enjoyed all the advantages in the way of education that ample means and high social standing could give. In 1722 he was entered of St John's College, Cambridge, where in due course he took the ordinary degrees. In 1742 he was chosen M.P. for the county of Cambridge, in which his property lay. In 1754 he sat for the borough of Dunwich; and seven years later he was returned for the town of Cambridge, which he continued to represent till his retirement from public life. In 1755 he was made one of the commissioners of the board of trade, and retained that office, amid all the changes of administration, till it was abolished in 1780. Jenyns was twice married, but left no issue by either of his wives. He died after a short illness December 18, 1787.

For the measure of literary repute which he enjoyed during his life Jenyns was indebted as much to his wealth and social standing as to his accomplishments or talents, though both were considerable. He made his début in literature as a poet; and his *Art of Dancing*, 1727, and *Miscellanies*, 1770, contain many passages graceful and lively, but occasionally verging towards license. The success of these efforts gained for his prose works a more indulgent reception than was warranted by their intrinsic merits. The first of these was his *Free Inquiry into the Nature and Origin of Evil*, 1756. This essay was severely criticised in many of the reviews of the day, and in none more severely than in the *Literary Magazine*. Dr Johnson, the author of the critique, condemned the book strongly as a slight and shallow attempt to solve one of the most difficult of moral problems; and though Jenyns put forth a second edition, with a vindication prefixed, the strong points of the critic's argument remained as strong as before. Johnson's critique, indeed, is the very best paper of that kind that he ever wrote—a masterpiece both of reasoning and of satirical pleasantry. Jenyns, a gentle and amiable man in the main, was extremely irritated by his failure, and tried to take vengeance on Johnson after his death by a sarcastic epitaph. In this he overshot his mark; an anonymous friend of the doctor retaliated by one still more cutting, and Jenyns was silenced. In 1776 Jenyns published his *View of the Internal Evidence of the Christian Religion*. In early life he had been noted as orthodox, even to bigotry; and though at a later period he had sported a kind of deistic scepticism, yet before this book appeared, he had returned to the creed of his youth, and was held even by his enemies to be a sincere and pious Christian. Yet he was accused by many of cherishing a secret enmity to the faith he professed, for defending it on the ground of its total variance with the principles of human reason. The charge would probably be fair enough against any one who should now venture to set up such a defence; but Jenyns seems to have regarded himself as having really done service to the Christian faith. The essay in question was very highly praised in its day for its literary merits. Like his other prose works, it is pure and graceful in style, and contains many acute remarks and happy illustrations. It is so plainly the work of a dilettante in theology that as a scientific treatise it is valueless. The writing dazzles and pleases the reader far more than the thought impresses or satisfies him.

Jeremiah.

JEREMIAH, the plaintive prophet, was the son of Hilkiah, one of the priests of Anathoth, not the high priest as some have imagined. At a very early age, Jeremiah received a Divine commission to be a prophet (in the 13th year of Josiah, B.C. 629). The hostility which he incurred, both from his townsmen and his own more immediate friends, drove him to Jerusalem, there, on a wider field though with no greater success, to help on the reformation of the people from idolatry. The death of Josiah was the signal for an attack upon Jeremiah by the priests and the prophets, and had it not been for the influence of a few powerful friends such as Ahikam, the prophet would probably have lost his life. As it was, he was imprisoned, and only allowed to write his predictions, and have them read to the people by Baruch. He escaped the vengeance of Jehoiakim through the favour of the princes; but in the time of Zedekiah, the princes became his enemies, while the monarch consulted him in secret. When Jerusalem was taken by Nebuchadnezzar, the prophet was found in prison to which the princes had consigned him. The heathen conqueror, forming a far more correct estimate of his worth than his own countrymen had done, gave special instructions to his general to provide for Jeremiah and attend to his counsels. Being offered the choice of going to Babylon or of remaining in his own fallen country, the patriotic prophet chose the latter, and went to Mizpah with Gedaliah, the Babylonian governor. At the time of the downfall of his country, Jeremiah had been fully forty years a prophet—

During Josiah	18	years (B.C. 629.)
... Jehoahaz	0¼	
... Jehoiakim	11	
... Jehoiachin	0¼	
... Zedekiah	11	
	40½	years (B.C. 588½.)

But he did not now cease to give warning to the remnant of the people. On the murder of Gedaliah he resisted the wayward movement among the Jews to go to Egypt, the scene of their bondage, and destined again to become the scene of their religious ruin. To stay their downward career, however, he went with them, and it is said met his death at their hands in the streets of Cairo, where his tomb used to be shown. A less credible tradition relates that his bones were removed to Alexandria by Alexander the Great.

The character of Jeremiah forms a remarkable contrast with that of his contemporary Ezekiel—the one displaying the latent boldness of a sensitive and shrinking spirit, the other showing the absorbent power of divine inspiration in a soul of finer and firmer texture. The style of Jeremiah is quite in accordance with such a character. A monotony of pain runs through the whole of his prophecy, which makes him dwell always on the same images; and there is marked carelessness of diction which befits a soul in the deepest grief. Numerous quotations from the older books of the Bible, and especially from the older prophets, betray his personal sensitiveness without subtracting from his power.

The authenticity and canonicity of the writings of Jeremiah may be regarded as beyond dispute. Only in very recent times have traces of a later hand been imagined in the second decade of the chapters into which his prophecy is now divided. In Matt. xxvii. 9, there is a quotation from Jeremiah not now found in that prophet's writings; but as it is found in Zech. xi. 12, 13, it is not improbable that the name of Jeremiah has crept into the text from the margin. Besides this, the difference of order in the prophecies as

Jericho. given in Hebrew and Septuagint copies, as well as the omission of numerous passages in the latter, have occasioned some difficulty. These diversities have been mostly accounted for by the supposition of a double recension.

The unchronological order of the prophecies, although it has been the occasion of much scientific criticism, can scarcely be regarded as a stumbling-block in the works of a prophet distinguished above all for the tragic looseness of his style. Ewald, on the supposition that the various parts have been dislocated accidentally, or even designedly after Jeremiah's prophetic career was broken by his departure into Egypt, attempts to reconstruct the whole, but in truth nearly follows the existing order of arrangement.

The principal commentators who have given separate treatises on Jeremiah are,—Calvin, Piscator, Venema, Michaelis, Schnurrer, Dahler, Movers, Umbreit, Nägelsbach (1850), and Neumann (1856).

JERICHO, a town in the plain of the same name, not far from the River Jordan, at the point where it enters the Dead Sea. It lay before the Israelites when they crossed the river on first entering the Promised Land, and was utterly destroyed by them, an awful curse being pronounced upon any one who should rebuild it. All the inhabitants were put to the sword except Rahab and her family (Josh. ii. vi.).

Notwithstanding the curse, Jericho was soon rebuilt, and became a school of the prophets. Its inhabitants returned after the exile, and it was eventually fortified by the Syrian general Bacchides. Pompey marched from Scythopolis, along the valley of the Jordan, to Jericho, and thence to Jerusalem; and Strabo speaks of the castles Thrax and Taurus, in or near Jericho, as having been destroyed by him. Herod the Great, in the beginning of his career, captured and sacked Jericho, but afterwards strengthened and adorned it, when he had redeemed its revenues from Cleopatra, on whom the plain had been bestowed by Antony. He appears to have often resided here, probably in winter; he built over the city a fortress called Cypros, between which and the former palace he erected other palaces, and called them by the names of his friends. Here also was a hippodrome, or circus, in which the same tyrant, when lying at Jericho on his deathbed, caused the nobles of the land to be shut up for massacre after his death: he died here, but his bloody intention was not executed. The palace at this place was afterwards rebuilt more magnificently by Archelaus. By this it will be seen that the Jericho which existed in the time of our Saviour was a great and important city, probably more so than it had ever been since its foundation. It was visited by him, as when he lodged with Zaccheus, and healed the blind man. Jericho was afterwards made the head of one of the toparchies, and was visited by Vespasian before he left the country, who stationed there the tenth legion in garrison. Eusebius and Jerome describe Jericho as having been destroyed during the siege of Jerusalem, on account of the perfidy of the inhabitants, but add that it was afterwards rebuilt; but, as Josephus is silent respecting this event, Dr Robinson regards it as doubtful. That the town continued to exist as a place of importance, appears from the names of five bishops of Jericho which have been collected (*Oriens Christ.* iii. 654). The emperor Justinian built here a Xenodochium, apparently for pilgrims, and also a church dedicated to the Virgin; and the monastery of St John, near the Jordan, was already in existence (Procop. *De Ædific. Justiniani*, v. 9). The town, however, appears to have been overthrown during the Mohammedan conquest; for Adamnanus, at the close of the seventh century, describes the site as without human habitations, and covered with corn and vines. The celebrated palm groves still existed. In the next century a church is mentioned; and in the ninth century several monasteries appear. About the same time the plain of Jericho is again noticed for its fertility and peculiar products; and it appears to have been brought under cultivation by the Saracens, for the sake of the sugar and other products for which the soil and climate were more suitable than any other in Palestine. Ruins of extensive aqueducts, with pointed Saracenic arches, remain in evidence of the elaborate irrigation and culture of this fine plain, at a period long subsequent to the occupation of the country by the Jews. It is to this age that we may probably refer the origin of the castle and village which have since been regarded as representing Jericho. The place has been mentioned by travellers and pilgrims down to the present time as a poor hamlet consisting of a few houses. In the fifteenth century the square castle or tower began to pass among pilgrims as the house of Zaccheus, a title which it bears to the present day. The village identified with Jericho now bears the name of Rihah, and is situate about the middle of the plain, 6 miles W. from the Jordan, in N. Lat. 31. 57., and E. Long. 35. 33.

Jerome, St.

JEROME, St, commonly accounted the most learned of the Latin fathers, was born at Stridon, a city of Pannonia, about, as it appears, A.D. 342. His father's name was Eusebius, that of his mother is unknown; he had a sister, who gave herself up to a religious life; and a brother, Paulinian, much younger than himself. When about twenty-five years old he came to Rome in the Episcopate of Damasus, and studied under the celebrated grammarian Donatus. He here received baptism; after which he went into Gaul, and spent a considerable time at the city of Treves, where he made himself familiar with the writings of the great St Hilary, transcribing more than one of them with his own hand. He then passed a short time at Aquillia, where he became acquainted with many eminent men, amongst whom were Rufinus and Heliodorus; with the latter of these, Evagrius, a priest of Antioch, and some others, he travelled through Thracia, Pontus, Bithynia, Galatia, and Cappadocia. From thence he passed into the East, and staid some time at Jerusalem; from which city he came to Antioch, where he made acquaintance with Apollinaris, who had not then openly taught his heresy. In 372 he retired to a desert lying between the countries of Syria and Arabia, where he employed himself in the study of the Hebrew language, and began his commentaries on the books of Scripture. After studying four years in these wilds, and seeing one of his companions leave him, two others sink under the hardships and privations of their desert life, and being himself much enfeebled by sickness, he abandoned for the present the life of a solitary, and came to Antioch. The church of this city was at that time divided by the factions of Paulinus, Meletius, and Vitalis, each of whom claimed to be its bishop. St Jerome, by the direction of Damasus, acknowledged Paulinus; and, about the year 375, was ordained priest by him, but upon condition that he should not be compelled to abandon the eremitical life, nor to perform any of the duties of his office. At the time of his ordination, or probably a little before, he had been assailed by the opposite factions of the Arians and Sabellians as to the sense in which he understood the word *Hypostasis;* a term which had formerly been used to express equally the Divine Nature and the Persons of the Holy Trinity; but which, since a council held at Alexandria in the year 362 at which the great St Athanasius presided, had been chiefly confined to the latter sense. St Jerome, when it was demanded of him, whether, with the Arians, he acknowledged three Hypostases; or, with the Sabellians, only one, replied, with great exactness and propriety, "If *Nature* be understood by this term, there is only one; but if *Person*, there are three." On account of these divisions he left Antioch, and fixed his abode at Bethlehem. In 380 he went to Constantinople, and became the pupil of Gregory of Nazianzum, the bishop of that city. In the

Jerome, St.

following year Gregory resigned his see, and Jerome returned to Syria. Soon afterwards, with Paulinus of Antioch and St Epiphanius, he revisited Rome, and was made his secretary by Damasus, taking at the same time the spiritual care of several eminent Romans of both sexes. In 385, the year following the death of Damasus, he returned to the East, saw St Epiphanius as he passed through Cyprus, went to Antioch and Jerusalem, spent a month with the blind Didymus, then one of the most celebrated teachers at Alexandria, visited some of the Egyptian monasteries, and thence returned to Bethlehem, where he spent the remainder of his life as head of a monastic institution, and where he composed the greater number of his works. Towards the close of his life Palestine suffered much from an inroad of barbarians; and in 416, after the Council of Diospolis, the Pelagians, supported by John the heretical bishop of Jerusalem, sent bands of armed men to destroy the monastery of their opponent, St Jerome, and disperse the religious of both sexes who lived under his direction. A deacon was killed, and St Jerome himself escaped with difficulty by flight. After this he continued his literary labours for four years; and on the 30th September, A.D. 420, he died. His most valuable work is his Latin version of the Old and New Testaments, commonly called the Vulgate; of which, however, the Psalter is not his, it having been made from the Septuagint, and not from the Hebrew, which St Jerome always followed. The books of the Apocrypha, except Tobit and Judith, he also omitted, as not being contained in the Hebrew canon. St Jerome enjoyed very singular advantages for the performance of this great undertaking, not only from his intimate acquaintance with the Hebrew, his long abode in Syria, and his knowledge of the places, local traditions, and customs of the country, but also from the fact of the existence in his time of the *Hexapla* of Origen, by the Greek version of which (the most accurate of any extant) he was enabled to correct both the commonly received Greek and the ancient Italic texts. The Council of Trent declared the Vulgate to be an authentic version, and corrected editions of it were published by the popes Sixtus V. and Clement VIII., A.D. 1590, 1592, 1593. We are also indebted to St Jerome for the best commentary extant on the prophets, for one on Ecclesiastes, on St Matthew, and the Epistles of St Paul to the Galatians, Ephesians, Titus, and Philemon. He was besides one of the chief polemical writers of his age, opposing vigorously the Montanists, Helvidius, Jovinian, Rufinus and the Origenists, the Luciferians, Vigilantius, and Pelagius. He translated a work of Didymus on the Holy Ghost, composed a biographical account of the lives and writers of those ecclesiastical authors who had flourished before his time, and made several additions to the *Chronicon* of Eusebius, which he continued to the year 378,—it is contained in the eighth volume of the edition of Villarsius. He also left behind him more than 150 letters on different subjects connected with theology and the Scriptures. St Jerome, in his very valuable commentary on the prophets, opposes the literal and semi-Judaic ideas of Theodore, "the interpreter," as he is called, who was bishop of Mopsuestia in the time of St Jerome, and one of the chief doctors and representatives of the school of Syria and Antioch (See THEODORE of Mopsuestia.) He had attacked St Jerome, as it appears, under the name of Aram, for teaching the doctrines of original sin, and the remission of sins by the sacraments of baptism and the Lord's supper. Theodore, wherever it is possible, gives to the prophecies meanings exclusively literal and temporal, the result of which is, of course, to deprive us of that evidence of our religion which prophecy supplies, to divest the typical writings of the Old Testament of great part of their meaning, and, by confining the promised blessings to a particular locality, to do away with all idea of a church Christian and universal. Thus the very remarkable words of Hosea vi., 2, 3,—"After two days will he revive us: in the third day he will raise us up, and we shall live in his sight. Then shall we know, if we follow on to know the Lord: his going forth is prepared as the morning; and he shall come unto us as the rain, as the latter and former rain unto the earth,"—are explained by Theodore, merely of the restoration of the chosen people to their temporal prosperity after the Assyrian captivity; but St Jerome, as might be expected, explains them of the resurrection of Christ, and the regeneration of the human race through it. The words of chap. xiii. 14, of the same prophet,—"I will ransom them from the power of the grave; I will redeem them from death: O death, I will be thy plagues; O grave, I will be thy destruction,"—Theodore treats in the same manner, and refers for their fulfilment to the same period, but St Jerome applies them in their most perfect meaning to the death of Christ. The commencement of the 2d chap. of Joel,—"The day of the Lord cometh, for it is nigh at hand: a day of darkness and of gloominess, a day of clouds and of thick darkness,"—Theodore supposes to describe a merely physical obscurity, which, he says generally, and without allusion to any specific event, was fulfilled in the days of Hezekiah and Sennacherib; and "the day of the Lord," he thinks to be a period of intolerable calamity caused by the Assyrians. St Jerome gives to both a spiritual and Christian meaning, extending them from the narrow and partial one of Theodore, to the end of all things, and the final day of judgment. Lastly, notwithstanding the apostolic declaration of the fulfilment in our Lord's betrayal, of the words of Zechariah xi. 12, 13,—"They weighed for my price thirty pieces of silver. And the Lord said unto me, cast it unto the potter: a goodly price that I was prised at of them. And I took the thirty pieces of silver, and cast them to the potter in the house of the Lord,"—Theodore maintains that the number "thirty" there mentioned, is not to be taken to signify any fixed sum, "but merely to show the great benevolence of the people to the prophet, and their honourableness;" whilst the casting of the thirty pieces to the potter, means, according to him, merely the trial of the people through the furnace of their sufferings. St Jerome pointedly opposes both ideas, as he does Theodore's assertion, that "the rising of the sun of righteousness" in Malachi, means only the victories of the Maccabees. We conclude St Jerome to be opposing Theodore, not only from the internal evidence afforded by a comparison of their respective works, but because the former more than once makes allusion to some living person of note whose name he will not mention, and who, from his method of dealing with prophecy, should rather, he says, be termed a Jew than a Christian. It is clear that there was no one of those times but Theodore who answers to St Jerome's description. The style of St Jerome varies according to the nature of his subject. In his controversial works he is exceedingly pointed and cutting, and proves himself a considerable master of rhetoric and logic; and shows, moreover, his acquaintance with the writings of the ancient philosophers and poets, by introducing frequent citations from their works. Simplicity and earnestness are the chief characteristics of his commentaries. In those on the prophetical writings, his intimate knowledge of Jewish habits and antiquities, has enabled him to do more perhaps than any other commentator to elucidate that portion of the sacred text. The best edition of his works is that of *Villarsius*, 11 vols. folio, Verona, 1734–40. (G. J. D.)

Jerome.

JEROME, the friend and disciple of John Huss, and, like him, a martyr to the truth. His family name was Faulfisch, but he is generally called "of Prague," from the Bohemian capital in which he was born and brought up. After completing his studies in his native city, he visited the universities of Cologne, Heidelberg, Oxford, and Paris. It is said that he first understood and learned to value the

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doctrines of Wycliffe while copying the works of that reformer during his stay in England. Certain it is that before he returned to Bohemia from his wanderings over Europe he had signalized himself by a strong opposition to the Church of Rome, and had defended brilliant theses at Paris against Gerson, the famous chancellor of that university. His reputation for learning and practical sagacity was so great, that he was employed by Ladislaus II. of Poland to organise the University of Cracow, and similar compliments were paid him by other crowned heads of that era. Everywhere he proclaimed himself the disciple of Wycliffe, and though such a profession was becoming daily more dangerous, scorning to curb his impetuous temper, he often allowed himself, in his denunciations of Popery, to be hurried away beyond the limits of prudence, and sometimes even of decency. In a short time he observed no measures towards the pope and the cardinals, and among other problems, proposed the following:—Whether the pope possessed more power than another priest? and whether the bread in the Eucharist or the body of Christ possessed more virtue in the mass of the Roman pontiff than in that of any other officiating ecclesiastic? One day, along with some of his friends, he drew a sketch of Christ's disciples on one side following, with naked feet, their master mounted on an ass; whilst on the other they represented the pope and the cardinals, in great state, on superb horses, and preceded as usual with drums and trumpets. These pictures were exposed in public; and it is easy to conceive the effect they were calculated to produce on an excitable and enthusiastic multitude. On another occasion Jerome, when arguing with a monk, lost his temper at being sharply opposed, and carried his violence so far as to fling his adversary into the Moldau. The monk reached the bank, but, as the chronicler of this incident naively observes, "he found when he touched the land that he had lost the thread of his argument, and was unable to pursue the discussion." These outbursts of temper soon involved Jerome in troubles from which a politic prudence would have saved him. At Vienna he was thrown into prison as a heretic, and was only released by the urgent intercession of his countrymen at Prague. Obtaining his freedom, he hastened to join his friend Huss in that city, and made himself conspicuous by the fiery zeal with which he inveighed against the abuses of the hierarchy, and the dissolute lives of the clergy. In 1415, when he heard that Huss had been thrown into prison by the Council of Constance, there to abide his trial, he set out for that city without a safe conduct, determined to plead his friend's cause. He arrived at Constance on the 4th April, and was there dismayed to learn that Huss was to be judged and condemned in secret, and would only leave his prison to die. A panic seized him, and he fled from the town as rapidly as he had come to it. Had he been arrested, he would undoubtedly have shared his master's fate in his master's company. Though without a safe-conduct he reached Uberlingen undisturbed, and he might easily have reached Prague had he only held his tongue. But so many crosses and dangers had not increased his prudence. Wherever he went he declaimed openly and vehemently against the council. One day, at the table of a curé, who had invited him to his house as he was journeying through the Black Forest, he forgot himself so far as to call it "a school of the devil, a synagogue of iniquity." Some priests of the company, deeply offended, laid the matter before the governor of the nearest town, and Jerome was arrested and thrown into prison. Other accounts state simply that Jerome was seized at Hirschau by John of Bavaria, prince of Saltzbach, and kept in confinement by him till the council made known its wishes. Certain it is that he was carried in chains to Constance, and when in prison there, learned the terrible tidings of his friend's martyrdom. More than once he was brought to trial, but his eloquence, learning, and logic, were more than a match for the most subtle accuser that could be suborned against him. Meanwhile, his confinement and the cruel indignities which he suffered, undermined his health, and when his energies of mind and body were totally worn out, he was induced on the 11th September 1415, to recant the heresies with which he was charged. A less rigorous imprisonment was the only reward of this apostacy. After languishing in the darkness of his dungeon for several months longer, he was once more brought before the council on the 26th May 1416. Triumphing over all his weaknesses he defended himself with a boldness, vehement energy, and learning, that filled even his accusers with wonder and admiration. He solemnly retracted his recantation: "Of all the sins," he said, "that I have committed since my youth, none weigh so heavily on my mind and cause me such poignant remorse, as that which I committed in this fatal place, when I approved of the iniquitous sentence rendered against Wycliffe and against the holy martyr John Huss, my master and friend." His defence had inclined his judges to mercy; but with these words he sealed his own death-warrant. Four days later (May 30th, 1416) he was publicly burnt at the stake, and his ashes, like those of Huss, were collected and thrown into the Rhine.

Historians, Catholic and Protestant alike, vie with each other in paying homage to the heroic courage and apostolic resignation with which Jerome met his doom. Posterity has confirmed their verdict, and reveres him as a martyr to the truth, who, unwearied in life, and noble in death, has acquired an immortal renown for his share in the Reformation. In many respects far beyond his age, Jerome was identified with it in the weaknesses of his character. With a mind more variously endowed than Huss, he wanted the moral weight which gave his master so great an ascendancy over the minds of men. Bold, even to rashness, his courage was shown rather in bursts of furious vehemence than in the equable tenor of his life, and more than once failed him in critical moments. In this weakness he only reflected the turbulent and unruly spirit of the age he lived in, and gave a colour to the charge of his adversaries, that he always allowed his prejudices and passions to outrun his better judgment. This, without being absolutely true, is so to some extent. To no one was it more disastrous than to Jerome himself. For it not only led him to the stake, but it also undid much of the effect which might have been looked for from his labours and his martyrdom.

Jersey.

JERSEY, the largest and most important of the Channel Islands, is situate in the bay of St Michael, 13 miles W. of the nearest coast of France, and 85 miles from the nearest point in the English coast; N. Lat. (St Helier's) 49. 11. 3., W. Long. 2. 7. It is 12 miles in length from E. to W., and 7 in breadth from N. to S., and has an area of about 40,000 acres. The N. coast of the island is rocky, bold, and precipitous, rising sometimes to the height of more than 200 feet above the sea. From this the land has a general slope to the S. coast, where it sinks nearly to the level of the sea. The surface is hilly and undulating, and diversified with many deep and well watered valleys. The prevailing rocks are granitic, in some localities overlaid by schists. Along the northern coast sienite is abundant, and passes in some places into porphyry and greenstone. The climate, though moist, is mild, and the mean annual temperature (52° Fahr.) is higher than that of any part of England. The mean summer temperature is 62°·2, and the mean winter 42°·6. The island enjoys an early spring and a lengthened autumn, vegetation being generally well advanced in March, and the landscape far from naked at the end of December. Snow and long continued frosts are rare, but rains and dense sea fogs and violent winds are frequent. Agriculture has recently been greatly improved, but its progress is still much retarded by the minute division

Jersey. of property occasioned by the law of gavelkind. The farms average about four acres, and few of them exceed ten. The principal manure is vraic, a sea-weed which at certain seasons is gathered in large quantities, and is used, either fresh or after it has been burned, for fuel. Wheat is the principal grain crop; but barley and oats are also grown. Potatoes and parsnips are extensively cultivated. Lucerne is also extensively reared, being a great favourite with the farmers, as it grows well on soils unfit for other purposes. A large portion of the land is laid out in orchards, apples and cider being among the chief exports of the island. The common fruits of England are abundant, and the grape and melon are raised in the open air. The great pride of the island, however, is the *Chaumontelle* pear, which attains great perfection, and is frequently a pound in weight. Cattle-rearing is conducted on an extensive scale. The cows, which belong to the variety known in England as the Alderney, yield large quantities of butter for exportation. Few sheep are reared. The horse is a small, hardy variety. The Channel Islands are considered as belonging to the crown, but as forming no part of the realm, so that they are not represented in Parliament; and Acts of Parliament, as such, have no legal force as regards them, unless they are therein specially named, or unless the acts, in virtue of an order of council, are registered on the records of the islands. In their institutions, customs, and laws, the people still retain much that is Norman; and, in this respect, Jersey has retained considerably more of the old institutions and of their free spirit than the sister island of Guernsey. The people appear to have at all times enjoyed much freedom and great privileges.

The island of Jersey is divided into twelve parishes, each of which has its own parochial government. The chief officer is the *connétable*, or constable, elected by the parishioners for three years, and who may be called the mayor of the parish. He is aided in his duties by *centeniers*, *vingteniers*, and *officiers du connétable*. The *centeniers* are elected by the rate-payers of each parish for three years, and are two in number for each of the country parishes, and eight for St Helier's. The vingtenier is an officer appointed over a *vingtaine*, or district of a parish, their number varying with the number of vingtaines into which each parish is divided. He collects the parish rates, and is also invested with considerable power in his district, subject, however, to the approval of the *centenier* or *connétable*. The connétable and centenier are assisted in their police duties by the *officiers du connétable*, of whom there are twelve in each parish, with the exception of those of St Brélade's and St Helier's,—the former having fifteen, and the latter twenty-four. They are elected by the rate-payers for seven years, in all the parishes except St Helier's, where their term of office is only four years. The duties of all these offices are performed gratuitously. The superior offices are eagerly sought after, from the honour and influence attached to them, and even the subordinate offices are much desired, and are filled by persons of good social standing. The connétable, centeniers, vingteniers, and officiers du connétable, are *ex officio* members of the parish assembly, composed of all the rate-payers in the parish above a certain rate, and certain officials. In civil matters the connétable presides over the parish assembly, in ecclesiastical the rector. The connétable is, in virtue of his office, a member of the legislative assembly or states, and thus has a voice in the general direction of the affairs of the island. The states are composed of a bailiff, as president, twelve jurats, twelve rectors, and twelve connétables. There is no regular session, nor any fixed times of meeting. They are convened by the bailiff whenever he believes that a meeting is necessary to consider certain measures. The bailiff is chief justice of the island. He is nominated by the crown, and holds office *durante bene placito*. He has a salary of L.300 per annum from the crown, which, with certain fees derived from the office, make up an income of about L.800. The bailiff, with the twelve jurats, compose the royal court. The jurats, or judges, are elected by the people and hold office for life. They receive no salary, the honour and dignity of the office being considered a sufficient reward. The qualifications required for the due discharge of the office of jurat are,—an inviolable attachment to truth, justice, and equity; an acquaintance with the laws, customs, and history of his country, to understand the spirit and working of its institutions, and the devotion of all his energies and ability to the promotion of the welfare and well-being of his fellow-men. The attorney-general, *vicomte*, and solicitor-general, are appointed by the crown, and have each a fixed salary from the crown revenues. They have seats but not votes at the states, and the attorney and solicitor generals may also express their opinions on matters brought before that assembly, but they cannot introduce a measure or make any proposition. The vicomte has not the right of discussion. He is the chief executive officer of the court, both in civil and criminal affairs. The twelve rectors are appointed by the governor for life, and, in addition to their ecclesiastical, have certain civil duties to perform as members of the states. The dean is the head of the church, and his nomination is in the hands of the crown. He must be a Jersey man, and has invariably been one of the rectors. The governor and lieutenant-governor are named by the crown. The former holds office for life, and has the appointment of a receiver of the crown revenues, and the nomination of clergy to vacant cures. He is not required to reside on the island, nor is it even necessary for him to visit it. He derives a large income from the crown revenues. The lieutenant-governor, who is usually a major-general in the army, is commander-in-chief of all the forces and militia in the island. He may negative any act passed by the states, and may even withhold his consent to their assembling, but in such cases he must give his reasons to the secretary of state. The lieutenant-governor has the power of ordering foreigners out of the island, which, however, is rarely exercised. Jersey.

The language of the churches and courts of law, and of the upper classes generally, is French; that of the common people is the old Norman or Romance language. English, however, is becoming daily more common, and is now very generally understood and spoken.

The island of Jersey was visited by Her Majesty in 1846, and in commemoration of that event, a college was founded, which was opened on 29th of September 1852. It has professorships of the classics, mathematics, English, French, German, and drawing; and in 1855 had 118 students.

Since the commencement of the present century, commerce has been making rapid progress in the island. At the latter end of the seventeenth century there was no harbour at St Helier's, and even a century later, only two vessels could unload at a time in the harbour. In 1790, the north pier was commenced, but from want of funds it was many years in completion. The commercial or merchants' quays were built soon after by the chamber of commerce and the merchants at their own expense. The old south pier was commenced in 1821. The accommodation having soon become insufficient for the increasing traffic, a new harbour was commenced in 1841, and completed in 1846. In 1842 the shipping belonging to the island consisted of 296 vessels, having an aggregate of 27,075 tons; and in 1854, of 381 vessels, having an aggregate of 36,404 tons, and navigated by 3057 men. In 1854 the arrivals at the port of St Helier's were 1677 vessels, of the aggregate burden of 138,177 tons. The gross amount of harbour dues received during that year was L.4800.

The principal source of revenue is the duty on spirits and

Jersey ‖ Jerusalem.

wines, imported and consumed on the island. The net total amount received from this source for year ending 25th of March 1853, was L.14,950. Another source of revenue is the licences to publicans, which produces about L.1500 annually.

The manufactures are almost entirely confined to shoemaking, hosiery, and ship-building. The oyster fishery affords employment to many of the inhabitants. Steampackets leave Southampton for Jersey three times a week, and there is also a weekly steamer from Plymouth. Traders are constantly sailing from London, Weymouth, Bristol, and other English ports. The exports to England are chiefly cattle, potatoes, apples, cider, spirits, oysters, and granite, in return for cotton and woollen goods, hardware, and cutlery, earthenware, glass, soap, and coals. The foreign imports are wine, brandy, fruit, skins, poultry, timber, tallow, hemp, linen, and corn. The population of Jersey has been rapidly increasing from 28,600 in 1821, to 57,020 in 1851.

The Channel Islands were united to the English crown at the Norman conquest, having previously belonged to the dukes of Normandy. When the English lost the continental portion of Normandy, they kept possession of these islands, and have retained it ever since. Their importance in a military point of view, and their proximity to the coast of France, caused them to be eagerly coveted by the French, who have made frequent attempts to seize them, but always without success. The last attack was made in 1781, when the Baron de Rullecourt, with 800 men, landed at Jersey during the night, and, surprising the governor in bed, compelled him to sign a capitulation. The garrison, however, with the militia, under the command of Major Pierson, completely routed the invaders, whose general was mortally wounded. The loss of the English was small, but they had to lament the death of their gallant commander, who fell while cheering on his men at the moment of victory.

Jersey City ‖ Jerusalem.

JERSEY CITY, a seaport-town of the United States of North America, capital of Hudson county, in the state of New Jersey. It stands on the right bank of the Hudson River at its mouth, opposite the town of New York, from which it is 1 mile distant. The streets of the town are broad and well built. Besides several churches belonging to the leading sects, there are a good many educational establishments, the principal of which is the High School. The manufactures are important, including soap, glass, porcelain, delft-ware, black lead, iron, ropes, and starch. One or two newspapers are published in the town. Jersey City has become of considerable commercial importance from its proximity to New York, and from the great advantages it has in river, rail, and canal communications. The Great Southern Railway, as well as the Morris Canal have their termini here, and steam ferryboats constantly ply between Jersey City and New York. The town was incorporated in 1820, and in 1851 the adjoining villages of Harsimus and Pavonia, &c., were annexed to it. In 1850 the population of Jersey City proper amounted to 6856, while in 1853, along with its recent accessions, it had 18,456 inhabitants.

JERUSALEM.

History.

JERUSALEM (יְרוּשָׁלַיִם, *habitation of peace*; Sept. Ἱερουσαλήμ; Vulg. *Hierosolyma*; Arab. *El Kuds*), the Jewish capital of Palestine. It is mentioned very early in Scripture, being usually supposed to be the Salem of which Melchizedek was king. Such was the opinion of the Jews themselves; for Josephus, who calls Melchizedek king of Solyma, observes that this name was afterwards changed into Hierosolyma. All the fathers of the church, Jerome excepted, agree with Josephus, and understand Jerusalem and Salem to indicate the same place. The name Jerusalem first occurs in Josh. x. 1, where Adoni-zedek, king of Jerusalem, is mentioned as having entered into an alliance with other kings against Joshua, by whom they were all overcome.

In drawing the northern border of Judah, we find Jerusalem again mentioned (Josh. xv. 8). This border ran through the valley of Ben Hinnom; the country on the south of it, as Bethlehem, belonged to Judah; but the mountain of Zion, forming the northern wall of the valley, and occupied by the Jebusites, was assigned to Benjamin. Among the cities of Benjamin, therefore, is also mentioned (Josh. xviii. 28) "Jebus, which is Jerusalem."

After the death of Joshua, the Israelites took Jerusalem, smote it with the edge of the sword, and set it on fire. After that, the Judahites and the Benjamites dwelt with the Jebusites at Jerusalem; for it is recorded that the children of Judah could not drive out the Jebusites inhabiting Jerusalem; and we are farther informed that the children of Benjamin did not expel them from Jerusalem. Probably the Jebusites were removed by Judah only from the lower city, but kept possession of the mountain of Zion, which David conquered at a later period. Jerusalem is not again mentioned till the time of Saul, when it is stated that David took the head of Goliath and brought it to Jerusalem. After David, who had previously reigned over Judah alone in Hebron, was called to rule over all Israel, he led his forces against the Jebusites, and conquered the castle of Zion, which Joab first scaled. He then fixed his abode on this mountain, and called it "the City of David." The reasons which led him to fix upon Jerusalem as the metropolis of his kingdom are very intelligible. It was in his own tribe of Judah, in which his influence was the strongest, while it was the nearest to the other tribes of any site he could have chosen in Judah. The peculiar strength, also, of the situation, enclosed on three sides by a natural trench of valleys, could not be without weight.

The promise of its glory received its accomplishment when Solomon built his temple upon Mount Moriah. By him and his father Jerusalem had been made the imperial residence of the king of all Israel; and the temple, often called "the house of Jehovah," constituted it at the same time the residence of the King of Kings, whose vicegerents the human kings were taught to regard themselves. It now belonged, even less than a town of the Levites, to a particular tribe; it was the centre of all civil and religious affairs. The importance and splendour of Jerusalem were considerably lessened after the death of Solomon; under whose son, Rehoboam, ten of the tribes rebelled—Judah and Benjamin only remaining in their allegiance. Jerusalem was then only the capital of the very small state of Judah.

After the time of Solomon Jerusalem was much affected by the rapid alternation of good and bad kings. Under good kings the city flourished, and under bad kings it suffered greatly. Under Rehoboam (B.C. 973) it was conquered by Shishak, king of Egypt, who pillaged the treasures of the temple. Under Amaziah it was taken by Jehoash, king of Israel, who broke down 400 cubits of the wall of the city, and took all the gold and silver, and all the vessels that were found in the temple. Uzziah, son of Amaziah, who at first reigned well, built towers in Jerusalem at the corner-gate, at the valley-gate, and at the turning of the wall, and fortified them. His son, Jotham, built the high gate of the temple and many other structures. Hezekiah (B.C. 728) added to the other honours of his reign that of an improver of Jerusalem. His most eminent work in that character was the stopping of the upper course of

Jerusalem. Gihon, and bringing its waters by a subterraneous aqueduct to the west side of the city. This work is inferred, from 2 Kings xx., to have been of great importance to Jerusalem, as it cut off a supply of water from any besieging enemy, and secured it to the inhabitants of the city. Hezekiah's son, Manasseh, in his later and best years, built a strong and very high wall on the west side of Jerusalem. The works in the city connected with the names of the succeeding kings of Judah were, so far as recorded, confined to the defilement of the temple by bad kings, and its purgation by good kings, till about 100 years after Manasseh, when the city and temple were abandoned to destruction. After a seige of three years, Jerusalem was taken by Nebuchadnezzar, who razed its walls, and destroyed its temple and palaces with fire.

The ten tribes forming the kingdom of Israel had been already upwards of 130 years transported to Assyria, when Judah also was exiled to Babylon. The castle of David, the temple of Solomon, and the entire city, lay in ruins, and to all appearance there was an end of the people as well as of the holy city of the Jews. But the same prophets who foretold the destruction of Jerusalem, also announced the consolations of a coming time. Moses, Isaiah, Jeremiah, and Daniel, all foretold the searching probation which their countrymen were to undergo in captivity and exile, and their return home when the term of that probation was completed. Daniel lived to see the reign of Cyrus, king of Persia, through whose agency this prediction was fulfilled. It was in the year B.C. 536, in the first year of his reign, that Cyrus proclaimed the restoration of the Jews. This offer was accepted by a considerable number of persons, particularly priests and Levites; and the many who declined to quit their houses and possessions in Babylonia, committed valuable gifts to the hands of their more zealous brethren. Cyrus also caused the sacred vessels of gold and silver which Nebuchadnezzar had taken from the temple to be restored to Sheshbazzar, the prince of Judah, who took them to Jerusalem, followed by 42,360 people, beside their servants, of whom there were 7337 (Ezra i. 5–11).

On their arrival at Jerusalem they contributed according to their ability to rebuild the temple; and when in the following year the foundation was laid of the new house of God, "the people shouted for joy, but many of the Levites who had seen the first temple, wept with a loud voice." (Ezra iii. 2, 12.) When the Samaritans expressed a wish to share in the pious labour, Zerubbabel declined the offer; and in revenge the Samaritans sent a deputation to King Artaxerxes of Persia, describing Jerusalem as a rebellious city of old time, which, if rebuilt, and its walls set up again, would not pay toll, tribute, and custom. The deputation succeeded, and Artaxerxes ordered that the building of the temple should cease. The interruption thus caused, lasted to the second year of the reign of Darius, when Zerubbabel and Jeshua, supported by the prophets Haggai and Zechariah, again resumed the work, and would not cease though cautioned by the Persian governor of Judæa. On the matter coming before Darius Hystaspis, and the Jews reminding him of the permission given by Cyrus, he decided in their favour, and also ordered that the expenses of the work should be defrayed out of the public revenue. In the sixth year of the reign of Darius the temple was finished, when the people kept the Feast of Dedication with great joy, and next celebrated the Passover. Afterwards, in the seventh year of the second Artaxerxes, Ezra, a descendant of Aaron, came up to Jerusalem, accompanied by a large number of Jews who had remained in Babylon. At a later period, in the twentieth year of King Artaxerxes, Nehemiah, who was his cupbearer, obtained permission to proceed to Jerusalem, and to complete the rebuilding of the city and its wall, which he happily accomplished in the face of great opposition. (Neh. i., ii., iv., and vi.) The city was then capacious and large, but the people in it were few, and many houses lay still in ruins. Jerusalem.

It is said by Josephus (*Antiq.* xi. 8) that when the dominion of this part of the world passed from the Persians to the Greeks, Alexander the Great advanced against Jerusalem to punish it for the fidelity to the Persians which it had manifested while he was engaged in the siege of Tyre. His hostile purposes, however, are said to have been averted by the appearance of the high-priest Jaddua at the head of a train of priests in their sacred vestments.

After the death of Alexander at Babylon (B.C. 324), Ptolemy surprised Jerusalem on the Sabbath-day, when the Jews would not fight, plundered the city, and carried away a great number of the inhabitants to Egypt, where, however, from the estimation in which the Jews of this period were held as citizens, important privileges were bestowed upon them (Joseph. *Antiq.* xii. 1). In the contests which afterwards followed for the possession of Syria (including Palestine), Jerusalem does not appear to have been directly injured, and was even spared when Ptolemy gave up Samaria, Acco, Joppa, and Gaza to pillage. The contest was ended by the treaty in B.C. 302, which annexed the whole of Palestine, together with Arabia Petræa and Cœle-Syria, to Egypt. Under easy subjection to the Ptolemies, the Jews remained in much tranquillity for more than a hundred years, in which the principal incident, as regards Jerusalem itself, was the visit which was paid to it, in B.C. 245, by Ptolemy Energetes, on his return from his victories in the East. He offered many sacrifices, and made magnificent presents to the temple. In the wars between Antiochus the Great and the kings of Egypt, from B.C. 221 to 197, Judæa could not fail to suffer severely; but we are not acquainted with any incident in which Jerusalem was principally concerned till the alleged visit of Ptolemy Philopator in B.C. 211. He offered sacrifices and gave rich gifts to the temple, but venturing to enter the sanctuary, in spite of the remonstrances of the high-priest, he was seized with a supernatural dread, and fled in terror from the place. But the whole story of his visit, and its results, rests upon the sole authority of the third book of Maccabees (chaps. i. and ii.), and is therefore not entitled to implicit credit. Towards the end of this war, the Jews seemed to favour the cause of Antiochus; and after he had subdued the neighbouring country, they voluntarily tendered their submission, and rendered their assistance in expelling the Egyptian garrison from Mount Zion. For this conduct they were rewarded by many important privileges by Antiochus. He issued decrees directing, among other things, that the outworks of the temple should be completed, and that all the materials for needful repairs should be exempted from taxes. The peculiar sanctity of the temple was also to be respected.

Under their new masters the Jews enjoyed for a time nearly as much tranquillity as under the generally benign and liberal government of the Ptolemies. But in B.C. 176, Seleucus Philopator, hearing that great treasures were hoarded up in the temple, and being distressed for money to carry on his wars, sent his treasurer, Heliodorus, to bring away these treasures. But this personage is reported to have been so frightened and stricken by an apparition that he relinquished the attempt; and Seleucus left the Jews in the undisturbed enjoyment of their rights (2 Macc. iii. 4–40; Joseph. *Antiq.* xii. 3. 3). His brother and successor, Antiochus Epiphanes, however, was of another mind. He took up the design of reducing them to a conformity of manners and religion with other nations—or, in other words, of abolishing those distinctive features which made the Jews a peculiar people, socially separated from all others. This design was odious to the great body of the people,

Jerusalem. although there were many among the higher classes who regarded it with favour. Of this way of thinking was Menelaus, whom Antiochus had made high priest, and who was expelled by the orthodox Jews with ignominy, in B.C. 169, when they heard the joyful news that Antiochus had been slain in Egypt. The rumour proved untrue, and Antiochus on his return punished them by plundering and profaning the temple. Worse evils befel them two years after: for Antiochus, out of humour at being compelled by the Romans to abandon his designs upon Egypt, sent his chief collector of tribute, Apollonius, with a detachment of 22,000 men, to vent his rage on Jerusalem. This person plundered the city, and razed its walls, with the stones of which he built a citadel that commanded the temple mount. A statue of Jupiter was set up in the temple; the peculiar observances of the Jewish law were abolished; and a persecution was commenced against all who adhered to these observances, and refused to sacrifice to idols. Jerusalem was deserted by priests and people, and the daily sacrifice at the altar was entirely discontinued (1 Macc. i. 29-40; 2 Macc. v. 24-26; Joseph. *Antiq.* xii. 5, 4). These cruelties led to the celebrated revolt of the Maccabees, who, after an arduous and sanguinary struggle, obtained possession of Jerusalem (B.C. 163), and repaired and purified the temple, which was then dilapidated and deserted. New utensils were provided for the sacred services; the old altar, which had been polluted by heathen abominations, was taken away, and a new one erected. The sacrifices were then recommenced, exactly three years after the temple had been dedicated to Jupiter Olympius. The castle, however, remained in the hands of the Syrians, and long proved a sore annoyance to the Jews, although Judas Maccabæus surrounded the temple with a high and strong wall, furnished with towers, in which soldiers were stationed to protect the worshippers from the Syrian garrison. Eventually the annoyance grew so intolerable that Judas laid siege to the castle. This attempt brought a powerful army into the country under the command of the regent Lysias, who, however, being constrained to turn his arms elsewhere, made peace with the Jews; but when he was admitted into the city, and observed the strength of the place, he threw down the walls, in violation of the treaty. In the ensuing war with Bacchides, the general of Demetrius Soter, in which Judas was slain, the Syrians strengthened their citadel, and placed in it the sons of the principal Jewish families as hostages. The year after (B.C. 159) the temporising high priest Alcimus directed the wall which separated the court of Israel from that of the Gentiles to be cast down, to afford the latter free access to the temple; but he was seized with palsy as soon as the work commenced, and died in great agony. When, a few years after, Demetrius and Alexander Balas sought to outbid each other for the support of Jonathan, the hostages in the castle were released; and subsequently all the Syrian garrisons in Judæa were evacuated, excepting those of Jerusalem and Bethzur, which were chiefly occupied by apostate Jews, who were afraid to leave their places of refuge. Jonathan then rebuilt the walls of Jerusalem, and repaired the buildings of the city, besides erecting a palace for his own residence. The particular history of Jerusalem for several years following is little more than an account of the efforts of the Maccabæan princes to obtain possession of the castle, and of the Syrian kings to retain it in their hands. At length, in B.C. 142, the garrison was forced to surrender by Simon, who demolished it altogether, that it might not again be used against the Jews by their enemies. Simon then strengthened the fortifications of the mountain on which the temple stood, and built there a palace for himself. This building was afterwards turned into a regular fortress by John Hyrcanus, and was ever after the residence of the Maccabæan princes. It is called by Josephus "the castle of Baris," in his *History of the Jews*; till it was strengthened and enlarged by Herod the Great, who called it the Castle of Antonia, under which name it makes a conspicuous figure in the Jewish wars with the Romans. Jerusalem.

Of Jerusalem itself we find nothing of consequence, till it was taken by Pompey in the summer of B.C. 63, and on the very day observed by the Jews as one of lamentation and fasting, in commemoration of the conquest of Jerusalem by Nebuchadnezzar. Twelve thousand Jews were massacred in the temple courts, including many priests, who died at the very altar rather than suspend the sacred rites. On this occasion Pompey, attended by his generals, went into the temple and viewed the sanctuary; but he left untouched all its treasures and sacred things, while the walls of the city itself were demolished. From this time the Jews are to be considered as under the dominion of the Romans. The treasures which Pompey had spared were seized a few years after (B.C. 51) by Crassus. In the year B.C. 43, the walls of the city, which Pompey had demolished, were rebuilt by Antipater, the father of that Herod the Great under whom Jerusalem was destined to assume the new and more magnificent aspect which it bore in the time of Christ, and which constituted the Jerusalem which Josephus describes. This Jerusalem—the Jerusalem as improved by the magnificent tastes and profuse expenditure of Herod—was probably as different from the Jerusalem before his time as the London of 1856 is from the London of 1800. And perhaps the difference was even greater, for our great fanes still exist, whereas the temple, which always formed the great architectural glory of Jerusalem, was taken down and rebuilt by Herod the Great, with a magnificence exceeding that of Solomon's. Nor was the city in this state admired by Jews only. Pliny calls it "longe clarissimam urbium orientis, non Judææ modo" (*Hist. Nat.* v. 16). Jerusalem seems to have been raised to this greatness, as if to enhance the misery of its overthrow. So soon as the Jews had set the seal to their formal rejection of Christ, by putting him to death, and invoking the responsibility of his blood upon the heads of themselves and of their children, its doom went forth. After having been the scene of horrors without example, it was, in A.D. 70, abandoned to the Romans, who razed the city and temple to the ground, leaving only three of the towers and a part of the western wall to show how strong a place the Roman arms had overthrown.

This demolition, however, did not cause the site of the city to be utterly forsaken. Titus left there in garrison the whole of the tenth legion, besides several squadrons of cavalry and cohorts of foot. For these troops, and for those who ministered to their wants, there must have been dwellings; and there is no reason to suppose that such Jews or Christians as appeared to have taken no part in the war were forbidden to make their abode among the ruins, and building them up so far as their necessities might require. But nothing like a restoration of the city could have arisen from this, as it was not likely that any but poor people, who found an interest in supplying the wants of the garrison, were likely to resort to the ruins under such circumstances. However, we learn from Jerome that for fifty years after its destruction, until the time of Adrian, there still existed remnants of the city. But during all this period there is no mention of it in history.

Up to A.D. 131 the Jews remained tolerably quiet, although apparently waiting any favourable opportunity of shaking off the Roman yoke. The then emperor, Adrian, seems to have been aware of this state of feeling, and, among other measures of precaution, ordered Jerusalem to be rebuilt as a fortified place, wherewith to keep in check the whole Jewish population. The works had made some progress, when the Jews, unable to endure the idea that their holy city should be occupied by foreigners, and that strange gods should be set up within it, broke out into open

Jerusalem. rebellion under the notorious Barchochebas, who claimed to be the Messiah. His success was at first very great; but he was crushed before the tremendous power of the Romans, so soon as it could be brought to bear upon him; and a war scarcely inferior in horror to that under Vespasian and Titus was, like it, brought to a close by the capture of Jerusalem, of which the Jews had obtained possession. This was in A.D. 135, from which period the final dispersion of the Jews has been often dated. The Romans then finished the city according to their first intention. It was made a Roman colony, inhabited wholly by foreigners, the Jews being forbidden to approach it on pain of death: a temple to Jupiter Capitolinus was erected on Mount Moriah, and the old name of Jerusalem was sought to be supplanted by that of Ælia Capitolina, conferred upon it in honour of the emperor, Ælius Adrianus, and Jupiter Capitolinus. By this name was the city known till the time of Constantine, when that of Jerusalem again became current, although Ælia was still its public designation, and remained such so late as A.D. 536, when it appears in the acts of a synod held there. This name even passed to the Mohammedans, by whom it was long retained; and it was not till after they recovered the city from the Crusaders that it became generally known among them by the name of El-Khuds—the holy—which it still bears.

From the rebuilding by Adrian the history of Jerusalem is almost a blank till the time of Constantine, when its history, as a place of extreme solicitude and interest to the Christian church, properly begins. Pilgrimages to the holy city now became common and popular. Such a pilgrimage was undertaken, in A.D. 326, by the emperor's mother, Helena, then in the 80th year of her age, who built churches on the alleged site of the nativity at Bethlehem, and of the resurrection on the Mount of Olives. This example may probably have excited her son to the discovery of the site of the holy sepulchre, and to the erection of a church thereon. He removed the temple of Venus, with which, in studied insult, the site had been encumbered. The holy sepulchre was then purified, and a magnificent church was, by his order, built over and around the sacred spot. This temple was completed and dedicated with great solemnity in A.D. 335. There is no doubt that the spot thus singled out is the same which has ever since been regarded as the place in which Christ was entombed; but the correctness of the identification then made has been of late years much disputed, though, as it seems, needlessly, and on quite insufficient grounds. The very cross on which our Lord suffered was also, in the course of these explorations, believed to have been discovered.

By Constantine the edict excluding the Jews from the city of their fathers' sepulchres was so far repealed that they were allowed to enter it once a-year to wail over the desolation of "the holy and beautiful house," in which their fathers worshipped God. When the nephew of Constantine, the Emperor Julian, abandoned Christianity for the old Paganism, he endeavoured, as a matter of policy, to conciliate the Jews. He allowed them free access to the city, and permitted them to rebuild their temple. They accordingly began to lay the foundations in A.D. 362; but the speedy death of the emperor probably occasioned that abandonment of the attempt, which contemporary writers ascribe to supernatural hindrances. The edicts seem then to have been renewed which excluded the Jews from the city, except on the day of annual wailing.

In the following centuries the roads to Zion were thronged with pilgrims from all parts of Christendom, and the land abounded in monasteries, occupied by persons who wished to lead a religious life amid the scenes which had been sanctified by the Saviour's presence. After much struggle of conflicting dignities, Jerusalem was, in A.D. 451, declared a patriarchate by the council of Chalcedon. In the next century it found a second Constantine in Justinian, who Jerusalem ascended the throne A.D. 527. He repaired and enriched the former structures, and built upon Mount Moriah a magnificent church to the Virgin, as a memorial of the persecution of Jesus in the temple. He also founded ten or eleven convents in and about Jerusalem and Jericho, and established an hospital for pilgrims in each of those cities.

But these prosperous days were soon to end. The Persians, who had long harassed the empire of the East, penetrated into Syria in A.D. 614, and, after defeating the forces of the Emperor Heraclius, took Jerusalem by storm. Many thousands of the inhabitants were slain, and much of the city, including the finest churches—that of the holy sepulchre among them—was destroyed. When the conquerors withdrew, they took away the principal inhabitants, the patriarch, and the true cross; but when, the year after, peace was concluded, these were restored, and the Emperor Heraclius entered Jerusalem in solemn state, bearing the cross upon his shoulders.

The damage occasioned by the Persians was speedily repaired. But Arabia soon furnished a more formidable enemy in the Khalif Omar, whose troops appeared before the city in A.D. 636; Arabia, Syria, and Egypt having already been brought under the Moslem yoke. After a long siege the austere Khalif himself came to the camp, and the city was at length surrendered to him in A.D. 637. The conqueror of mighty kings entered the holy city in his garment of camel's hair, and conducted himself with much discretion and generous forbearance. By his orders the magnificent mosque which still bears his name was built upon Mount Moriah, upon the site of the Jewish temple.

Jerusalem remained in possession of the Arabians, and was occasionally visited by Christian pilgrims from Europe till towards the year 1000, when a general belief that the second coming of the Saviour was near at hand, drew pilgrims in unwonted crowds to the Holy Land, and created an impulse for pilgrimages thither, which ceased not to act after the first exciting cause had been forgotten. The Moslem government, in order to derive some profit from this enthusiasm, imposed the tribute of a piece of gold as the price of entrance into the holy city. The sight, by such large numbers, of the holy place in the hands of infidels, the exaction of tribute, and the insults to which the pilgrims, often of the highest rank, were exposed from the Moslem rabble, excited an extraordinary ferment in Europe, and led to those remarkable expeditions for recovering the holy sepulchre from the Mohammedans, which, under the name of the Crusades, will always fill a most important and curious chapter in the history of the world.

The dominion over Palestine had passed in A.D. 960 from the khalifs of Baghdad to the Fatemite khalifs of Egypt, who, in their turn, were dispossessed in A.D. 1073 by the Turkmans, who had usurped the powers of the eastern khalifat. The severities exercised by these more fierce and uncivilized Moslems upon both the native Christians and the European pilgrims supplied the immediate impulse to the first eastern expedition. But by the time the crusaders, under Godfrey of Bouillon, appeared before Jerusalem, on the 17th of June 1099, the Egyptian khalifs had recovered possession of Palestine, and driven the Turkmans beyond the Euphrates.

After a siege of forty days, the holy city was taken by storm on the 15th day of July, and a dreadful massacre of the Moslem inhabitants followed, without distinction of age or sex. As soon as order was restored, and the city cleared of the dead, a regular government was established by the election of Godfrey as king of Jerusalem. One of the first cares of the new monarch was to dedicate anew to the Lord the place where His presence had once abode; and the mosque of Omar became a Christian cathedral, which the historians of the time distinguish as "the temple of the

Jerusalem. Lord" (*Templum Domini*). The Christians kept possession of Jerusalem eighty-eight years. During this long period they appear to have erected several churches and many convents. Of the latter, few if any traces remain; and of the former, save one or two ruins, the church of the holy sepulchre, which they rebuilt, is the only memorial which attests the existence of the Christian kingdom of Jerusalem. In A.D. 1187 the holy city was wrested from the hands of the Christians by the Sultan Saladin, and the order of things was then reversed. The cross was removed with ignominy from the sacred dome, the holy places were purified from Christian stain with rose-water brought from Damascus, and the call to prayer by the muzzin once more sounded over the city. From that time to the present day the holy city has remained, with slight interruption, in the hand of the Moslems. On the threatened siege by Richard of England in 1192, Saladin took great pains in strengthening its defences. New walls and bulwarks were erected, and deep trenches cut, and in six months the town was stronger than it ever had been, and the works had the firmness and solidity of a rock. But in A.D. 1219, the Sultan Melek el Moaddin of Damascus, who then had possession of Jerusalem, ordered all the walls and towers to be demolished, except the citadel and the inclosure of the mosque, lest the Franks should again become masters of the city and find it a place of strength. In this defenceless state Jerusalem continued till it was delivered over to the Christians in consequence of a treaty with the Emperor Frederick II., in A.D. 1229, with the understanding that the walls should not be rebuilt. Yet ten years later (A.D. 1239) the barons and knights of Jerusalem began to build the walls anew, and to erect a strong fortress on the west of the city. But the works were interrupted by the emir David of Kerek, who seized the city, strangled the Christian inhabitants, and cast down the newly erected walls and fortress. Four years after, however (A.D. 1243), Jerusalem was again made over to the Christians without any restriction, and the works appear to have been restored and completed; for they are mentioned as existing when the city was stormed by the wild Kharismian hordes in the following year; shortly after which the city reverted for the last time into the hands of its Mohammedan masters, who have kept it to the present day.

From this time Jerusalem appears to have sunk very much in political and military importance; and it is scarcely named in the history of the Memluk sultans who reigned over Egypt and the greater part of Syria in the fourteenth and fifteenth centuries. At length, with the rest of Syria and Egypt, it passed under the sway of the Turkish sultan Selim I., who paid a hasty visit to the holy city from Damascus after his return from Egypt. From that time Jerusalem has formed a part of the Ottoman empire, and during this period has been subject to few vicissitudes: its history is accordingly barren of incident. The present walls of the city were erected by Suleiman the Magnificent, the successor of Selim, in A.D. 1542, as is attested by an inscription over the Jaffa gate. So lately as A.D. 1808, the church of the holy sepulchre was partially consumed by fire; but the damage was repaired with great labour and expense in September 1810, and the traveller now finds in this imposing fabric no traces of the recent calamity.

In A.D. 1832, Jerusalem became subject to Mohammed Ali, the pasha of Egypt, the holy city opening its gates to him, without a siege. During the great insurrection in the districts of Jerusalem and Nabulus, in 1834, the insurgents seized upon Jerusalem, and held possession of it for a time; but by the vigorous operations of the government order was soon restored, and the city reverted quietly to its allegiance on the approach of Ibrahim Pasha with his troops. In 1841 Mohammed Ali was deprived of all his Syrian possessions by European interference, and Jerusalem was again subjected to the Turkish government, under which it now remains. It is not, perhaps, the happier for the change. Jerusalem. The only subsequent event of interest has been the establishment of a Protestant bishopric at Jerusalem by the English and Prussian governments, and the erection upon Mount Zion of a church, calculated to hold 500 persons, for the celebration of Divine worship according to the ritual of the English church. The wardenship of the holy places at Jerusalem has always been keenly contested by the Greek and Latin churches; and on the anniversaries of some of the festivals common to both, scenes of a most indecorous and irreverent nature were regularly witnessed. It was in vain that the Turkish governor of the city endeavoured to mediate between them; and it was well if the most solemn services of the two churches ended without bloodshed. The Greeks, countenanced by Russia, and the Latins by France, kept up the old feud with such fierce animosity, that it at length embroiled the peace of Europe, and was one of the ostensible causes of the Russo-Turkish war of 1853–55. For the history of Jerusalem see *Geschichte von Jerusalem*, Strasbourg, 1518; Spalding, *Gesch. d. Christl. Königreichs Jerusalem*, Berlin, 1803; Delying, *Æliæ Capitolinæ Origg. et Historia*, Lips. 1743; Poujoulat, *Histoire de Jérusalem*, Brux. 1842; Raumer's *Palastina;* Robinson's *Bib. Researches in Palestine.*

Before proceeding to inquire into the ancient state of the city, and to describe its present condition, it will be well to furnish the reader with a general description of the site, that he may be enabled to follow the details with the more precision. For this purpose we shall avail ourselves of the able sketch given by Professor Robinson in his *Researches* (i. 380–384).

" Jerusalem lies near the summit of a broad mountain- General Topography. ridge. This ridge, or mountainous tract, extends without interruption from the plain of Esdraelon to a line drawn between the S. end of the Dead Sea and the S.E. corner of the Mediterranean; or, more properly, perhaps, it may be regarded as extending as far S. as to Jebel Arâif in the Desert, where it sinks down at once to the level of the great western plateau. This tract, which is everywhere not less than from 20 to 25 geographical miles in breadth, is, in fact, high uneven table-land. It everywhere forms the precipitous western wall of the great valley of the Jordan and the Dead Sea; while towards the W. it sinks down by an off-set, into a range of lower hills, which lie between it and the great plain along the coast of the Mediterranean. The surface of this upper region is everywhere rocky, uneven, and mountainous; and is, moreover, cut up by deep valleys which run E. or W. on either side towards the Jordan or the Mediterranean. The line of division, or watershed, between the waters of these valleys—a term which here applies almost exclusively to the waters of the rainy season—follows for the most part the height of land along the ridge; yet not so but that the heads of the valleys, which run off in different directions, often interlap for a considerable distance. Thus, for example, a valley which descends to the Jordan, often has its head a mile or two westward of the commencement of other valleys which run to the western sea.

" From the great plain of Esdraelon onwards to the S., the mountainous country rises gradually, forming the tract anciently known as the mountains of Ephraim and Judah; until, in the vicinity of Hebron, it attains an elevation of nearly 3000 Paris feet above the level of the Mediterranean Sea. Further N., on a line drawn from the N. end of the Dead Sea towards the true W., the ridge has an elevation of only about 2500 Paris feet; and here, close upon the watershed, lies the city of Jerusalem. Its mean geographical position is in N. Lat. 31. 46. 43., and E. Long. 35. 13. from Greenwich.

" Six or seven miles N. and N.W. of the city is spread

Jerusalem. out the open plain or basin round about El-Jib (Gibeon), extending also towards El-Bireh (Beeroth); the waters of which flow off at its S.E. part through the deep valley here called by the Arabs Wady Beit Hanîna; but to which the monks and travellers have usually given the name of the 'Valley of Turpentine,' or of the Terebinth, on the mistaken supposition that it is the ancient valley of Elah. This great valley passes along in a S.W. direction, an hour or more W. of Jerusalem; and finally opens out from the mountains into the western plain, at the distance of six or eight hours S.W. from the city, under the name of Wady es-Sŭrâr. The traveller, on his way from Ramleh to Jerusalem, descends into, and crosses this deep valley, at the village of Kulônieh on its western side, an hour and a half from the latter city. On again reaching the high ground on its eastern side, he enters upon an open tract sloping gradually downwards towards the E.; and sees before him, at the distance of about two miles, the walls and domes of the holy city, and beyond them the higher ridge or summit of the Mount of Olives. The traveller now descends gradually towards the city along a broad swell of ground, having at some distance on his left the shallow northern part of the valley of Jehoshaphat; close at hand, on his right, the basin which forms the beginning of the valley of Hinnom. Further down both these valleys become deep, narrow, and precipitous; that of Hinnom bends S. and again E. nearly at right angles, and unites with the other, which then continues its course to the Dead Sea. Upon the broad and elevated promontory within the fork of these two valleys lies the holy city. All around are higher hills; on the E. the Mount of Olives; on the S. the Hill of Evil Council, so called, rising directly from the vale of Hinnom; on the W. the ground rises gently, as above described, to the borders of the Great Wady; while on the N. a bend of the ridge, connected with the Mount of Olives, bounds the prospect at the distance of more than a mile. Towards the S.W. the view is somewhat more open; for here lies the plain of Rephaim, commencing just at the southern brink of the valley of Hinnom, and stretching off S.W., where it runs to the western sea. In the N.W. too, the eye reaches up along the upper part of the valley of Jehoshaphat; and from many points can discern the mosque of Neby Samwil, situated on a lofty ridge beyond the Great Wady, at the distance of two hours.

"The surface of the elevated promontory itself, on which the city stands, slopes somewhat steeply towards the E., terminating on the brink of the valley of Jehoshaphat. From the northern part, near the present Damascus gate, a depression or shallow wady runs in a southern direction, having on the W. the ancient hills of Akra and Zion, and on the E. the lower ones of Bezetha and Moriah. Between the hills of Akra and Zion another depression or shallow wady (still easy to be traced) comes down from near the Jaffa gate, and joins the former. It then continues obliquely down the slope, but with a deeper bed, in a southern direction, quite to the pool of Siloam and the valley of Jehoshaphat. This is the ancient Tyropœon. West of its lower part Zion rises loftily, lying mostly without the modern city; while on the E. of the Tyropœon and the valley first mentioned, lie Bezetha, Moriah, and Ophel, the last a long and comparatively narrow ridge, also outside of the modern city, and terminating in a rocky point over the pool of Siloam. These three last hills may strictly be taken as only parts of one and the same ridge. The breadth of the whole site of Jerusalem, from the brow of the valley of Hinnom, near the Jaffa gate, to the brink of the valley of Jehoshaphat, is about 1020 yards, or nearly half a geographical mile; of which distance 318 yards are occupied by the area of the great mosque El-Haram Esh-Sherif. North of the Jaffa gate the city wall sweeps round more to the W., and increases the breadth of the city in that part.

"The country around Jerusalem is all of limestone for- Jerusalem.
mation, and not particularly fertile. The rocks everywhere come out above the surface, which in many parts is also thickly strewed with loose stones; and the aspect of the whole region is barren and dreary; yet the olive thrives here abundantly, and fields of grain are seen in the valleys and level places, but they are less productive than in the region of Hebron and Nabulus. Neither vineyards nor fig-trees flourish on the high ground around the city, though the latter are found in the gardens below Siloam, and very frequently in the vicinity of Bethlehem."

Every reader of Scripture feels a natural anxiety to form some notion of the appearance and condition of Jerusalem as it existed in the time of Jesus, or rather as it stood before its destruction by the Romans. It is certain that our knowledge of its ancient state must proceed upon an accurate knowledge of its present condition. But if we compare the accounts of different travellers, and the plans which many of them have laid down, the irreconcilable differences between them produce a discouraging conviction of the insufficiency of the basis thus offered for the foundation of any fixed conclusions. And even if there were agreement in the accounts of the superficies, something more than this would be required—something more than ever perhaps will be realized while the site continues to be trodden under foot by the Gentiles. Much was done by Dr Robinson and others during the period of the rule of the Pasha of Egypt, in which greater facilities were offered for exploration than are likely to be soon again obtained. But a far more minute and searching examination of the site than was even then realized is necessary for the purposes of antiquarian comparison. For instance, the surface is in many parts covered to a vast depth, and the character and properties of particular spots are necessarily much altered, by the accumulated rubbish of ages. Some notion of this may be formed from the fact that in seeking a foundation for the Protestant church on Mount Zion, superincumbent rubbish to the depth of fifty feet was dug through before reaching the solid rock (*Olin*, ii. 254). It would therefore appear that not only a very minute survey, but numerous excavations, would be necessary to the ends of a really satisfactory investigation.

To the obscurity originating in these causes may be added that which arises from the many ambiguities in the description left by Josephus, the only one which we possess, and which must form the ground-work of most of our notices respecting the ancient city. There are indeed some manifest errors in his account, which the critical reader is able to detect without having the means to rectify.

In describing Jerusalem as it stood just before its destruction by the Romans, Josephus states that the city was built upon two hills, between which lay the Valley Tyropœon (Cheesemonger's Valley), to which the buildings on both hills came down. This valley extended to the fountain of Siloam. The hill on which the upper town stood was much higher than the other, and straighter in its extent. On account of its fortifications, David called it the Fortress or Castle; but in the time of Josephus it was known by the name of the Upper Market. The other hill, on which was situated the lower town, was called Akra. It was in the form of a horseshoe or crescent. Opposite to Akra was a third, and naturally lower hill (Moriah), on which the temple was built; and between this and Akra was originally a broad valley, which the inhabitants of Jerusalem filled up in the time of Simon Maccabæus for the purpose of connecting the town with the temple. At the same time they lowered the hill Akra, so as to make the temple rise above it. Both the hills on which the upper and lower towns stood were externally surrounded by deep valleys, and here there was no approach because of the precipices on every side.

The single wall which inclosed that part of the city

Jerusalem.

skirted by precipitous valleys, began at the tower of Hippicus. On the west it extended (southward) to a place called Bethso, and the gate of the Essenes; thence it kept along on the south to a point over against Siloam; and thence on the east was carried along by Solomon's Pool and Ophla (Ophel), till it terminated at the eastern portico of the temple. Of the triple walls, we are told that the first and oldest of these began at the tower of Hippicus, on the northern part, and extending (along the northern brow of Zion) to the Xystus, afterwards terminated at the western portico of the temple. The second wall began at the gate of Gennath (apparently near Hippicus), and encircling only the northern part of the city, extended to the castle of Antonia at the north-west corner of the area of the temple. The third wall was built by Agrippa at a later period: it also had its beginning at the tower of Hippicus, ran northward as far as the tower Psephinos; and thence sweeping round towards the north-east by east, it turned afterwards towards the south, and was joined to the ancient wall at or in the valley of the Kidron. This wall inclosed the hill Bezetha.

From other passages we learn that the Xystus, named in the above descriptions, was an open place in the extreme part of the upper city, where the people sometimes assembled, and that a bridge connected it with the temple (*De Bell. Jud.* ii. 16. 3; vi. 6. 2; vi. 8. 1; comp. *Antiq.* xiv. 4, 2). Further, we are informed that on the western side of the temple area were four gates; one leading over the valley to the royal palace (on Zion) adjacent to the Xystus, probably by the bridge just mentioned; two conducting to the suburb (or new city) on the north; and the remaining one leading to "the other city," first by steps down into the intervening valley, and then by an ascent (Joseph. *Antiq.* xv. 11. 5; xx. 8. 11). By this "other city" can be meant only the lower city or Akra. The hill Bezetha, which was last inclosed, lay quite near on the north of the temple (Joseph. *De Bell. Jud.* v. 5. 8). From the account of the operations of the Romans under Titus, it may also be collected that the interior and most ancient of the three walls on the north, lay between Akra and the upper city, forming the defence of the latter in this part. It was, doubtless, the same wall which ran along the northern brow of Zion.

It would be only going over this statement in other words to explain the results which it offers; and there is the less need of doing so, as they only serve to support the conclusions which have long been regarded as established. Dr Robinson, in comparing the information derived from Josephus with his own more detailed account, declares that the main features depicted by the Jewish historian may still be recognised. "True," he says, "the valley of the Tyropœon, and that between Akra and Moriah, have been greatly filled up with the rubbish accumulated from the repeated desolations of nearly eighteen centuries. Yet they are still distinctly to be traced: the hills of Zion, Akra, Moriah, and Bezetha, are not to be mistaken; while the deep valleys of the Kidron, and of Hinnom, and the Mount of Olives, are permanent natural features, too prominent and gigantic indeed to be forgotten, or to undergo any perceptible change" (*Bibl. Researches*, i. 414).

The details embraced in this general notice must be more particularly examined in connection with modern observations; for it is to be remembered that the chief or only value of these observations consists in the light which they throw on the ancient condition and history of the site.

The walls.

Some questions of much interest, chiefly relating to the site of the crucifixion of our Lord, and of the sepulchre in which he was laid, are connected with the attempt to determine the course and extent of the ancient walls of Jerusalem. The first, or most ancient wall, appears to have inclosed the whole of Mount Zion. The greater part of it, therefore, must have formed the exterior and sole wall on the south, overlooking the deep valleys below Mount Zion; and the northern part evidently passed from the tower of Hippicus on the west side, along the northern brow of Zion, and across the valley, to the western side of the temple area. It probably nearly coincided with the ancient wall which existed before the time of David, and which enabled the Jebusites to maintain themselves in possession of the upper city, long after the lower city had been in the hands of the Israelites. Mount Zion is now unwalled, and is excluded from the modern city. Some traces of this wall were visible in the time of Benjamin of Tudela, who says that the stones of the foundation were then taken away for building (*Itiner.*, ed. Asher., i. 73). No trace of it can now be perceived, but by digging through the rubbish, the foundations might perhaps be discovered.

Jerusalem.

The account given by Josephus of the second wall is very short and unsatisfactory. This is the more to be regretted, as on the course taken by the eastern part of that wall rests the question, whether that which is now shown as the site of Calvary and the Holy Sepulchre was anciently beyond the wall or not. The difficulties of this question are very great, the historical evidence being just as strongly in favour of the present site as the topographical evidence is against it. It cannot be denied that the breadth of the city, in a site limited by nature, and where, therefore, every foot of ground was precious, would be greatly and inconveniently narrowed by drawing the line so as to place the present holy sepulchre beyond the walls. But, on the other hand, it must be admitted that the phrase "beyond the walls" is often interpreted with a larger meaning than necessary. When applied to executions, gibbetings, or any purpose not allowable within the walls, we have always understood, from the analogous usages in all walled towns, that it denotes the slope or any other practicable space *immediately under* the wall, and so near to it that a slight advance of the wall would include the site. The fastening of the bodies of Saul and his sons *to* the wall of Beth-shan may illustrate this view of the case, which tends in some degree to lessen the difficulty of the question. For our present purpose it is sufficient to indicate the evident fact that this second wall inclosed the whole of the lower city, or Akra, excepting that part of the eastern side of it which fronted the temple area on Mount Moriah, and the southern side, towards the valley which separated the lower from the upper city. In short, it was a continuation of the external wall, so far as necessary, on the west and north, and on so much of the east as was not already protected by the strong wall of the temple area. The precise course of this wall might perhaps be determined by excavations. It is, indeed, our strong conviction that one good excavation along one of the two streets which intersect the Via Dolorosa would go far to settle for ever the only question of real interest connected with the subject. It is likely that the foundations of the old wall still exist; and if it lay at any point *within* the present wall, those foundations must pass under this street, and an excavation of not greater extent than those which are made every day in London for sewerage, would bring them to light, and show whether the alleged site of Calvary lay within or without the wall.

Although these were the only walls that existed in the time of our Saviour, we are not to infer that the habitable city was confined within their limits. On the contrary, it was because the city had extended northward far beyond the second wall that a third was built to cover the defenceless suburb: and there is no reason to doubt that this unprotected suburb, called Bezetha, existed in the time of Christ. This wall is described as having also begun at the tower of Hippicus: it ran northward as far as to the tower Psephinos, then passed down opposite the sepulchre of Helena (queen of Adiabene), and being carried along through the royal sepulchres, turned at the corner tower by the Fullers' monument, and ended by making a junction with

Jerusalem. the ancient wall at the valley of the Kidron. It was begun ten or twelve years after our Lord's crucifixion by the elder Herod Agrippa, who desisted from completing it for fear of offending the Emperor Claudius. But the design was afterwards taken up and completed by the Jews themselves, although on a scale of less strength and magnificence. Dr Robinson thinks that he discovered some traces of this wall, which are described in his great work (*Bibl. Researches*, i. 466).

The same writer thinks that the wall of the new city, the Ælia of Adrian, nearly coincided with that of the present Jerusalem: and the portion of Mount Zion which now lies outside, would seem then also to have been excluded; for Eusebius and Cyril, in the fourth century, speak of the denunciation of the prophet being fulfilled, and describes Zion as a "ploughed field."

We know from Josephus that the circumference of the ancient city was 33 stadia, equivalent to nearly three and a half geographical miles. The circumference of the present walls does not exceed two and a half geographical miles; but the extent of Mount Zion, now without the walls, and the tract on the north formerly inclosed, or partly so, by the third wall, sufficiently account for the difference.

The history of the modern walls has already been given in the sketch of the modern history of the city. The present walls have a solid and formidable appearance, especially when cursorily observed from without; and they are strengthened, or rather ornamented, with towers and battlements after the Saracenic style. They are built of limestone, the stones being not commonly more than a foot or 15 inches square. The height varies with the various elevations of the ground. The lower parts are probably about 25 feet high, while in more exposed localities, where the ravines contribute less to the security of the city, they have an elevation of 60 or 70 feet.

Gates. Much uncertainty exists respecting the ancient gates of Jerusalem. Many gates are named in Scripture; and it has been objected that they are more in number than a town of the size of Jerusalem could require—especially as they all occur within the extent embraced by the first and second walls, the third not then existing. It has, therefore, been suggested as more than probable that some of these gates were within the city, in the walls which separated the town from the temple, and the upper town from the lower, in which gates certainly existed. On the other hand, considering the circumstances under which the wall was rebuilt in the time of Nehemiah, it is difficult to suppose that more than the outer wall was then constructed, and certainly it was in the wall then built that the ten or twelve gates mentioned by Nehemiah occur. But these may be considerably reduced by supposing that two or more of the names mentioned were applied to the same gate. If this view of the matter be taken, no better distribution of these gates can be given than that suggested by Raumer.

(*a.*) On the north side,—1. The *Old-gate*, probably at the north-east corner (Neh. iii. 6; xii. 39). 2. The *Gate of Ephraim* or *Benjamin* (Jer. xxxviii. 7), &c. This gate doubtless derived its names from its leading to the territory of Ephraim and Benjamin; and Dr Robinson supposes it may possibly be represented by some traces of ruins which he found on the site of the present Gate of Damascus. 3. The *Corner-gate*, 400 cubits from the former, and apparently at the north-west corner (2 Chron. xxv. 23), &c. Probably the *Gate of the Furnaces* is the same (Neh. iii. 2; xii. 38). (*b.*) On the west side,—4. The *Valley-gate*, over against the Dragon-fountain of Gihon (Neh. ii. 13), &c. It was probably about the north-west corner of Zion, where there appears to have been always a gate; and Dr Robinson supposes it to be the same with the Gennath of Josephus. (*c.*) On the south side,—5. The *Dung-gate*, perhaps the same as Josephus's Gate of the Essenes (Neh. ii. 13). It was 1000 cubits from the Valley-gate, and the Dragon-well was between them. This gate is probably also identical with "the gate between two walls" (2 Kings xxv. 4), &c. 6. The *Gate of the Fountain*, to the south-east (Neh. ii. 14); the gate of the fountain near the king's pool (Neh. ii. 14); the gate of the fountain near "the pool of Siloah by the king's garden" (Neh. iii. 15). The same gate is probably denoted in all these instances, and the pools seem to have been also the same. It is also possible that this Fountain-gate was the same otherwise distinguished as the Brick-gate (or Potter's-gate), leading to the valley of Hinnom. (*d.*) On the east side,—7. The *Water-gate* (Neh. iii. 26). 8. The *Prison-gate*, otherwise the *Horse-gate*, near the temple (Neh. iii. 28). 9. The *Sheep-gate*, probably near the sheep-pool (Neh. iii. 1, 32). 10. The *Fish-gate* was quite at the north-east (Neh. iii. 3). Jerusalem.

It will be observed that in two of the cases the distances of the gates from each other are mentioned. Thus the Corner-gate (3) was only 400 cubits from the gate of Ephraim (2), and the Dung-gate (5) was 1000 cubits from the Valley-gate (4). This suggests that the gates were really nearer to each other than the objections already stated would assume; and the "hundred-gated Thebes" may be recollected as warranting a doubt whether the ancient Orientals had the same objection to gates which are now entertained. At all events, if the circumference of the wall of Jerusalem, before the third wall was added, be assumed to have been $2\frac{1}{2}$ miles, or equal to the present wall, then this extent would have allowed ten gates at the *highest* named distance of 1000 cubits apart, and more than thrice that number at the lowest named distance of 300 cubits.

In the middle ages there appear to have been two gates on each side of the city, making eight in all; and this number, being only two short of those assigned in the above estimate to the ancient Jerusalem, seems to vindicate that estimate from the objections which have been urged against it. On the west side were two gates, of which the principal was the *Porta David* (Gate of David), often mentioned by the writers on the Crusades. It was called by the Arabs *Bab el-Mihrab*, and corresponds to the present Jaffa-gate, or *Bab el-Khulil*. The other was the gate of the Fuller's Field (*Porta Villæ Fullonis*), so called from Isa. vii. 3. This seems to be the same which others call *Porta Judiciaria*, and which is described as being in the wall over against the church of the Holy Sepulchre, leading to Silo (*Neby Samwîl*) and Gibeon. This seems to be that which the Arabian writers call *Serb*. There is no trace of it in the present wall. On the north there were also two gates; and all the middle-age writers speak of the principal of them as the Gate of St Stephen, from the notion that the death of the protomartyr took place near it. This was also called the gate of Ephraim, in reference to its probable ancient name. Arabic writers called it *Bab 'Amud el-Ghurab*, of which the present name, *Bab el-'Amud*, is only a contraction. The present Gate of St Stephen is on the *east* of the city, and the scene of the martyrdom is now placed near it; but there is no account of the change. Further east was the Gate of Benjamin (*Porta Benjaminis*), corresponding apparently to what is now called the Gate of Herod. On the east there seem to have been at least two gates. The northernmost is described by Adamnanus as a small portal leading down to the valley of Jehoshaphat. It was called the Gate of Jehoshaphat, from the valley to which it led. It seems to be represented by the present Gate of St Stephen. The Arabian writers call it *Bab el-Usbat* (Gate of the Tribes) being another form of the modern Arabic name *Bab es-Subat*. The present Gate of St Stephen has four lions sculptured over it on the outside, which, as well as the architecture, show that it existed before the present walls. Dr Robinson suggests that the original "small portal" was rebuilt on a larger scale by the Franks, when they built up the walls of the city, either in A.D. 1178 or 1239. The other

Jerusalem. gate is the famous Golden-gate (*Porta aurea*) in the eastern wall of the temple area. It is now called by the Arabs *Bab ed-Dahariyeh*, but formerly *Bab er-Rahmeh* (Gate of Mercy). The name Golden-gate appears to have come from a supposed connection with one of the ancient gates of the temple, which are said to have been covered with gold; but this name cannot be traced back beyond the historians of the Crusades. This gate is, from its architecture, obviously of Roman origin, and is conjectured to have belonged to the inclosure of the temple of Jupiter which was built by Adrian upon Mount Moriah. The exterior is now walled up; but being double, the interior forms within the area a recess, which is used for prayer by the Moslem worshipper. Different reasons are given for the closing of this gate. It was probably because it was found inconvenient that a gate to the mosque should be open in the exterior wall. Although not walled up, it was kept closed even when the Crusaders were in possession of the city, and only opened once a year on Palm-Sunday, in celebration of our Lord's supposed triumphal entry through it to the temple. On the south side were also two gates. The easternmost is now called by the Franks the Dung-gate, and by the natives *Bab el-Mugharibeh*. The earliest mention of this gate is by Brocard, about A.D. 1283, who regards it as the ancient Water-gate. Further west, between the eastern brow of Zion and the Gate of David, the Crusaders found a gate which they call the Gate of Zion, corresponding to one which now bears the same name.

It thus appears that before the rebuilding of the walls of Jerusalem by the Turks in the sixteenth century, the principal gates of the city were much the same as at the present day. But of the seven gates mentioned as still existing, three, the Dung-gate, the Golden-gate, and Herod's-gate, are closed. Thus there are only four gates now in use, one on each side of the town, all of which have been enumerated. St Stephen's, on the east, leads to the Mount of Olives, Bethany, and Jericho. From the nature of the ground, taken in connection with the situation of the temple, a little south, there must always have been a great thoroughfare here. Zion-gate, on the south side of the city, connects the populous quarter around the Armenian convent with that part of Mount Zion which is outside the walls, and which is much resorted to as being the great field of Christian burial, as well as for its traditionary sanctity as the site of David's tomb, the house of Caiaphas, house of Mary, &c. The Jaffa-gate, on the west, is the termination of the important routes from Jaffa, Bethlehem, and Hebron. The formation of the ground suggests this as one of the great thoroughfares of the ancient city, which could here be approached from the quarters just indicated much more conveniently than at any other point. The Damascus-gate, on the north, is also planted in a vale, which in every age of Jerusalem must have been a great public way, and the easiest approach from Samaria and Galilee.

Towers. The towers of Jerusalem are often mentioned in Scripture and in Josephus. There is, indeed, no general account of them; but some of the principal are described, and we may reasonably infer that the others resembled them more or less in form and arrangement. Most of the towers mentioned by Josephus were erected by Herod the Great, and were consequently standing in the time of Christ. It was on these, therefore, that his eyes often rested when he approached Jerusalem, or viewed its walls and towers from the Mount of Olives. Of all these towers, the most important is that of Hippicus, which Josephus, as we have already seen, assumed as the starting point in his description of all the walls of the city. Herod gave to it the name of a friend who was slain in battle. It was a quadrangular structure, 25 cubits on each side, and built up entirely solid to the height of 30 cubits. Above this solid part was a cistern 20 cubits; and then, for 25 cubits more, were chambers of various kinds, with a breastwork of 2 cubits, and battlements of 3 cubits upon the top. The altitude of the whole tower was consequently 80 cubits. The stones of which it was built were very large—20 cubits long by 10 broad and 5 high, and (probably in the upper part) were of white marble. Dr Robinson has shown that this tower should be sought at the north-west corner of the upper city, or Mount Zion. This part, a little to the S. of the Jaffa-gate, is now occupied by the citadel. It is an irregular assemblage of square towers, surrounded on the inner side towards the city by a low wall, and having on the outer, or west side, a deep fosse. The towers, which rise from the brink of the fosse, are protected on that side by a low sloping bulwark or buttress, which rises from the bottom of the trench at an angle of 45°. This part bears evident marks of antiquity; and Dr Robinson is inclined to ascribe these massive outworks to the time of the rebuilding and fortifying of the city by Adrian. This fortress is described by the middle-age historians as the tower or citadel of David. Within it, as the traveller enters the city by the Jaffa-gate, the north-eastern tower attracts his notice as bearing evident marks of higher antiquity than any of the others. The upper part is, indeed, modern, but the lower part is built of larger stones, bevelled at the edges, and apparently still occupying their original places. This tower has been singled out by the Franks, and bears among them the name of the Tower of David, while they sometimes give to the whole fortress the name of the Castle of David. Taking all the circumstances into account, Robinson, Raumer, and other travellers, think that the antique lower portion of this tower is, in all probability, a remnant of the tower of Hippicus, which, as Josephus states, was left standing by Titus when he destroyed the city. Jerusalem.

Josephus describes two other towers—those of Phasaëlus and Mariamne—both built by Herod; one of them being named after a friend, and the other after his favourite wife. They stood not far from Hippicus, upon the first or most ancient wall, which ran from the latter tower eastward, along the northern brow of Zion. Connected with these towers and Hippicus was the royal castle or palace of the first Herod, which was inclosed by this wall on the N., and on the other sides by a wall 30 cubits high. The whole was furnished with great strength and regal splendour, and furnished with halls, and galleries, and cisterns, and apartments without number (Joseph. *De Bell. Jud.* v. 4. 3, 4; v. 4. 4). These were the three mighty towers which Titus left standing as monuments of the strength of the place which had yielded to his arms; but nothing now remains save the above mentioned supposed remnant of the Tower of Hippicus.

A fourth tower, called Psephinos, is mentioned by Josephus (*De Bell. Jud.* v. 4, 2, 3). It stood at the north-west corner of the third or exterior wall of the city. It did not, consequently, exist in the time of Christ, seeing that the wall itself was built by Herod Agrippa, to whom also the tower may be ascribed. It was of an octagonal form, 70 cubits high, and from it could be seen Arabia towards the rising sun, and the inheritance of the Hebrews quite to the sea. This shows that it must have stood upon the high swell of ground which extends up north-north-west from the north-west corner of the present city. In this quarter there are ancient substructions, apparently of towers and other fortifications; and although none of them may be actually those of Psephinos, Dr Robinson conceives that the tower stood somewhere in this vicinity.

The above are the only towers which the historian particularly mentions. But, in describing the outer or third wall of Agrippa, he states that it had battlements of 2 cubits, and turrets of 3 cubits more; and, as the wall was 20 cubits high, this would make the turrets of the height of 25 cubits, or nearly 38 feet. Many loftier and more sub-

Jerusalem.

stantial towers than these were erected on each of the walls at regulated distances, and furnished with every requisite for convenience or defence. Of those on the third or outer wall are enumerated 90; on the middle or second wall, 40; and on the inner or ancient wall, 60.

Public Buildings.

The temple was in all ages the great glory and principal public building of Jerusalem, as the heathen temple, church, or mosque, successively occupying the same site, has been ever since the Jewish temple was destroyed.

After the Israelites had exchanged their nomadic life for a life in permanent habitations, it was becoming that they should exchange also their moveable sanctuary or tabernacle for a temple. There elapsed, however, after the conquest of Palestine, several centuries during which the sanctuary continued moveable, although the nation became more and more stationary. It appears that the first who planned the erection of a stone-built sanctuary was David, who meditated the design of building a temple in which the ark of God might be placed, instead of being deposited "within curtains," or in a tent, as hitherto. This design was at first encouraged by the prophet Nathan; but he was afterwards instructed to tell David that such a work was less appropriate for him, who had been a warrior from his youth, and had shed much blood, than for his son, who should enjoy in prosperity and peace the rewards of his father's victories. Nevertheless, the design itself was highly approved as a token of proper feelings towards the Divine King (2 Sam. vii. 1–12), &c. We learn, moreover, from 1 Kings v., and 1 Chron. xxii., that David had collected materials which were afterwards employed in the erection of the temple, which was commenced four years after his death, about B.C. 1012, in the second month, that is, the month of Siv, 480 years after the Exodus from Egypt. We thus learn that the Israelitish sanctuary had remained moveable more than four centuries subsequent to the conquest of Canaan.

The site of the temple is clearly stated in 2 Chron. iii. 1:—"Then Solomon began to build the house of the Lord at Jerusalem, in Mount Moriah, where the Lord appeared unto David his father, in the place that David had prepared in the threshing-floor of Ornan (or Araunah) the Jebusite." It seems that the summit of Moriah, although large enough for the agricultural purposes of Araunah, had no level sufficient for the plans of Solomon. According to Josephus (*De Bell. Jud.* v. 5), the foundations of the temple were laid on a steep eminence, the summit of which was at first insufficient for the temple and altar. As it was surrounded by precipices, it became necessary to build up walls and buttresses in order to gain more ground by filling up the interval with earth. The hill was also fortified by a threefold wall, the lowest tier of which was in some places more than 300 cubits high; and the depth of the foundation was not visible, because it had been necessary in some parts to dig deep into the ground in order to obtain sufficient support. The dimensions of the stones of which the walls were composed were enormous; Josephus mentions a length of 40 cubits. It is, however, likely that some parts of the fortifications of Moriah were added at a later period. The characteristics of the site of the Solomonic temple have undergone so many changes, that it is at present scarcely possible to discern them. Niebuhr gave an accurate description of what he found, illustrated by a map, in the *Deutsches Museum*, 1784, vol. i., p. 448, sq.; ii. 137, sq.; and also in the third volume of his travels (comp. also Mishna, *Middoth*, ii. 4).

The workmen and the materials employed in the erection of the temple were chiefly procured by Solomon from Hiram, king of Tyre, who was rewarded by a liberal importation of wheat. Josephus states that duplicates of the letters which passed between Solomon and King Hiram were still extant in his time, both at Jerusalem and among the Tyrian records. He informs us that the persons employed in collecting and arranging the materials for the temple were ordered to search out the largest stones for the foundation, and to prepare them for use on the mountains where they were procured, and then convey them to Jerusalem. In this part of the business, Hiram's men were ordered to assist.

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Josephus adds, that the foundation was sunk to an astonishing depth, and composed of stones of singular magnitude, and very durable. Being closely mortised into the rock with great ingenuity, they formed a basis adequate to the support of the intended structure. Josephus gives to the temple the same length and breadth as are given in 1 Kings, but mentions 60 cubits as the height. He says that the walls were composed entirely of white stone; that the walls and ceilings were wainscoted with cedar, which was covered with the purest gold; that the stones were put together with such ingenuity that the smallest interstices were not perceptible, and that the timbers were joined with iron cramps.

Divines and architects have repeatedly endeavoured to represent the architectural proportions of the temple, which was 60 cubits long, 20 wide, and 30 high. Josephus, however (*Antiq.* viii. 3, 2), says, "The temple was 60 cubits high, and 60 cubits in length, and the breadth was 20 cubits; above this was another stage of equal dimensions, so that the height of the whole structure was 120 cubits." It is difficult to reconcile this statement with that given in 1 Kings, unless we suppose that the words ἴσος τοῖς μέτροις, *equal in measures*, do not signify an equality in all dimensions, but only as much as equal in the number of cubits; so that the porch formed a kind of steeple, which projected as much above the roof of the temple as the roof itself was elevated above its foundations. As the Chronicles agree with Josephus in asserting that the summit of the porch was 120 cubits high, there remains still another apparent contradiction to be solved, namely, how Josephus could assert that the temple itself was 60 cubits high, while we read in 1 Kings that its height was only 30 cubits. We suppose that in the book of Kings the internal elevation of the sanctuary is stated, and that Josephus describes its external elevation, which, including the basement and an upper story (which may have existed, consisting of rooms for the accommodation of priests, containing also vestries and treasuries), might be double the internal height of the sanctuary. The internal dimension of the "holy," was 40 cubits long, 20 cubits wide, and 30 cubits high. The holy was separated from the "holy of holies" by a partition, a large opening in which was closed by a suspended curtain. The holy of holies was on the western extremity of the entire building, and its internal dimensions formed a cube of 20 cubits. On the eastern extremity of the building stood the porch. At the entrance of this pronaos stood the two columns called Jachin and Boaz, which were 23 cubits high.

The temple was also surrounded by three *stories of chambers*, each of which stories was 5 cubits high, so that there remained above ample space for introducing the windows, requisite more for ventilation than for the admission of light into the sanctuary. Now the statement of Josephus, who says, that each of these stories of chambers was 20 cubits high, cannot be reconciled with the biblical statements, and may prove that he was no very close reader of his authorities. Perhaps he had a vague kind of information that the chambers reached half-way up the height of the building, and taking the maximum height of 120 cubits instead of the internal height of the "holy," he made each story four times too high. The windows, which are mentioned in 1 Kings vi. 4, consisted probably of lattice-work.

The lowest story of the chambers was 5 cubits, the middle 6, and the third 7 cubits wide. This differ-

Jerusalem. ence of the width arose from the circumstance that the external walls of the temple were so thick that they were made to recede one cubit after an elevation of five feet, so that the scarcement in the wall of the temple gave a firm support to the beams which supported the second story, without being inserted into the wall of the sanctuary; which insertion was perhaps avoided, not merely for architectural reasons, but also because it appeared to be irreverent. The third story was supported likewise by a similar scarcement, which afforded a still wider space for the chamber of the third story. From this description it may be inferred that the entrance to these stories was from without; but some architects have supposed that it was from within; which arrangement seems to be against the general aim of impressing the Israelitish worshippers with sacred awe by the seclusion of their sanctuary.

In reference to the windows it should be observed, that they served chiefly for ventilation, since the light within the temple was obtained from the sacred candlesticks. It seems from the descriptions of the temple to be certain that the *oracle*, or "holy of holies," was an *adytum* without windows. It had probably no other opening besides the entrance, which was, as we may infer from the prophetic visions of Ezekiel (which probably correspond with the historic temple of Solomon) six cubits wide.

From 1 Kings vii. 10, we learn that the private dwellings of Solomon were built of massive stone. We hence infer that the framework of the temple also consisted of the same material. The temple was, however, wainscoted with cedar wood, which was covered with gold. The boards within the temple were ornamented by beautiful carvings representing cherubim, palms, and flowers. The ceiling of the temple was supported by beams of cedar wood. The wall which separated the "holy" from the "holy of holies," probably consisted not of stone, but of beams of cedar. It seems, further, that the partitions partly consisted of an *opus reticulatum;* so that the incense could spread from the "holy" to the "most holy."

The floor of the temple was, throughout, of cedar, but boarded over with planks of fir. The doors of the oracle were composed of olive tree; but the doors of the outer temple had posts of olive tree, and leaves of fir. Both doors, as well that which led into the temple as that which led from the "holy" to the "holy of holies," had folding leaves, which, however, seem to have been usually kept open, the aperture being closed by a suspended curtain—a contrivance still seen at the church-doors in Italy, where the church-doors usually stand open, but the doorways can be passed only by moving aside a heavy curtain. From 2 Chron. iii. 5, it appears that the greater house was also ceiled with fir. It is stated in ver. 9, "that the weight of the nails employed in the temple was fifty shekels of gold;" and, also, that Solomon "overlaid the upper chambers with gold."

The lintel and side-posts of the oracle seem to have circumscribed a space which contained one-fifth of the whole area of the partition; and the posts of the door of the temple one-fourth of the area of the wall in which they were placed. Thus we understand the passage, 1 Kings vi. 31–35, which also states that the door was covered with carved work overlaid with gold. Within the "holy of holies" stood only the ark of the covenant; but within the "holy" were ten golden candlesticks, and the altar of incense.

The temple was surrounded by an inner court, which in Chronicles is called the court of the Priests, and in Jeremiah the upper-court. This again was surrounded by a wall consisting of cedar beams placed on a stone foundation. This inclosure, according to Josephus (*Antiq.* viii. 3–9), was three cubits high. Besides this inner court, there is mentioned a great-court which seems to have been also called outward-court. This court was also more especially known as the court of the Lord's house (Jer. xix. 12; xxvi. 2). These courts were surrounded by spacious Jerusalem. buildings, which, however, according to Josephus (*De Bell. Jud.* v. 5, 1), seem to have been partly added at a period later than that of Solomon. For instance (2 Kings xv. 35), Jotham is said to have "built the higher gate of the house of the Lord." In Jer. xxvi. 10, and xxxvi. 10, there is mentioned a "new gate" (Comp. also Ezek. xl. 5–47; xlii. 1–14). The *third* entry into the house of the Lord mentioned in Jer. xxxviii. 14, does not seem to indicate that there were three courts, but appears to mean that the entry into the outer court was called the first, that into the inner court the second, and the door of the sanctuary the third. It is likely that these courts were quadrilateral. In the divisions of Ezekiel they form a square of four hundred cubits. The inner court contained towards the east the altar of burnt-offering, the brazen sea, and ten brazen lavers; and it seems that the sanctuary did not stand in the centre of the inner court, but more towards the west. From these descriptions we learn that the temple of Solomon was not distinguished by magnitude, but by good architectural proportions, beauty of workmanship, and costliness of materials. Many of our churches have an external form not unlike that of the temple of Solomon. In fact, this temple seems to have been the pattern of our church buildings, to which the chief addition has been the Gothic arch. Among others, the Roman Catholic church at Dresden is supposed to bear a strong resemblance to the temple of Solomon.

It is remarkable that after the temple was finished, it was not consecrated by the high priest, but by a layman, by the king in person, by means of extempore prayers and sacrifices. The temple remained the centre of public worship for all the Israelites only till the death of Solomon, after which ten tribes forsook this sanctuary. But even in the kingdom of Judah it was from time to time desecrated by altars erected to idols. For instance, Manasseh "built altars for all the host of heaven in the two courts of the house of the Lord. And he made his son pass through the fire, and observed times, and used enchantments, and dealt with familiar spirits and wizards: he wrought much wickedness in the sight of the Lord, to provoke him to anger. And he set a graven image of the grove that he had made in the house," &c. Thus we find also that king Josiah commanded Hilkiah the high priest, and the priests of the second order, to remove the idols of Baal and Asherah from the house of the Lord (2 Kings xxiii. 4, 13). In fact, we are informed that in spite of the better means of public devotion which the sanctuary undoubtedly afforded, the national morals declined so much that the chosen nation became worse than the idolaters whom the Lord destroyed before the children of Israel (2 Kings xxi. 9). It appears also that, during the times when it was fashionable at court to worship Baal, the temple stood desolate, and that its repairs were neglected. We further learn that the cost of the repairs was defrayed chiefly by voluntary contribution, by offerings, and by redemption money. The original cost of the temple seems to have been defrayed by royal bounty, and in great measure by treasures collected by David for that purpose.

There was a treasury in the temple, in which much precious metal was collected for the maintenance of public worship. The gold and silver of the temple was, however, frequently applied to political purposes (1 Kings xv. 18, sq.), &c. The treasury of the temple was repeatedly plundered by foreign invaders. For instance, by Shishak (1 Kings xiv. 26); by Jehoash, king of Israel (2 Kings xiv. 14); by Nebuchadnezzar (2 Kings xxiv. 13); and lastly, again by Nebuchadnezzar, who, having removed the valuable contents, caused the temple to be burned down (2 Kings xxv. 9, sq.), B.C. 588. The building had stood since its completion 417 or 418 years (Josephus has 470, and Ruffinus

Jerusalem. ancient warfare almost impregnable, from the ravines at the precipitous edge of which it stood; but it required more artificial fortifications on its western and northern sides, which were surrounded by the city of Jerusalem; for this reason there was erected at its north-western corner the tower of Antonia, which although standing on a lower level than the temple itself, was so high as to overlook the sacred buildings with which it was connected, partly by a large staircase, and partly by a subterraneous communication. Under the sons of Herod, the temple remained apparently in good order, and Herod Agrippa, who was appointed by the Emperor Claudius its guardian, even planned the repair of the eastern part, which had probably been destroyed during one of the conflicts between the Jews and Romans of which the temple was repeatedly the scene (*Antiq.* xvii. 10). There are a few indications from which we learn that important documents were deposited in the tabernacle and temple. Even in Deut. xxxi. 26, we find that the book of the law was deposited in the ark. According to 2 Kings xxii. 8, Hilkiah rediscovered the book of the law in the house of Jehovah. In 2 Macc. ii. 13, we find a library mentioned, apparently consisting chiefly of the canonical books, and probably deposited in the temple. In Josephus (*De Bell. Jud.* v. 5) it is mentioned that a book of the law was found in the temple. It appears that the sacred writings were kept in the temple (*Antiq.* v. 1–17). Copies of political documents seem to have been deposited in the treasury of the temple.

This treasury was managed by an inspector, and it contained the great sums which were annually paid in by the Israelites, each of whom paid a half shekel, and many of whom sent donations in money, and precious vessels, *ἀναθήματα*. Such costly presents were especially transmitted by rich proselytes, and even sometimes by pagan princes (2 Macc. iii. 3; Joseph. *Antiq.* xiv. 16. 4), &c., &c. It is said especially that Ptol. Philadelphus was very liberal to the temple, in order to prove his gratitude for having been permitted to procure the Septuagint translation. The gifts exhibited in the temple are mentioned in Luke xxi. 5; we find even that the rents of the whole town of Ptolemais were given to the temple. There were also preserved historical curiosities, especially the arms of celebrated heroes (Joseph. *Antiq.* xix. 6. 1): this was also the case in the tabernacle.

The temple was of so much political importance that it had its own guards. Their general had his own secretary (*Antiq.* xx. 6. 2; 9. 3), and had to maintain the police in the courts (comp. Acts iv. 1, and v. 24). He appears to have been of sufficient dignity to be mentioned together with the chief priests. It seems that his Hebrew title was, *the man of the mountain of the house.*

The priests themselves kept watch on three different posts, and the Levites on twenty-one posts.

It was the duty of the police of the temple to prevent women from entering the inner court, and to take care that no person who was Levitically unclean should enter within the sacred precincts. Gentiles were permitted to pass the first enclosure, which was therefore called the court of the Gentiles; but persons who were on any account Levitically unclean were even not permitted to advance thus far. Some sorts of uncleanness, for instance that arising from the touch of a corpse, excluded only from the court of the men. If an unclean person had entered by mistake, he was required to offer sacrifices of purification. The high-priest himself was forbidden to enter the "holy of holies" under penalty of death on any other day but the day of atonement. Nobody was admitted within the precincts of the temple who carried a stick or a basket, and who wanted to pass merely to shorten his way, or who had dusty shoes (Middoth, ii. 2).

During the final struggle of the Jews against the Romans, A.D. 70, the temple was the last scene of the tug of war. The Romans rushed from the tower Antonia into the sacred precincts, the halls of which were set on fire by the Jews themselves. It was against the will of Titus that a Roman soldier threw a firebrand into the northern outbuildings of the temple, which caused the conflagration of the whole structure, although Titus himself endeavoured to extinguish the fire (Joseph. *De Bell. Jud.* vi. 4). "One cannot but wonder at the accuracy of this period thereto relating; for the same month and day were now observed, as I said before, wherein the holy house was burnt formerly by the Babylonians. Now, the number of years that passed from its first foundation, which was laid by King Solomon, till this its destruction, which happened in the second year of the reign of Vespasian, are collected to be 1130, besides 7 months and 15 days; and from the second building of it, which was done by Haggai, in the second year of Cyrus the king, till its destruction under Vespasian, there were 639 years and 45 days." Jerusalem.

The sacred utensils, the golden table of the shewbread, the book of the law, and the golden candlestick, were displayed in the triumph at Rome. Representations of them are still to be seen sculptured in relief on the triumphal arch of Titus. The place where the temple had stood seemed to be a dangerous centre for the rebellious population, until, in A.D. 136, the Emperor Hadrian dedicated a temple to Jupiter Capitolinus on the ruins of the temple of Jehovah. Henceforth no Jew was permitted to approach the site of the ancient temple, although the worshippers of Jehovah were in derision compelled to pay a tax for the maintenance of the temple of Jupiter. Under the reign of Constantine the Great some Jews were severely punished for having attempted to restore the temple (comp. Fabricii *Lux Evangelii*, p. 124). In A.D. 363, the Emperor Julian undertook to rebuild the temple; but after considerable preparations and much expense, he was compelled to desist by flames which burst forth from the foundations. Repeated attempts have been made to account for these igneous explosions by natural causes; for instance, by the ignition of gases which had long been pent up in subterraneous vaults. A similar event is mentioned by Josephus (*Antiq.* xvi. 7. 1), where we are informed that Herod, while plundering the tombs of David and Solomon, was suddenly frightened by flames which burst out and killed two of his soldiers.

A splendid mosque now stands on the site of the temple. This mosque was erected by the Caliph Omar after the conquest of Jerusalem by the Saracens, A.D. 636. It seems that Omar changed a Christian church, that stood on the ground of the temple, into this mosque, which is called El Aksa, *the outer*, or *northern*, because it is the third of the most celebrated mosques, two of which, namely, those of Mecca and Medina, are in a more southern latitude.

The tower or castle of Antonia stood on a steep rock adjoining the N.W. corner of the temple. It has already been mentioned, that it originated under the Maccabees, who resided in it. The name of *Baris*, which it obtained, was originally the Persian name of a royal palace; but which, according to Jerome (*Epist. ad Princip.* ii. 639), was afterwards adopted in Palestine, and applied to all the large quadrangular dwellings built with turrets and walls. As improved by Herod, who gave it the name of Antonia, after his patron Mark Antony, this fortress had all the extent and appearance of a palace, being divided into apartments of every kind, with galleries and baths, and also broad halls or barracks for soldiers; so that, as having everything necessary within itself, it seemed a city, while in its magnificence it was a palace. At each of the four corners was a tower, one of which was 70 cubits high, and overlooked the whole temple with its courts. The fortress communicated with the cloisters of the temple by secret passages, through which the soldiers could enter and quell any tumults, which

Jerusalem. were always apprehended at the time of the great festivals. This tower was also "the castle" into which St Paul was carried when the Jews rose against him in the temple, and were about to kill him; and where he gave his able and manly account of his conversion and conduct. It was, in fact, the citadel of Jerusalem.

Waters of Jerusalem. In his account of the siege of Jerusalem by Pompey, Strabo says that the town was well provided with water within the walls, but that there was none in the environs (*Geog.* xvi. 2, 40). Probably the Roman troops then suffered from want of water, as did other armies which laid siege to Jerusalem. In the narratives of all such sieges we never read of the besieged suffering from thirst, although driven to the most dreadful extremities and resources by hunger, while the besiegers are frequently described as suffering greatly from want of water, and as being obliged to fetch it from a great distance. The agonies of thirst sustained by the first Crusaders in their siege of Jerusalem will be remembered by most readers from the vivid picture drawn by Tasso, if not from the account furnished by William of Tyre. Yet when the town was taken plenty of water was found within it. This is a very singular circumstance, and is perhaps only in part explained by reference to the system of preserving water in cisterns, as at this day, in Jerusalem.

Solomon's aqueduct near Bethlehem to Jerusalem could have been no dependence, as its waters might easily have been cut off by the besiegers. All the wells also are now outside the town; and no interior fountain is mentioned save that of Hezekiah, which is scarcely fit for drinking. At the siege by Titus the well of Siloam may have been in possession of the Jews, *i.e.*, within the walls; but at the siege by the Crusaders it was certainly held by the besieging Franks; and yet the latter perished from thirst, while the besieged had *ingentes copias aquæ*. We cannot here go through the evidence which by combination and comparison might throw some light on this remarkable question. There is, however, good ground to conclude, that from very ancient times there has been under the temple an unfailing source of water, derived by secret and subterraneous channels from springs to the W. of the town, and communicating by other subterraneous passages with the Pool of Siloam and the fountain of the Virgin in the E. of the town, whether they were within or without the walls of the town.

The existence of a perennial source of water below the temple has always been admitted. Tacitus knew of it (*Hist.* v. 12); and Aristeas, in describing the ancient temple, informs us that "the supply of water was unfailing." The Moslems also have constantly affirmed the existence of this fountain or cistern. But a reserve has always been kept up as to the means by which it is supplied. This reserve seems to have been maintained by the successive occupants of Jerusalem as a point of civic honour; and this fact alone intimates that there was danger to the town in its becoming known, and points to the fact that the supply came from without the city by secret channels, which it was of importance not to disclose. Yet we are plainly told in the Bible that Hezekiah "stopped the upper water-course of Gihon, and brought it down to the west side of the city of David" (1 Kings i. 33, 38); from 2 Chron. xxxii. 30, it seems that all the neighbouring fountains were thus "stopped" or covered, and the brook which they had formed diverted by subterraneous channels into the town, for the express purpose of preventing besiegers from finding the "much water" which previously existed outside the walls (comp. also Eccles. xlviii. 17). Perhaps, likewise, the prophet Ezekiel (xlvii. 1–12) alludes to this secret fountain under the temple when he speaks of waters issuing from the threshhold of the temple towards the east, and flowing down towards the desert as an abundant and beautiful stream. This figure may be drawn from the waters of the inner source under the temple, being at the time of overflow discharged by the outlets at Siloam, into the Kidron, which takes the eastward course thus described. Jerusalem.

There are certainly wells, or rather shafts, in and near the temple area, which are alleged to derive their waters through a passage of masonry 4 or 5 feet high, from a chamber or reservoir cut in the solid rock under the grand mosque, in which the water is said to rise from the rock into a basin at the bottom. The existence of this reservoir and source of water is affirmed by all Moslems, and coincides with the preceding intimations, but it must be left for future explorers to clear up all the obscurities in which the matter is involved. The ordinary means taken by the inhabitants to secure a supply of water are minutely described in Raumer's *Palästina*, pp. 329-333; Robinson's *Researches*, i. 479-516; and Olin's *Travels*, ii. 168-181.

Modern Jerusalem. In proceeding to furnish a description of the present Jerusalem, we shall, for the most part, place ourselves under the guidance of Dr Olin, whose account is one of the most recent, and by far the most complete and satisfactory which has of late years been produced.

The general view of the city from the Mount of Olives is mentioned more or less by all travellers as that from which they derive their most distinct and abiding impression of Jerusalem.

The summit of the Mount of Olives is about half a mile E. from the city, which it completely overlooks, every considerable edifice and almost every house being visible. The city seen from this point appears to be a regular inclined plain, sloping gently and uniformly from W. to E., or towards the observer, and indented by a slight depression or shallow vale, running nearly through the centre, in the same direction. The south-east corner of the quadrangle—for that may be assumed as the figure formed by the rocks—that which is nearest to the observer, is occupied by the mosque of Omar and its extensive and beautiful grounds. This is Mount Moriah, the site of Solomon's temple; and the ground embraced in the sacred enclosure, which conforms to that of the ancient temple, occupies about an eighth of the whole modern city. It is covered with green sward and planted sparingly with olive, cypress, and other trees, and it is certainly the most lovely feature of the town, whether we have reference to the splendid structures or the beautiful lawn spread out around them.

The south-west quarter, embracing that part of Mount Zion which is within the modern town, is to a great extent occupied by the Arminian convent, an enormous edifice, which is the only conspicuous object in this neighbourhood. The north-west is largely occupied by the Latin convent, another very extensive establishment. About midway between these two convents is the castle or citadel, close to the Bethlehem-gate, already mentioned. The north-east quarter of Jerusalem is but partially built up, and it has more the aspect of a rambling agricultural village than that of a crowded city. The vacant spots here are green with gardens and olive-trees. There is another large vacant tract along the southern wall, and west of the Haram, also covered with verdure. Near the centre of the city also appear two or three green spots, which are small gardens. The church of the Holy Sepulchre is the only conspicuous edifice in this vicinity, and its domes are striking objects. There are no buildings which, either from their size or beauty, are likely to engage the attention. Eight or ten minarets mark the position of so many mosques in different parts of the town, but they are only noticed because of their elevation above the surrounding edifices. Upon the same principle the eye rests for a moment upon a great number of low domes, which form the roofs of the principal dwellings, and relieve the heavy uniformity of the flat plastered roofs which cover the greater mass of more humble habita-

Jerusalem. tions. Many ruinous piles, and a thousand disgusting objects, are concealed or disguised by the distance. Many inequalities of surface, which exist to so great an extent that there is not a level street of any length in Jerusalem, are also unperceived.

From the same commanding point of view a few olive and fig trees are seen in the lower part of the valley of Jehoshaphat, and scattered over the side of Olivet from its base to the summit. They are sprinkled yet more sparingly on the southern side of the city on Mounts Zion and Ophel. North of Jerusalem the olive plantations appear more numerous as well as thriving, and thus offer a grateful contrast to the sun-burnt fields and bare rocks which predominate in this landscape. The region west of the city appears to be destitute of trees. Fields of stunted wheat, yellow with the drought rather than white for the harvest, are seen on all sides of the town.

Jerusalem, as seen from Mount Olivet, is a plain inclining gently and equally to the E. Once enter its gates, however, and it is found to be full of inequalities. The passenger is always ascending or descending. There are no level streets, and little skill or labour has been employed to remove or diminish the inequalities which nature or time has produced. Houses are built upon mountains of rubbish, which are probably 20, 30, or 50 feet above the natural level, and the streets are constructed with the same disregard to convenience, with this difference, that some slight attention is paid to the possibility of carrying off surplus water. The latter are, without exception, narrow, seldom exceeding 8 or 10 feet in breadth. The houses often meet, and in some instances a building occupies both sides of the street, which runs under a succession of arches barely high enough to permit an equestrian to pass under them. A canopy of old mats or of plank is suspended over the principal streets when not arched. This custom had its origin, no doubt, in the heat of the climate, which is very intense in summer, and it gives a gloomy aspect to all the most thronged and lively parts of the city. These covered ways are often pervaded by currents of air when a perfect calm prevails in other places. The principal streets of Jerusalem run nearly at right angles to each other. Very few, if any, of them bear names among the native population. They are badly paved, being merely laid irregularly with raised stones, with a deep square channel, for beasts of burden, in the middle; but the steepness of the ground contributes to keep them cleaner than in most Oriental cities.

The houses of Jerusalem are substantially built of the limestone of which the whole of this part of Palestine is composed: not usually hewn, but broken into regular forms, and making a solid wall of very respectable appearance. For the most part there are no windows next to the street, and the few which exist for the purposes of light or ventilation are completely masked by casements and lattice-work. The apartments receive their light from the open courts within. The ground plot is usually surrounded by a high enclosure, commonly forming the walls of the house only, but sometimes embracing a small garden and some vacant ground. The rain-water which falls upon the pavement is carefully conducted, by means of gutters, into cisterns, where it is preserved for domestic uses. The people of Jerusalem rely chiefly upon those reservoirs for their supply of this indispensable article. Every house has its cistern, and the larger habitations are provided with a considerable number of them, which occupy the ground-story or cells formed for the purpose below it. Stone is employed in building for all the purposes to which it can possibly be applied, and Jerusalem is hardly more exposed to accidents by fire than a quarry or subterranean cavern. The floors, stairs, &c., are of stone, and the ceiling is usually formed by a coat of plaster laid upon the stones, which at the same time form the roof and the vaulted top of the room. Doors, sashes, and a few other appurtenances, are all that can usually be afforded of a material so expensive as wood. The little timber which is used is mostly brought from Mount Lebanon, as in the time of Solomon. A large number of houses in Jerusalem are in a dilapidated and ruinous state. Nobody seems to make repairs, so long as his dwelling does not absolutely refuse him shelter and safety. If one room tumbles about his ears, he removes into another, and permits rubbish and vermin to accumulate as they will in the deserted halls. Tottering staircases are propped to prevent their fall; and when the edifice becomes untenable, the occupant seeks another a little less ruinous, leaving the wreck to a smaller or more wretched family, or, more probably, to a goatherd and his flock. Habitations which have a very respectable appearance as seen from the street, are often found, upon entering them, to be little better than heaps of ruins. Jerusalem.

Nothing of this would be suspected from the general appearance of the city as seen from the various commanding points without the walls, nor from anything that meets the eye in the streets. Few towns in the East offer a more imposing spectacle to the view of the approaching stranger. He is struck with the height and massiveness of the walls, which are kept in perfect repair, and naturally produce a favourable opinion of the wealth and comfort which they are designed to protect. Upon entering the gates, he is apt, after all that has been published about the solitude that reigns in the streets, to be surprised at meeting large numbers of people in the chief thoroughfares, almost without exception decently clad. A longer and more intimate acquaintance with Jerusalem, however, does not fail to correct this too favourable impression, and demonstrate the existence and general prevalence of the poverty and even wretchedness which must result in every country from oppression, from the absence of trade, and the utter stagnation of all branches of industry. Considerable activity is displayed in the bazaars, which are supplied scantily, like those of other eastern towns, with provisions, tobacco, coarse cottons, and other articles of prime necessity. A considerable business is still done in beads, crosses, and other sacred trinkets, which are purchased to a vast amount by the pilgrims who annually throng the holy city. The support and even the existence of the considerable population of Jerusalem depend upon this transient patronage,—a circumstance to which a great part of the prevailing poverty and degradation is justly ascribed. The worthless articles employed in this pitiful trade are, almost without exception, brought from other places, especially Hebron and Bethlehem,—the former celebrated for its baubles of glass, the latter chiefly for rosaries, crucifixes, and other toys made of mother-of-pearl, olive-wood, black stones from the Dead Sea, &c. These are eagerly bought up by the ignorant pilgrims, sprinkled with holy water by the priests, or consecrated by some other religious mummery, and carried off in triumph and worn as ornaments to charm away disease and misfortune, and probably to be buried with the deluded enthusiast in his coffin, as a sure passport to eternal blessedness. With the departure of the swarms of pilgrims, however, even this poor semblance of active industry and prosperity deserts the city. With the exception of some establishments for soap-making, a tannery, and a very few weavers of coarse cottons, there do not appear to be any manufactures properly belonging to the place. Agriculture is almost equally wretched, and can only give employment to a few hundred people. The masses really seem to be without any regular employment. A considerable number, especially of the Jews, professedly live on charity. Many Christian pilgrims annually find their way hither on similar resources, and the approaches to the holy places are thronged with beggars, who in piteous tones demand alms in the name of Christ and the blessed Virgin. The general condition of the

Jerusalem. population is that of abject poverty. A few Turkish officials, ecclesiastical, civil, and military; some remains of the old Mohammedan aristocracy,—once powerful and rich, but now much impoverished and nearly extinct,—together with a few tradesmen in easy circumstances, form almost the only exceptions to the prevailing indigence. There is not a single broker among the whole population, and not the smallest sum can be obtained on the best bills of exchange short of Jaffa or Beirout.

Population. The population of Jerusalem has been variously estimated by different travellers, some making it as high as 30,000, others as low as 12,000. An average of these estimates would make it somewhere between 12,000 and 15,000; but the Egyptian system of taxation and of military conscription in Syria has lately furnished more accurate data than had previously been obtainable, and on these Dr Robinson estimates the population at not more than 11,500, distributed thus:—

Mohammedans	4,500
Jews	3,000
Christians	3,500
Total	11,000

If to this be added something for possible omissions, and the inmates of the convents, the standing population, exclusive of the garrison, cannot well exceed 11,500. The Moslems, it will be seen, exceed in number the Jews or Christians respectively, but are much fewer than these two bodies united. To all these classes Jerusalem is holy; and is the only city in the world which peoples of such different origin, races, language, and religions agree to regard with nearly equal veneration.

The language most generally spoken among them is the Arabic. Schools are rare, and consequently facility in reading is not often met with. The general condition of the inhabitants has already been indicated.

The Turkish governor of the town holds the rank of Pasha, but is responsible to the Pasha of Beirout. The government is somewhat milder than before the period of the Egyptian dominion; but it is said that the Jewish and Christian inhabitants at least have ample cause to regret the change of masters. Yet the Moslems reverence the same spots which the Jews and Christians account holy, the holy sepulchre only excepted; and this exception arises from their disbelief that Christ was crucified or buried, or rose again. Formerly there were in Palestine monks of the Benedictine and Augustine orders, and of those of St Basil and St Anthony; but since 1304 there have been none but Franciscans, who have charge of the Latin convent and the holy places. They resided on Mount Zion till A.D. 1561, when the Turks allowed them the monastery of St Salvador, which they now occupy. They had formerly a handsome revenue out of all Roman Catholic countries, but these sources have fallen off since the French Revolution, and the establishment is said to be poor and deeply in debt. The expenses arise from the duty imposed upon the convent of entertaining pilgrims; and the cost of maintaining the twenty convents belonging to the establishment of the Terra Santa is estimated at 40,000 Spanish dollars a year. Formerly it was much higher, in consequence of the heavy exactions of the Turkish government. Burckhardt says that the brotherhood paid annually L.12,000 to the pasha of Damascus. But the Egyptian government relieved them from these heavy charges, and imposed instead a regular tax on the property possessed. For the buildings and lands in and around Jerusalem the annual tax was fixed at 7000 piastres, or 350 Spanish dollars. It is probable that the restored Turkish government has not yet, in this respect, recurred to its old oppressions. The convent contains fifty monks, half Italians and half Spaniards. In it resides the intendant or the principal of all the convents, with the rank of abbot, and the title of Guardian of Mount Zion and Custos of the Holy Land. He is always an Italian, and has charge of all the spiritual affairs of the Roman Catholics in the Holy Land. There is also a president or vicar, who takes the place of the guardian in case of absence or death: he was formerly a Frenchman, but is now either an Italian or Spaniard. The procurator, who manages their temporal affairs, is always a Spaniard. A council, called *Descretorium*, composed of these officials and three other monks, has the general management of both spiritual and temporal matters. Much of the attention of the order is occupied, and much of its expense incurred, in entertaining pilgrims and in the distribution of alms. The native Roman Catholics live around the convent, on which they are wholly dependant. They are native Arabs, and are said to be descended from converts in the times of the Crusades. Jerusalem.

There is a Greek patriarch of Jerusalem, but he usually resides at Constantinople, and is represented in the holy city by one or more vicars, who are bishops residing in the great convent near the church of the Holy Sepulchre. At present the vicars are the bishops of Lydda, Nazareth, and Kerek (Petra), assisted by the other bishops resident in the convent. In addition to thirteen monasteries in Jerusalem, they possess the convent of the Holy Cross near Jerusalem, that of St Helena between Jerusalem and Bethlehem, and that of St John, between Jerusalem and the Dead Sea. All the monks of the convents are foreigners. The Christians of the Greek rite who are not monks are all native Arabs, with their native priests, who are allowed to perform the church services in their mother tongue—the Arabic.

The Armenians in Jerusalem have a patriarch, with three convents and 100 monks. They have also convents at Bethlehem, Ramleh, and Jaffa. Few of the Arminians are natives: they are mostly merchants, and among the wealthiest inhabitants of the place; and their convent in Jerusalem is deemed the richest in the Levant. Their church of St James upon Mount Zion is very showy in its decorations, but void of taste. The Coptic Christians at Jerusalem are only some monks residing in the convent of Es-Sultan, on the north side of the pool of Hezekiah. There is also a convent of the Abyssinians, and one belonging to the Jacobite Syrians.

The estimate of the number of the Jews in Jerusalem at 3000 is given by Dr Robinson, on the authority of Mr Nicolayson, the resident missionary to the Jews, and seems to be confirmed from other sources. They inhabit a distinct quarter of the town between Mount Zion and Mount Moriah. This is the worst and dirtiest part of the holy city, and that in which the plague never fails to make its first appearance. Few of the Jerusalem Jews are natives: and most of them come from foreign parts to die in the city of their fathers' sepulchres. The greater proportion of them are from different parts of the Levant, and appear to be mostly of Spanish and Polish origin. Few are from Germany, or understand the German language. They are for the most part wretchedly poor, and depend in a great degree for their subsistence upon the contributions of their brethren in different countries. These contributions have of late years been smaller than usual, and, when they arrive, are the occasion of much heartburning and strife. The Scottish Deputation (*Narrative*, p. 148) say, "They are always quarrelling, and frequently apply to the consul to settle their disputes. The expectation of support from the annual European contributions leads many of them to live in idleness. Hence there are in Jerusalem 500 acknowledged paupers, and 500 more who receive charity in a quiet way. Many are so poor that, if not relieved, they would not stand out the winter season. A few are shopkeepers, and a few more hawkers, and a very few are operatives. None of them are agriculturists,—not a single Jew cultivates the soil of his fathers."

Jervis. Consult Reisner, *Ierusalem Vetust. Descripta*, Francof. 1563; Olshausen, *Zur Topographie d. alten Jerusalem*, Kiel, 1833; Adrichomius, *Jerusalem sicut Christi tempore floruit*, Colon. 1593; Chrysanthi (Beat. Patr. Hierosolymorum) *Historia et Descriptio Terræ Sanctæ, Urbisque Sanctæ Hierusalem*, Venet. 1728 (this work is in Greek); D'Anville, *Dissert. sur l'Etendue de l'Ancienne Jerusalem*, Paris, 1747; the articles on JERUSALEM in Ersch and Grüber's *Encyclopädie*; in Raumer's *Palästina*; in Winer's *Realwörterbuch*; in Eugene Roger's *La Terre Saincte, ou Descript. Topographique très-particulière des Sainctes Lieux, et de la Terre de Promission*, Paris, 1646; and in Dr Robinson's *Bibl. Researches in Palestine*; with the additions since published in the *Biblical Repository* and *Bibliotheca Sacra*; Stanley's *Sinai and Palestine*; also, the notices of Jerusalem in the travels of Cotovicus, Zuallart, Radzivil, Morison, Nau, Sandys, Doubdan, D'Arvieux, Maundrell, Pococke, Niebuhr, Clarke, Turner, Buckingham, Richardson, Richter, Jolliffe, Jowett, Prokesch, Scholz, Monro, Hardy, Stephens, Paxton, Schubert, Olin, Stent, Formby, and the Scottish Deputation. Less important notices may be found in other books of travels; and the Journals of Missionaries, printed in the *Missionary Register*, *American Missionary Herald*, and *Jewish Expositor*, have occasional notices of the Holy City. In regard to the Temple, consult Lightfoot, *Descriptio Templi Hieros.*, Opp. i., p. 533, sq.; J. Bapt. Villalpando et Pradi, *in Ezechiel*; J. Jud. Leonis, libri quatuor, *De Templo Hieros. tam priori quam poster. ex Hebr. Lat. vens*, a J. Saubert, Helmst., 1665, 4to.; L. Capelli, *Τριπάγιον, sive Triplex Templi delineatio*, Amst. 1643, 4to. This is also inserted in the *Critici Anglicani*, tom. viii., and in the first volume of Walton's Polygott. Harenberg, *in d. Brem. u. Verdisch. Biblioth.* iv. 1. sq.; 573, sq.; 879, sq.; Bh. Lamy, *De tabern. foed., urbe Hieros et de Templo*, Par. 1720, sq.; Hirt, *Der Tempel Salomons*, Berl. 1809, 4to. m. 3 Kpfrn.; Stieglitz, *Gesch. der Baukunst*, Nürmb. 1827, p. 125, sq.; and Less, *Beiträge zur Geschich. d. Ausbild. Baukunst*, Leipz. 1834, i. 63, sq.; V. Meyer, *Der Temple Salom.*, Berl. 1830; inserted also in *Blätter f. höhere Wahrneue Folge*, i.; Grüneisen, *im Kunstblatt z. Morgenbl.* 1831, No. 73–75, 77–80. Some more works are mentioned by Meusel, *Biblioth. Histor.* i. ii., 113, sq. The best works on the antiquities and history of the Jews contain also chapters illustrative of the temple. Among the biblical dictionaries, see especially Winer's *Real-Wörterb. sub* "Tempel;" *Ezekiel's Temple, being an attempt to delineate the Structure of the Holy Edifice, its Courts, Chambers, and Gates, as described in the last nine chapters of the Book of Ezekiel, with plates*, by Joseph Isreels, London, 1827. Jervis.

JERVIS, SIR JOHN, *Earl St Vincent*, a distinguished naval officer, was born at Meaford, in Staffordshire, on the 9th of January 1734, old style. His father, Lwynfen Jervis, Esq., was counsel and solicitor to the Admiralty, and treasurer of Greenwich Hospital. Young Jervis was destined for the law, but having contracted a dislike to that profession, and a strong predilection for the sea, he ran away from school, and expressed his determination to be a sailor. He was therefore placed under Commodore Townsend, who was at that time going out in the Gloucester as commander-in-chief to Jamaica. This was in the year 1748. In 1754 he was made a lieutenant out of the Prince into the Royal Anne; and in the year 1759 he distinguished himself very much at the siege and capture of Quebec, when General Wolfe was killed. He was in consequence promoted by Sir Charles Saunders, the commander-in-chief, to the rank of commander, into the Porcupine sloop of war. In the following year he was made a post-captain. He commanded the Foudroyant in July 1778, when the memorable *rencontre* took place between Admiral Keppel and Count d'Orvilliers, and bore a very distinguished part in that action. In 1782 Captain Jervis fell in off Brest harbour with the French ship Pégase, of seventy-four guns and 700 men, and took her after an engagement which lasted three-quarters of an hour. The Pégase had eighty men killed and wounded, while Captain Jervis and four men only were wounded on board the Foudroyant. In consequence of this action, which at once raised his renown to the highest pitch, he was created a knight companion of the Bath. In 1784 he was elected member of parliament for Launceston, and he afterwards sat for North Yarmouth. In 1787 he was advanced to the rank of rear-admiral of the blue, in 1793 to that of vice-admiral, and in 1795 he became admiral.

In November 1793 an expedition was fitted out to attack the French Caribbee islands, and Sir Charles Grey and Sir John Jervis were nominated respectively to command the land and sea forces to be employed on the occasion. The expedition was at first completely successful, and Martinique, St Lucia, and Guadaloupe, were surrendered to the British arms. The French however succeeded in retaking Guadaloupe, and the rainy season and the yellow fever frustrated all the efforts of the British to regain possession of it. In 1795, on the resignation of Admiral Hood, Jervis was appointed to the command of the British fleet in the Mediterranean, and was employed in blockading the French fleet in Toulon, and protecting our trade in the Levant, a service which he performed with consummate skill and success.

In 1797 Admiral Jervis, with only fifteen ships of the line, gained his celebrated victory over the Spanish fleet, consisting of twenty-seven ships of the line. The engagement, which took place off Cape St Vincent, on the 14th of February, lasted about ten hours. The Spaniards were completely defeated, and four sail of the line, two of 112, one of 84, and one of 74 guns, were taken. The thanks of both houses of Parliament were voted to the fleet, and the commander-in-chief was created a peer, by the title of Earl of St Vincent. This victory was much more important in its consequences than might be supposed from the mere numerical loss which it caused to the enemy. It paralyzed the power of Spain, gave encouragement to our allies, and added fresh vigour to the efforts of the government in prosecuting the war. The battle of Cape St Vincent was followed by the mutiny of the British fleet at Spithead; and in the month of May and June following its effects were felt in the fleet which was cruizing before Cadiz under the command of Lord St Vincent. But the ringleaders were executed, and the mutiny speedily repressed by the resolute and determined conduct of the commander-in-chief: with a combination of humanity and ingenuity eminently characteristic of the man, he contrived to make one execution produce the effect of many, by ordering it on an unusual day, Sunday morning. It was the practice to dispatch mutinous vessels to serve under his orders; and by his masterly operations of combined mercy and justice, he soon reduced them to order, restoring discipline by such examples as should be most striking, without being more numerous than absolute necessity required. In June 1799 he resigned the command of the fleet, in consequence of ill health, and returned to England in the month of August following. On the resignation of Lord Bridport, and his final retirement from active service, he was appointed to the command of the Channel fleet, and in the spring of 1800 hoisted his flag in the Ville de Paris. In the following year, on the formation of the Addington ministry, he was made first lord of the admiralty, and in that important office the great capacity for business with which he was endowed by nature shone forth in all its lustre. He instituted the celebrated Commission of Naval Inquiry, which not only led to numberless discoveries of abuse and extravagance, but laid the foundation of a system of economical administration, which has since been extended from the navy to all the departments of the state. The extent of corruption brought to light by the Commissioners of Naval Inquiry almost exceeds belief. From the dockyard alone the government was plundered at the rate of a million sterling annually; and the same nefarious practices prevailed in all the other departments. Lord St Vincent grappled boldly with these monstrous and deep-rooted abuses, and by his unsparing rigour, inflexible honesty, and resistless energy, succeeded in putting them down. "It is impossible," says

Jesi ‖ Jessore.

Lord Brougham, "to calculate what would have been the saving effected to the revenues of this country, had Lord St Vincent presided over any great department of national affairs from the beginning of the war, instead of coming to our assistance after its close." The resignation of Mr Addington in 1804 put an end to the naval administration of St Vincent, as first lord of the admiralty; but the exigencies of the state caused him in 1806 to be called from his well-earned retirement and from the enjoyment of his domestic comforts, at the age of seventy-two, to take the command of the Channel fleet. He was at the head of the expedition and the commission sent to the court of Portugal in 1806; and his conduct in that delicate and important affair displayed great talents and address. In the spring of 1807, advanced age and impaired health compelled him finally to resign his command. The remainder of his life was spent in retirement at his beautiful seat of Rochetts, where he died on the 14th of March 1823, in the eighty-eighth year of his age. The character of Lord St Vincent presented an admirable union of the brightest qualities which can adorn both civil and military life. As a statesman, he was distinguished for his sagacity and foresight, and the profoundness of his views. He was a steady and consistent supporter of liberal principles, ever preferring the side of humanity and freedom. He was not more distinguished for his great talents than for his magnanimity and complete freedom from every feeling of jealousy or envy. And it has been justly said by one who knew him well, that "all good officers, all good men employed under him, whether in civil or military service, spoke of him as they felt, with admiration of his genius approaching to enthusiasm." (Brenton's *Life of Earl St Vincent;* Lord Brougham's *Statesmen of the Times of George III.*) (J. T—R.)

JESI (the ancient *Æsium*), a walled city of the Papal States, on the left bank of the Æsina, delegation of Ancona, 16 miles W.S.W. of the town of that name. It is the see of a bishop, and has a cathedral, five churches, and twelve convents. Pop. about 6000, chiefly engaged in the manufacture of silk and worsted stockings.

JESSELMERE, a native state of Hindustan, in the province of Rajpootana, situate between the 26th and 28th degrees of N. Lat., and extending to the sandy desert, which constitutes the western boundary of that province. It is a barren country, being for the most part an uninterrupted tract of sand, without rivers, and the wells being of very great depth under ground.

The ruler of Jesselmere has an annual revenue of L.8500, of which about one-half is derived from transit duties, and the remainder from miscellaneous sources. A small military force maintained by the feudal chiefs is kept up for the service of the state. The history of Jesselmere is little known before 1808, when its ruler, alarmed at the encroachments of his neighbour, the chief of Bahawulpore, made advances to an amicable understanding with the British government. This relation matured in 1818 into an alliance by which Jesselmere became entitled to British protection, and engaged to act in subordinate co-operation with the British government, and with submission to its supremacy. Jesselmere, the capital of this state, contains about 8000 houses, and a population of 35,000. Distant N.W. from Calcutta 1290 miles. Lat. 26. 56; Long. 70. 58.

JESSORE, a district of the province of Bengal, to the N.E. of Calcutta, bounded on the N. by the district of Pubna, and on the E. by Dacca Jelalpoor, and Buckergunge; on the S. by the Sunderbunds, and on the W. by Baraset and Nuddea. It is 105 miles in length from S.E. to N.W., and 48 in breadth. The area, according to official statement, is 3512 square miles. The northern part of this district is very fertile; but the southern division is in the Sunderbunds, and composed of salt marshy islands covered with trees. Some parts lie so low that embankments are found necessary to protect them against inundation. The land is fertile, and produces rice, indigo, sugar, and tobacco in large quantities. The population, according to official statement, is 381,744. According to recent authority, the Brahminists form one-half of the population, the Mussulmans the other; but this unusually large proportion of Mussulmans appears remarkable in a tract so remote from the seat of their former empire in India. Jessore, the chief town, is situate 77 miles N.E. of Calcutta, in Lat. 23. 10., Long. 89. 10.

Jesuitism.

JESUITISM.—If a very few exceptive instances are allowed for, it holds good as a rule, that canonization shuts the door against authentic history. The instance now before us has no claim to be regarded as one of those rare exceptions. The existing memoirs whence we derive our knowledge of the personal history of the founder of the order of Jesuits, are probably genuine, and, in the main they may be authentic; but it is impossible that we, at this time, should know them to be so. They contain indeed little that should be regarded as improbable, and very little that is absolutely incredible; and even this little is of a kind which the practised reader of the literature of the *Calendar* will find it easy to detach from the places where it occurs without a disintegration of the mass.

But then, in accepting these now extant materials, we do so in simple faith; for scanty means, if any, are within our reach by aid of which we might assure ourselves of the truth of what we admit to be true, or might effect an excision of the spurious parts. The life of "St Ignatius," just such as we find it in the documents which the Church of Rome and the Society itself recognise as authentic, is of a kind which would attract no special notice. It would take its place among instances without number of similar conversions, and of equal intensities of feeling, and of extravagancies of behaviour not less absurd. The only kind of surprise for which there can be ground in perusing the biographies of Ignatius Loyola, is this—that a narrative exhibiting so little which is indicative of extraordinary intelligence, or of any rare qualities of the moral nature, should be found standing at the head of a course of events which has no parallel in the history of the human family. The reader is impelled to exclaim, and to ask—"Is *this* the man from whose brain can have sprung the Jesuit institute and its polity?" An answer in the affirmative can scarcely be accepted apart from the supposition that the Jesuitism, of which Loyola himself may be regarded as the author, was little more than a germ-idea, caught at, cherished, evolved, by minds of far greater compass than his own.

Be this as it may, no proper account of Jesuitism can be presented without a preliminary, though it be a much condensed, biography of the man who has been signalized as its founder, and who undoubtedly bore sway as its chief, through the period of its infancy and of its rapid growth.

The sources whence the customary notices of the life of Loyola have been drawn are, chiefly, those compilations which the Society itself has put forth, or which it sanctioned after the time when any independent testimony might have been collected and appealed to.

The Bollandists, in their vast collection, the *Acta Sanctorum*, have, in their usual elaborate manner, collected those materials of Jesuit history which came to their hand. These materials were digested and amplified by Orlandinus; and his voluminous memoir of the founder is the one to which the Society has attached its sanction. The Jesuit, John Peter Maffei, an agreeable writer, and author of a History of the Indies, and a Life of the heroic St Francis Xavier, has brought the narrative within moderate compass, and given it a form acceptable to general readers. He appears to have availed himself of the notes of a contemporary, Polancus, who had lived on terms of intimacy with Loyola. Maffei's book first appeared in 1585. Ludovico

Jesuitism. Gonsalvo, a Spaniard, and one who also had been Loyola's companion, left memoirs relating to his master's earlier years, and these notes carry an air of truthfulness and simplicity.

At a later time, the Jesuit Pietro Ribadeneira, taking Gonsalvo's Memoirs as his text, with which he combined whatever had been done by his predecessors, compiled a formal and very copious history of the founder of the order. This writer differs in various instances from Maffei, and generally he does so when narratives involving the supernatural are to be disposed of; in these cases he trenches as little as possible upon the marvellous, and hastens forward to set his foot on firmer ground. It is from the writers above named that we are to learn all that can now be known of the personal history of the founder.

Inigo de Recalde Loyola, the son of a nobleman of Guipuscoa, was born in the year 1491. He was made a page at the court of Ferdinand and Isabella, where he distinguished himself in every accomplishment proper to a soldier and courtier; and more than this, it is affirmed that he was noted for the correctness of his behaviour, his respect for religion, and his strict regard to truth. At this early age he gave proof, we are told, of that sagacity which made him, through life, master of the most hidden dispositions of those around him; and of that tact which enabled him to bend all dispositions to his will. He had reached his twenty-ninth year when an incident, so often related, gave a turn to his mind, his purposes, and his course of life; a turn to which, as to an incidental cause, we must trace an evolution deeply affecting the condition of Christendom through three centuries.

The wound, which had spoiled this young gentleman's fortunes as a soldier and as a man of the gay world, had been received at the siege of Pampeluna. The constitutional force of his will, which was displayed in submitting to the cure of a badly set fracture, brought him near to death; but at the last moment he is restored by an immediate intervention—so he believes—of the "Prince of the Apostles." A recovery protracted through many months, and which, as he did not doubt, had taken its rise in a miracle of grace, brought him into acquaintance with books of piety; and the fervour of his temperament, thenceforward, took a corresponding turn. The infinite, the unseen, and the eternal, were accepted by him in place of whatever perishes in the using, and which cloys even in the moment of possession. The limping soldier becomes, not because it was his only alternative, but with the full and free choice of his soul, the man of prayer and of unconditional devotion to the most arduous religious enterprises.

It is of some importance to remark that, on the probable supposition of Loyola's knowledge of Christian history having been derived from one of those picture-book Gospels which were in the hands of the laity at that time, we have a clue to the fragmentary and excerptive character of his first and chief literary work, the *Spiritual Exercises*. Of Christianity he seems to have known just the main incidents of the life of Christ; but little or nothing of those principles which are to be gathered from the apostolic writings at large. Yet although, even to the last, he was only a slender theologian, he had become, as if by intuition and in the first stage of his religious progress, a profound master of human nature, a skilfully exact physician of souls, a prudent director of the religious conscience, and a master of all varieties of waywardness in religious feeling. It is on this ground that we find him what we should look for in the founder of a religious order.

That difficult subject, the devotion of some of the most eminent Romish saints to the worship and service of the "Blessed Virgin," meets us at the threshold of Loyola's personal history. Easy it may be to deal with this problem in the instance of men like St Bernard, or Bonaventura, or Ignatius Loyola, on principles purely psychological: the perplexity which meets us springs from the endeavour to make so gross a form of polytheism consist with genuine piety, in the Christian sense of the term. In this place we do not attempt a solution of such a problem; but yet, a passing reference to it belongs to even the most hasty sketch of the Jesuit institute, which has ever shown itself pre-eminently the "religion of Mary." The personal consequences, as they affected the sentiments of this gallant Spaniard and soldier, when he dedicated himself to the "Most Blessed Virgin," are quite intelligible. It is also easy to see, when we look to the ripened Jesuitism of a later time, that a scheme of life founded upon the dethronement of the individual conscience, and the neutralization of genuine morality, should well consist with a sensuous conception of a female divinity, displacing the religious idea of the Eternal and Infinite Being inflexibly true and holy. There is no mystery thus far; but rather a satisfaction in finding that an ethical system such as that of the "Society" has consorted, as if by an instinct, with a theology so deeply corrupted. Jesuitism.

It was in the year 1522—a year memorable in the history of the German reformation—that Loyola, by a formal act, dedicated himself, body and soul, to the service of the "Blessed Mother of God;" and it was about this time, we are told, that he composed the book—if book it can be called—entitled *Spiritual Exercises*, and of which book something more must presently be said. But an ambition, or a philanthropy, which should embrace the human family, had already begun to develope itself within him; and its early promptings led him to undertake nothing less arduous than the conversion of the people of the East, even the Mohammedan nations, Turks, Arabians, Persians. To carry out this vast project his first step was a pilgrimage to the Holy Land. The many adventures which befel him in this journey, from which he returned in 1524, we must leave where it may be found, on the ample pages of his biographers. In the end the followers of the false prophet were necessarily abandoned to their errors, and then it was Christendom which he chose as the field of his mission; and on *this* ground he encountered no similar disappointment, for although the Mohammedan nations remained unconverted, yet he lived to see them environed on all sides, E. and W., by his agents, and, as it were, beleaguered by his institute.

A settled purpose, large in its bearing, must at this time have lodged itself firmly in his mind; for to secure success in the prosecution of it, he submitted himself, being then in his thirtieth year, to the irksome drudgery of acquiring the learning with which he had formed no acquaintance in his boyhood. If what has been related of their master's course at this time by his disciples be simply true, the humiliations he underwent, the assiduity he displayed, and the proficiency which he made in his college training, afford proof the most striking of a force of mind which must—which could not but, prevail against all difficulties that were not absolutely insurmountable. During these years of personal preparation he continued to exercise his peculiar gifts, both as a spiritual adviser, and as a popular instructor.

About this time when Loyola's course of theological study in the University of Paris was drawing to its close, he looked about for some who should be his companions and coadjutors in carrying forward the scheme which he had already devised for reforming the Catholic world. There can be no doubt that he possessed, in a very eminent degree, the rare faculty which has enabled a few men to surround themselves with, and permanently to retain in their service, minds of superior strength and of more varied accomplishments. Several of those who, to the last, yielded the place of power and honour to Ignatius Loyola, seem to have been more than his equals in grasp of intellect, while they far surpassed him in learning and in knowledge of the

Jesuitism. world. Of these eminent men who became, at length, the Fathers of the Society, the chief were,—Peter Faber, a Savoyard, a man of fervent temper, and devout from boyhood; the heroic Francis Xavier, the illustrious apostle of the Indies, who achieved a high renown for himself independently of Loyola, though not formally alienated from him; James Laynez, who succeeded him as general of the order, and of whose intelligence and astuteness the Jesuit polity was, as it seems, mainly the product—he is believed to have compiled a principal part of the *Constitutions* of the Society;—Alphonso Salmeron; Nicolas Alphonso, surnamed Bobadilla, a man of a penetrating spirit, and a master in the knowledge of human nature; and Simon Rodriguez d'Arevedo, a Spaniard of noble birth, and many accomplishments, as well as ardent piety and devotedness.

To these, who were Loyola's earliest associates, were added others in course of time. One of the most noted of these was Claude le Jay; and it was by their aid, and as yielding themselves unreservedly to the will of the master mind, that this band of devotees digested their scheme of life, fixed themselves in their purpose in relation to the church and the world, and imparted coherence and consistency to their individual labours. It was these men who, in concert, framed the Society of Jesus, and who, by that undiverted intensity of purpose which marked them, launched it on its course—a course of unexampled efficiency and power. From this time forward we almost lose the clue whereby to trace Loyola's individual mind, as the mover of the Jesuit polity, or as the mainspring of the Society; for it appears that two, at least, of his companions—Laynez and Faber—lent him the forces and the treasures of their minds entire, and without conditions, as to any share of fame or visible authority; they were content to witness the success of the great enterprise to which they had committed themselves, and to witness in silence its fast-spreading triumphs.

This band of men, dedicating themselves by a solemn act, to the "service of the Saviour," and imploring the protection and favour of "Mary, the Queen of Virgins," constituted themselves as a religious body, by vows and solemnities, on the 15th of August in the year 1534. But this act did not constitute them a "religious order," in the authentic sense which that phrase carries in the Church of Rome. To obtain the Papal sanction, which was needed for *this* purpose, Loyola sent forward certain of his friends to Rome in the year 1537; and there, for a length of time, they urged their suit with the sovereign pontiff, Paul III. What was at first asked was the apostolic sanction and benediction in behalf of a missionary pilgrimage to the Holy Land—a boon at length accorded. While awaiting at Venice an opportunity for passing over the seas, the three friends, Loyola, Laynez, and Faber, are believed to have matured the principles of the institute, and to have digested those maxims, so peculiar, when brought to bear upon the consciences of the Jesuit agents, and upon secular interests, which have seemed to contradict the first principles of morals, and to tend to the subversion of civil society. Yet these men must be thought of as sincere and devout, and as in a sense philanthropists.

These "Fathers," after a year of waiting at Venice, found they might excuse themselves from the mission they had proposed, namely, to convert the Mohammedan nations, and instead of so impracticable a task they turned themselves toward that of renovating the Catholic world. A new application at Rome for authority was now needed; and in this instance Loyola himself took the lead, as the originator of the order, "the Company of Jesus," and having at length obtained this grace, he thenceforward exercised the sway belonging to him as its "General." The profession made at this time included not merely the three vows of "obedience, poverty, and charity;" but that of an unreserved submission to the papal will, in all cases, and a dedication of body and soul to the service of the church, and to the maintenance of the papal authority, especially as it was at that time imperilled by the prevalent heresy of which Martin Luther had been the mover. This last condition, although not verbally expressed, was no doubt clearly understood, and distinctly kept in view, as well by the Jesuit fathers in offering themselves to the service of the papal authority, as by this authority in accepting so timely an aid. The papal bull which constituted the Society as a religious order, by Paul III., is dated 1540. It was not until after the date of this authentic recognition that Loyola's election as superior, or general, for life was formally made and openly recognised. Jesuitism.

Loyola possessed in a high degree that administrative faculty which displays itself in the distribution of tasks, in the classification of labours, in order, carried into the most minute details of daily life in large establishments. It was as thus gifted that he constituted the central Jesuit establishment at Rome; in which he secured economy in all things, time especially, and the appointment of offices according to the individual ability of each member. It was here that he realized, in the highest perfection, the mechanism in which living agents are at once the means and the material. At the same time, and while himself extensively employed as a spiritual adviser, or physician of souls, and as a popular preacher also, the general originated and controlled various missions to the several European states, as well as to heathen lands. So it was, that, within a few years from the date of the papal bull, the Society had established itself in almost every country in Europe, as well as in many places throughout the Old World and the New. Everywhere the Jesuit had come to be in request as the man who, beyond any others, was perfectly accomplished for whatever task it was which he undertook; and it was he who never failed to do his work well, whether it were as professor of the sciences or as a schoolmaster, or as the guide of souls, or as confessor, or as the adviser of princes and statesmen, or even as the superintendent of affairs purely secular and commercial. Houses of the "Order of Jesus" in Spain, Portugal, France, Germany, Italy, Sicily, India, had become the centres of an influence toward which the eyes and thoughts, the fears and the desires of minds, high and low, cultured and rude, were incessantly directed. Each of these potent establishments, with their "provincials," maintained submissive dependence upon the home of the order at Rome. Thus it was that the general held in his sole hand the reins of a spiritual government which was rapidly spreading itself over, and beyond the limits of the Christianized world.

With that prudence which belonged to Loyola as having once been a man of the world, he, with inexorable firmness, held his Society exempt from the cure of the souls of women, though this had been importunately urged upon him; those instances alone excepted in which ladies of the highest rank, by placing themselves under the guidance of a Jesuit father, might be usefully employed at the courts of princes in silently promoting the designs, or in protecting the interests, of the Society. With a like firmness, and at the dictate of the same sagacious perception of the remoter consequences of any course of action, he maintained that rule of the order which forbids a Jesuit to accept ecclesiastical dignities of any sort. Princes would gladly have welcomed Jesuit bishops in their dominions; but the general inexorably refused to give way to this desire, the issue of which, had he allowed it, must have been to open, in the view of ambitious members of the Society, a prospect of honour and of ease which would never consist with their devotion to its proper purposes, or with their perfect submission to the will of him to whose control they had surrendered everything.

But while the mitre and the hat were interdicted to the Jesuit fathers, the office of confessor to kings and queens

Jesuitism. and emperors was eagerly accepted by them whenever proffered. The reality of power, not its semblance or its pomps, was thus secured for the purposes of the Society; and it was thus that the general, while strictly abstinent as to the honours, and as to the revenues of the church, held in his hand, available for uses of whatever kind, the consciences of potentates, the revenues of kingdoms, and, in a word, all things earthly that might be employed for extending and confirming a universal ghostly domination.

There were moments when this spiritual empire seemed to be threatened from within; and when a mind, a will, an intelligence, springing up in some quarter, and as one might say, not drawing its sap from the root of the Society, brought the sovereignty of the one mind into question. The most noted of these instances was that which occurred in Portugal, where the provincial Rodriguez had acquired at court, as well as in the college over which he presided, a very great personal influence—an influence too great to consist with that submissiveness which was the rule of the Society. Loyola overcame, at length, yet not without much difficulty, this rising opposition; but the extreme peril through which he had carried his institute on this occasion, impelled him to preclude, if possible, a recurrence of the like danger, by embodying in a letter those principles upon a thorough understanding of which the Society might repose. The *Letter on the Virtue of Obedience*, addressed to the Portuguese fathers, sets forth, in terms beyond the possibility of mistake, those axioms of the Jesuit institute which constitute its very life, and which may be regarded as peculiarly characteristic of it.

Loyola had governed the Company of Jesus sixteen years: these had been years of incessant toil, and often of urgent and deep anxiety. In sustaining this burden his constitutional energy had been quite expended; and thus, as worn out, he tranquilly expired at Rome, in his sixty-fifth year, July 1556.

Minds which, on the scale of intellectual power, occupy extreme positions, the highest and the lowest, have often this feature in common, that through their course they are possessed by one idea, one form of thought, one purport and end of existence. The difference between those of the lofty and those of the low position is this, that while the latter are habitually ruled by their single idea, the former always rule it. A mind of the lower sort, when it is of the religious order, becomes, according to its temperament, the enthusiast, the fanatic, the zealot, the devotee, or the mystic transcendentalist. A mind of the higher sort, whose element also is religion, shapes an orbit for itself athwart the social system, draws a train of satellites in its track, gives a new direction to human affairs, takes a place in history, and, in a word, is such an one that Ignatius Loyola might fitly be pointed out as among the most illustrious samples of the class.

Loyola's one idea, if it be allowable to think of him as the founder of a religious order, was that of ruling the world in respect of its now present and its palpable interests, not by the universal diffusion of religious motives, not by fixing the eyes of mortal men upon the invisible and the eternal as their aim; but by using the invisible and the eternal as the fulcrum of his lever of government. It was, we must assume, his sincere belief—and his sincerity we should not question—that all things would go well in the world, in a *world-wise* sense, if only it were brought into a state of absolute, unreasoning, ungainsaying submissiveness to a single hand, ruling it for its good. But inasmuch as no immovable prop for any such universal domination can be found within, or upon the world itself, it must be sought for and found in the world overhead, and in the world underneath of this. This then is JESUITISM, as imagined and originated by its founder.

Loyola's individual religious sentiment, and his benevolence also, impelled him, at the same time, to labour for the purely religious welfare of the masses of the people, wherever he might have access to them. He was a zealous and effective street preacher and teacher, as well as from the pulpit, and in the house, and the closet. This was his occupation, in season and out of season. Jesuitism.

But when we look into the Jesuit system, considered as an institute framed for exerting a lasting influence in the world, we find it adapted to purposes of a very different order. To ascertain what those purposes are, we may either appeal to the notorious facts of its history, through a track of two centuries, or we may examine the constitutional documents of the Society, such as they were framed and left in the hands of Loyola's immediate successors. In fact, both these courses of inquiry should be pursued, and we now proceed to indicate, very briefly, in what manner, as we think, they should be carried forward.

DOCUMENTARY JESUITISM.

By the constitutional documents of Jesuitism, we mean those writings, tracts, digests of laws, or expositions, which the Company has from the first recognised as authentic, and to which it appeals as embodying the mind, the principles, and the practices of the order. These are,—1*st*, The book alleged and believed to be Loyola's own composition—viz., the *Spiritual Exercises*; 2*d*, The letters addressed to the Portuguese Jesuits, *On Obedience*, and which are also believed to be Loyola's own; 3*d*, The *Constitutions*, and the *Directorium*, which probably were wholly composed, or digested by his immediate coadjutors, Laynez, Faber, Aquaviva, and others. At a later time there was brought to light, unadvisedly as it seems, the *Monita Secreta*, believed, however, to be a spurious production. A word then for these documents in their order.

The *Spiritual Exercises*:—This book, when the important place it has held in the Jesuit Institute is remembered, will not be looked into by the modern reader without a mingled feeling of disappointment, amazement, and perhaps contempt. It is not a summary of Christian doctrines; it conveys no particle of instruction; it is not a collection of deep meditations; it is not a diary of those alternations of sorrow and joy, depression and hope, which have filled the religious life of some eminent Christians;—it is a manual of (so called) religious manœuvres, or manipulations, upon and concerning sacred subjects; the tendency and spirit of the whole being in the last degree mechanical. As opposed to what might be intellectual and reflective, it is perfunctory; as opposed to what is imaginative, it is sensuous or beggarly; as opposed to what is spontaneous and nobly free, it is slavish and stupifying. In conjecturing the probable results of a month's drilling—for a month is the time assigned to the entire course—regard must be paid to the moral and intellectual condition of those who submit themselves to such a treatment. A course like this, with its attendant seclusion in a cell, and abstinence from the incitements of pleasure or ambition—a four weeks' discipline carried forward in accordance with these prescriptions, might in a useful manner revive the decayed religious recollections of men of the world, supposing them to retain enough of religious conscience to make them uneasy while pursuing a course of lawless indulgence or ambition. There are also sedate, saturnine, and feeble natures to which this discipline would be well adapted. Men of this order might yield themselves inertly to so mechanical a scheme of life, and go on well in its trammels. As to strong minds, and as to the cultured, the month's task could be nothing but a temporary abnegation of their faculties of reason and feeling; it must induce a state of mind wholly factitious, and which must come to its end without result or product other than that of leaving

Jesuitism. upon the memory a repugnant and humiliating recollection, and upon the manners and style of behaviour a stiffness and conventional hypocrisy. The reader who is already better taught than this strange book can teach him, may glean from it—especially from its latter chapters—some few useful hints applicable to the religious life. On the whole, the *Spiritual Exercises* is to be regarded as an engine of spiritual despotism,—a tool for crushing the moral and intellectual life, preparatory to the function which the Jesuit will be required to fulfil.

The *Letter on Obedience*, addressed, as mentioned above, to the refractory Jesuits of Portugal, is, on sufficient grounds, attributed to Loyola himself. It was composed in 1553, three years only before his death, and it may be regarded as embodying, within the compass of a few pages, the very principle, the very distinctive element, of the Jesuit institute; and whoever wishes to understand this profound scheme of polity, and to form his judgment upon it, considered in its relation to the axioms of universal morality, or to Christian precepts, or in its bearing upon the wellbeing of nations, should read, and read again, this remarkable document. It is true that a doctrine nearly approaching that maintained in this *Letter*, may be gathered from the pages of some monastic writers, and is implied in the rules of some of the religious orders. But the differences are these two,—in the *first* place, in this *Letter* the Jesuit rule of obedience, involving,as it does, the stagnation of the intellectual faculties, and a total abrogation of the individual conscience, is expressed in terms far more absolute, reckless, and unexceptive than had hitherto been anywhere heard; and, in the *second* place, this doctrine had heretofore been addressed to those only, who, having renounced the world, and living or professing to live apart from it, might, with little risk of serious ill consequences, profess any sort, and practise any degree, of submissiveness to the will of their superior. Obedience, within the walls of a monastery, was obedience in the midst of a routine of inanities. But the Jesuit dogma of obedience was to be carried out and acted upon in the throng of the busy world. The Jesuit, deeply concerning himself, as he did, with the interests of the social system—domestic and municipal—and meddling always, when he could do so, with affairs of state, did this, not as an individual moral agent who is in some degree mindful of the quality of his personal acts, and who judges them to be lawful or criminal; but as a being who has surrendered his responsibility—his conscience, whole and entire, and unconditionally, into the hands of a superior. In the sense of this *Letter on Obedience*, there is but one sin of which a Jesuit can possibly be guilty—namely, *disobedience*, or the mere thought which might impel him to call in question the rectitude of the commands of his principal.

The *Constitutions* of the Society, or that body of rules and methods which are the law of the community, relate to the practices and the routine that attend the selection and admission of members; to the classification of those actually admitted, according to their individual qualities; to the rejection or exclusion of candidates, and to the government of the body by provincials and a General, who was chosen for life, including also a provision made for holding this autocrat in check, or even for removing him from his place in extreme cases. The reader, whom we may suppose already to have acquired, from the perusal of the *Spiritual Exercises*, and the *Letter* above mentioned, an idea of the *spirit* of the Jesuit institute, will find himself perplexed when he looks into these, its *forms* and its modes of procedure, as set forth in the *Constitutions*, if he endeavours to divine what may be the real object—the practical purport or end arrived at by so vast and elaborate a scheme of discipline and government. What final purposes are to be the result of a method and of a mechanism so profoundly contrived, so far-reaching in its means, and so appalling in the conditions which it imposes. Jesuitism.

Of this problem the documents in our hands afford no solution. To these reasonable questions no answer is returned by any of those writings to which the Society has been used to make its appeal when challenged to vindicate its doings before the world. If we grant, as we may, that Jesuitism is, to a certain extent, a *religious* institute, intended, like the more ancient monastic orders, to promote and carry forward the individual piety of its members, or to diffuse religious principles among the people, there yet remains, after these intelligible purposes have been secured, a vast apparatus *in excess*, which can have no relationship to objects or ends of this sort. What then *are* the ends which this deep scheme actually has in view? An answer to *this* question must be sought for in following the Jesuit Society through its history, from its earliest days to recent times. It is this history which expounds the *Code* and the *Constitutions*, of which Ignatius Loyola is the reputed author.

The *Constitutions*, as originally put forth, have become embossed—if so we may speak—with copious expositions, and they are followed by a body of instructions called the *Directorium*, which adapt the general principles to a vast variety of special cases. From these sources are to be gathered a true notion of the methods—peculiar to itself—of enforcing confession, and of surrounding every Jesuit with a network of delation. These practices which are the special characteristics of Jesuitism, as distinguished from Romanism, and from the pre-existing monastic orders, call for the closest attention, if we would, in a thorough manner, and with philosophic impartiality, come to an understanding of this, the most notable of all the religious schemes which the world has ever seen or tolerated.

If in inquiring concerning the Company of Jesuits, such as it had become at the time of Loyola's death, we were to measure it against the systems, the institutions, and the men of that time, its one prominent characteristic, its main distinction, would appear to be this, that it had at its command, at every moment, the unscrupulous services of a large number of men, fitted by natural talents, and by the most careful training, for functions, offices, and labours of every kind—spiritual, intellectual, political, economical, and even commercial. The selection of its agents from among the number, each well adapted by natural talent for the function assigned to him, is clearly the principal intention of the *Constitutions*, of the *Directory*, and of the other documents of the Society. Then, the fit men having been secured, their discipline and training was the second principal care of the Society; and then the distribution of them over the world was the third. In relation to almost every department of human labour, men of this Society were found to be better instructed than any others; they were by natural talent better adapted to their special tasks; they were more diligent, more assiduous, more self-denying and indefatigable; and, in a word, they were more practically efficient, and they were more successful, than their competitors on the same lines of labour. In any circle of affairs, public or private, the Jesuit of that early time was the Joseph in Potiphar's house. It can be no marvel, therefore, if everywhere his valuable services were sought for, and were highly prized. It was especially so in whatever related to the business of education, whether in schools or colleges; and also in the delicate position courted for its members, namely, that of directing the consciences of statesmen and princes.

The duties or offices which the Society professed at the first to undertake, and which have ostensibly filled its hands, and limited its views, were, as we have said, the cure of souls, the conversion of heathen nations, and the education of the young. But the work upon which, in fact—so we must infer from its history—the mind of the leaders of the Jesuit company has been always intensely fixed, but con-

Jesuitism.

cerning which it has observed a discreet silence, was the giving the aid of its casuistical direction to men in power, and to women also, upon whose influence the turn of political affairs so often depends. It has been the discharge of this occult function which has given its character to the Society; it has been the immoral refinements which it has been compelled to invent or to adopt in discharging this function which have drawn upon it general reprobation and hatred, and which have made it the object of well-founded jealousy and fear in almost every country, Catholic as well as Protestant.

The Jesuit missions among the heathen have been illustrated by instances of Christian zeal and devotedness, such as have never been surpassed; while at the same time these very missions have exhibited, as in India, and in South America, those characteristics of the Jesuit institute which are the most to be reprobated, namely—its unscrupulous compromises with pagan superstitions and vices, and its pursuit of worldly influence and power, as in Paraguay, apart from any genuine zeal for the spiritual, or even temporal, well-being of the people whom it has assumed to govern.

In like manner the Jesuit scheme of education has displayed the highest merits on the one side, combined always with a vitiating element, which, if it had prevailed without counteraction, must have led the mind of Europe in a backward direction, from the bright course it had entered upon, toward the dim regions of intellectual stagnation. No teachers, no professors, were more assiduous, or more able, than the Jesuits who placed themselves at the head of schools and colleges in the sixteenth century. Seldom could their rivals compete with them. But the education thus conveyed had a uniform characteristic—it was stationary, not germinant; it was dogmatic, not suggestive; it was static, not dynamic. The most ample and exact acquaintedness with things *as they are* was conveyed by the Jesuit teachers; but along with this proficiency there was a prohibition, tacit or explicit, of inquiry or progress. Whereas in the sixteenth century the human mind had received an irresistible impulse, carrying it forward in all directions over the field of action and of speculation, the Jesuit institute, considered as an educational scheme, came forward to stay or to neutralize that impulse by offering so to teach, and so to train the mind of Christendom as should render inquiry needless, and advancement undesirable. To some extent this endeavour to supplant the opening science of the age, and to arrest movement, actually took effect; and it might have done so in a degree that would have been fatal to our modern advancement, if the Jesuit body had not, at an early time, so displayed its vicious tendencies in another sphere as to awaken salutary distrust and alarm throughout Europe.

This reaction against the Jesuit body took its rise within the circle of political movements, where it had already whispered doctrines against which the moral instincts of men prompted them to make an outcry.

SKETCH OF THE HISTORY OF THE ORDER.

In taking a glance at the history of the order of Jesuits, there is little that can command attention beyond the field of its interference with the political interests of the European nations. So far as Jesuitism was an outbreak of religious fervour—and so far, when thus thought of, as it served in a time of laxity to reanimate the Roman Catholic world, and thus to maintain Catholicism against the assailing forces of the Lutheran and Calvinistic reformation—thus far, the Society may be regarded as having been a seasonable and useful conservative energy; for, unless the Church of Rome had at that moment found, and had availed itself of this aid, or of some aid of the same kind, it may well be believed that the Romanized Christianity which was destined for a lengthened term to hold the nations of southern Europe in a visibly Christian condition, must have given way to the hostile force, so that the places which knew it once should have known it no more. This was not to be. The reformation was itself far from being such as that the world could take it up as an ultimate type of Christian belief and worship; it was a sudden reaction from the errors and corruptions of many ages; it was moreover a *violent* reaction; it drew with itself large fragments of ancient errors, and an abundance also of crude novelties, and it was hurried forward by the tempests of the political world, and swayed this way and that by cross undercurrents. The German, the Swiss, the English, and the Scotch reformations—all and severally—were temporary forms of Christianity which could retain their own coherence only so long as they were each of them forcibly compacted by the vigorous circumjacent pressure of the old religion. The vivid zeal and the Protestant feeling of some overweening persons may prompt them to resent an averment of this sort, which, however, may be assented to without any peril by those who know how to hold fast their Christianity, while they forget their Protestantism. But Jesuitism, so far as it came in to save the Roman Catholicism of southern Europe, had done its destined work at an early time; or we might say, about the time when the Protestant evangelic fervour had subsided throughout the reformed nations. This counteractive energy had well spent itself on both sides toward the close of the seventeenth century. Thus far, therefore, the history of Jesuitism stands on record as a short chapter in the general history of the great religious movement of the sixteenth century. Thought of in this way, it may be granted that Martin Luther found his complement in Ignatius Loyola.

Jesuitism.

The history of Jesuitism, we have said, must mean its *political* history, and this is a dark narrative of a guileful interference with the course of national affairs; dark enough even when left to work itself out in its own way, but deriving a deeper colour, a fouler stain, from this source; not so much because crimes more flagitious were committed by the hands, or at the instigation of Jesuit agents, but because the Jesuit—whether suggesting crimes, or employed in smoothing the path of the criminal, or in extracting the sting of remorse—went about his work with refined reasonings, with an apparatus of orderly logic, with a carefully adjusted scheme of spurious ethics, which, as often as it made one man actually a criminal, prepared a hundred for walking in the same path. An aggravated mischief cannot but ensue in the social system when men who have been used to do ill at the blind impulse of sensual passions, cupidity, ambition, learn to do the very same things as recommended and palliated by sophistries. Those astute writers, who, at a very early time after the death of Loyola, and while his immediate successors were still living, gave themselves to the task of moulding an ethical system suited to the varied requirements of Jesuit confessors, may be regarded as compiling in cypher the blackest passages of the history of the courts of southern Europe for 150 years forward. The series of casuistic writers that is immortalized in the *Provincial Letters*—such as Sanchez, Molina, Bauney, Bobadilla, Escobar—are the expositors of the course of events in all those countries where the "Company of Jesus" had reared its establishments, and had been treated with favour by kings, queens, and statesmen. Peruse these casuists, make yourself master of the doctrine they profess for giving nerve to the arm of the assassin, and you are furnished with a sort of programme of the tragedies of European history, through the course of the following century. Sweeping statements of this sort, condemnatory of communities of men, may be true in substance; but they should never stand alone, as if they might be taken as unexceptionally and universally true. Counter-statements, well

Jesuitism. sustained by evidence, and assented to by eminent writers, not of the Society, have been advanced; and every candid mind will rejoice to find that, in relation even to the Jesuit Society, as to almost every other institute or community, it is true that the better impulses of human nature largely avail to correct and to modify the vicious tendency of systems, and of codes, and of *written* doctrines.

Within the borders of Protestant countries it was inevitable that the Jesuit should be regarded, and should be dealt with also, not so much as the teacher of a reprobated religion, as a conspirator, as an incendiary, as a convicted enemy of the there established government. In particular instances, unwarrantable severities may have been enacted; but, as a rule, the paramount reasons of self-preservation must be held to bear out every infliction under which the Jesuits of those times suffered. In England, for instance, the proclamation of James I. (1604), and the procedures thence resulting, infringed no rule of a just polity, if it be granted that every government must sustain itself against the machinations of traitors, or of agents of a foreign power, found lurking about palaces, and waylaying princes with daggers under their cloaks. Even in these times, if treason were rife—if disaffection were widely spread—if a pretender to the throne were at hand—any class of men professing the principles, or known to be governed by the principles, that are avowed by Jesuit writers, must be summarily disposed of.

In France the presence of the Jesuits, and their admitted influence at court, under the protection of the Cardinal de Lorraine, and the expulsion of the order at a much later time (1764), all involve facts and reasons of a far more complicated order than those belonging to the same questions as affecting England. Jealousies, alarms, hatreds, the balancing of parties in the Gallican church, and in the universities, the inclinations of the court (that of Francis II. and his successors), and that tendency towards freedom of thought and action which already was at work among the people, all these, and other undefined influences, give complexity to those struggles which ended in the suppression of the order. The first expulsion of the order from France dates 1592. They were recalled in 1603; but finally expelled in 1764, occasioned by the failure of its trading operations. From the first, the Jesuit teachers and professors were able to place themselves in a position of indisputable advantage as men of more energy and assiduity, and of higher accomplishments, than were generally the doctors of the Sorbonne, or the existing professors in colleges and schools. On this ground the competitors were very unequally matched; or it was so in all instances but one; the eminent—the pre-eminent—men of Port-Royal, were well qualified in all branches to dispute the ground with the most noted of the Jesuit teachers. A mortifying consciousness of this unlooked-for and yet indisputable fact—the existence of a body of learned and accomplished men, highly esteemed also for their piety, their orthodoxy, and their personal virtue, worked its way to the heart of the Jesuit Society, and suggested a purpose of vengeance which was at length triumphantly realized in the destruction of their rivals. The damage and the humiliation which had accrued to the Society from the *Provincial Letters* might now be patiently borne by the "reverend fathers," for they could take to themselves the comfort of knowing that they had moved the besom of royal violence to sweep over the home of their enemies—Port-Royal was no more.

An antagonism of another sort took place between the Jesuits and the clergy of the Gallican church, on the ground of those principles of national independence which were then in favour. Jesuitism, by its vow and its spirit, was ultramontane in the most extreme sense. Nothing which Hildebrand had affirmed, no enormity which Innocent III. had carried into effect, revolted the Jesuit leaders or writers of the sixteenth or seventeenth centuries. The papal authority—regarded as the visible and audible will of Christ—could acknowledge no limit on earth, could yield itself to no gainsaying. But by a large proportion of the clergy of France these notions were repudiated, and an appeal to the judgment of councils through a course of ages, supported a very different belief, which yet was held to consist with a due regard to the chair of St Peter. On this ground, therefore, the Jesuits in France found themselves—among Catholics—the advocates of an anti-national doctrine: they might believe themselves to be firmly established in the closet of the sovereign, but they could never feel themselves to be welcome, or at home, in the church, or in the nation. The Jesuit's church principles were disliked and rejected; his machinations were not unknown; the corrupt morality which he taught at court, and whenever among private persons it might, with advantage, be advanced—these several grounds of exception, of suspicion, of dislike, attached to the members of the order in France, as decisively almost as in England, although under different conditions. Jesuitism.

In other Catholic countries—as throughout the domains of Charles V., and in Portugal, whence the Society was expelled in 1759, and in Venice, where at an early date (1606) it gave ground, and in Sicily, in 1767—the Jesuit establishments made themselves obnoxious on somewhat different grounds. These governments found and felt themselves to be enveloped in the meshes of a mute organization, which held on to a distant and foreign authority—an organization which, spreading its fibres in the most intimate way throughout the very substance of the social system, domestic as well as political, acted in both directions—the centrifugal and the centripetal; that is to say, as an omnipresent reporter of all things, and as a universal influence controlling all affairs, under the direction of a power inaccessible and responsible to none—amenable nowhere. Loyola, or whoever it might be that was the contriver of the Jesuit institute, might have foreseen that course of events which ensued in almost every country within which it had at first triumphed—namely, that it must come to be regarded as politically incompatible with the security of civil government, whether autocratic or democratic. This incompatibility would be felt not less vividly in countries that were firmly Catholic, and intolerant of dissent, than in Protestant countries: the consequence was, the expulsion of the order from countries the most orthodox, as well as from the heretical.

Justice to the Jesuit Society demands that general allegations of this sort should be accompanied with modifying statements. In several instances—especially in that of the harsh and cruel measure of the Portuguese government, in concert with that of Spain, in 1750 and 1759—the Jesuit fathers were made the victims of state policy, taking its course in utter contempt of reason, truth, religious feeling, and common humanity. The history of the missions in Paraguay and Brazil, and the narrative of the violences attempted and perpetrated in these countries by the two Catholic governments, are of a kind to engage the sympathies of the reader strongly and entirely on the side of the Society. Little as we may approve of the principles which guided those missions, it is a fact not to be disputed, that, through a long course of time, the Jesuit rule secured to the aboriginal tribes an incalculably larger amount of social and individual well-being than they could have enjoyed in their native condition; or, need it be said, under the ferocious rule of their European conquerors.

But when Jesuitism had become the object of dread, of jealousy, and of dislike to the Papacy—that is to say to the pontiff and his immediate ministers, it was on a different ground. At a very early time the pope had seen that the vow of unconditional obedience to the vicar of Christ had

Jesuitism. absolutely no meaning, whenever occasions arose which made this silent submission, or submission at all, inconvenient. The Jesuit *doctrine* was, that its vow of obedience included not merely an outward compliance with the command of a superior, but a conformity of soul and judgment also—an inward and absolute approval of such commands, whatever might be the contrary dictate of a man's individual judgment and conscience: he must not only *say* that white is black, but *think* it so. Then this outward obedience, and this inward congruity of the will, forbade any attempt, even in the most urgent instances, to persuade the superior, or to bring him over by argument, by expostulation, by entreaty, to another mind. Nothing can be more clear or more imperative than are the several statements of this doctrine wherever it presents itself in the authentic writings of the Society. Yet notwithstanding these professions, and in the face of them, Loyola himself, and the generals who succeeded him, never scrupled to use every sort of disuasive importunity, when they thought it desirable to turn aside the sovereign pontiff from some course which they judged to be prejudicial to the interests, or damaging to the influence, of the Society. None could surpass the Jesuit General in silent obsequiousness, when this humble mood suited him; none so daringly contumacious as he, when it did not suit him to submit. If then the popes regarded the Society as a powerful auxiliary, they well understood also that it retained always a will of its own, which they could not control. The Society was at best a "fast and loose" ally.

This significant fact had betrayed itself from the first, and had been signalized several times during the lifetime of Loyola and of Paul IV. Such were those occasions when the general obtained release for his Society from the spiritual care of women, unless indeed, and this was an exception easily allowed, when ladies who sought the aid of a Jesuit confessor, occupied high positions at the court of princes. Such also was that occasion when the rule was to be maintained which forbade a Jesuit to accept a bishopric, or a benefice of any kind. The same practice of obedience, whenever convenient, and of contumacy on special occasions, had been freely resorted to in relation to the missions of the Society. At a time when the compromising behaviour of the Jesuit missionaries in India and China had become known in Europe, and had raised an outcry throughout Christendom, the popes made repeated endeavours to bring these propagandists back to a course of Christian simplicity and purity. These remonstrances, these injunctions, were scarcely heeded; they seemed scarcely to have become audible after they had traversed so many thousand miles. It was manifest that the "Company of Jesus" was governed, not merely from within, but that it had an independent life, and an object of its own, and that it might, as occasion arose, pursue its private ends in spite of injunctions, of decretals, of bulls, of anathemas. Hitherto no religious body had grown up within the pale of the Church which could in any comparable degree alarm the Papacy.

This jealousy and alienation had gone on always increasing, until it came to its natural issue in the decree of Clement XIV. in 1773, suppressing the order. At that time the relative forces of the two powers had become such as to render this act *possible* on the part of the Church. Besides that the Society, like every human combination springing into life with great energy, had by this time lost very much of its interior vitality; and it had, moreover, concentrated upon itself, from all quarters, an amount of opprobrium quite unexampled in any instance which might be brought into comparison with it. Religious orders had indeed often fallen into contempt from their laxity, and their departure from the spirit and rule of their founders. But the Jesuit institute had become hateful just because it had realized its original principle, and had fully developed, in act, the incurable viciousness of its constitution, of its maxims, of its distinctive tendency. Other religious bodies might retrace their downward steps, they might admit reforms, and might regain their position in the world's esteem. But as to the order of Jesuits, the fact had at length become incontestably certain—it was a truth uncontradicted (out of the Society)—that to this body a renovation, and a return to its primitive health, would be nothing less than a universal calamity—would bring every civil polity, every social interest, into peril. The act, therefore, which suppressed this order was borne out, and was assented to by the implicit approval of the European nations, Catholic not less than Protestant. In truth, it was by the urgency of the Catholic governments that Pope Ganganelli had been led, or driven, to take this course, which he did with the show, at least, of extreme reluctance. It was thenceforward in heretical Prussia and schismatic Russia that the Society found an asylum. Yet from Russia they were expelled by Alexander in 1817. Jesuitism.

The events of the next following forty years were of that sort which could not but induce a reaction within the pale of the Church, and which would favour and bring on a resuscitation of Jesuitism. Pius VII. yielded to an influence in re-establishing the order, which was almost as distinctly expressed as that which had had its effect with his predecessor in abolishing it. A deluge had swept over Europe in this interval; a tornado had laid waste the Church; heresy and atheism had reared themselves aloft, and had appeared to be in course for utterly obliterating religious belief, or such religious belief as the Roman Catholic Church could recognize, from the minds and consciences of men. The time, therefore, was come for having recourse anew to the most potent restoratives; nor could any means be devised so effective, or so near at hand, with this view, as a revival of the Jesuit order. It was called upon, therefore, at a time of need, to repeat its first services to the Church, and at the same time to redeem for itself the esteem which it had universally lost.

During the period that has elapsed since the re-establishment of the Society—now more than forty years—it has pursued its course, we may suppose, to the satisfaction of its patrons and employers. Undoubtedly, the Jesuit influence has come in to the aid of that reaction which has taken place throughout, and still more beyond, the limits of the Roman Catholic world. Every sort of tendency which there may be to seek for and to accept infallible authority in matters of religion, would meet Romanism under its Jesuitic form. It is the Jesuit who must be stationed at the gate of the Church to welcome and encourage returning and repentant heretics. The antique religious orders possess no powers of adaptation fitting them for a work of this sort; in every sense they are superannuated. But the very characteristic of Jesuitism is its appliant or polymorphous quality. It knows perfectly who and what the repentant are. It knows how those feel who stray away from Protestant communions, and what are likely to be their difficulties in seeking to return to the Catholic Church; then it has a perfect command of the pharmacopœia of Romanism, and more than all, it has always a choice of agents, among whom it may find the very one who can best adapt himself to the humours of the individual patient.

In labours of *this* sort, the restored Jesuitism of our times has no doubt rendered great service to the Romish Church. It has also made some progress in recovering the position it once occupied as the director of education, popular and professional. Something, also, in recent times, it may have effected in that which we must call its proper work—political intrigue. But beyond these faint revivals of the parts it played throughout the world in the seventeenth century, there is little which is now possible to this once formidable association; and henceforward every new development of the substantial forces of the social system

Jesus. must remove to a still greater distance an interfering force, such as that of Jesuitism. As measuring itself in turn against each of these energies, this force must be conscious of its insignificance. Our modern science, in its irresistible onward course, tramples down the Jesuit non-progress educational system. Popular enlightenment supersedes its labours on lower ground; the triumphs of mechanical science, and, along with these, the irrepressible energies of commerce, are leaving in the rear, and far behind, those movements which obey the tardy tortuosity of the religious machinator. Railways, steam navigation, electric telegraphs, instantaneous international correspondence, to all these things there belongs a velocity which wily intrigue can never overtake. The threads and wires of the general of the order of the Jesuits, which once covered Europe, and stretched across oceans, were at that time the quickest, the surest, the most secret, and the most effective of all modes of correspondence. Now they are surpassed, they are superseded, they are put out of question, by means which not princes and conspirators merely have at their command, but which obey the momentary call of every trader for a few shillings. Do these things refute Jesuitism? Assuredly they do not; but the irresistible tendency of them is, to leave it, as a power, to that contempt which the inherent turpitude of its principles has so amply earned for it.

Yet this is not all: Jesuitism we must believe to be in itself unchanged, and unchangeable; but its relative value, and its available efficiency as a scheme of silent political influence, has already undergone, and is every day undergoing a change—a change touching its very existence. The mind of the European community is now passing through a process which, far as it may fall short of the wishes of the enlightened moralist, or the anticipations of eager philanthropists, is yet full of a cheering promise for the age next ensuing. Those things in which consist the welfare of nations are every year coming to be better understood than heretofore; the folly—not merely the criminality—of violence, of ambition, of political fraud, and chicane, is coming to be more and more seen and felt; the few and the intelligible axioms of private morality, embodying the requirements of truth, honesty, and open dealing, are now in course of being applied, more and more widely, to the public conduct of public men, and also to the policy of governments. Is it not true that those astute methods of government and those traitorous arts to which the opprobrious phrase "Jesuitical" has for a century been applied, are falling fast into disesteem, and are becoming the objects of indignant scorn? Notwithstanding any single instances that might be cited to the contrary, we believe that this is broadly the fact, and it is a fact which is characteristic of the times now present. But if so, and if whatsoever is "Jesuitical" is becoming more and more odious, and therefore less and less serviceable, then assuredly Jesuitism itself will find it a task more and more difficult to maintain the position which once it held in the closets of princes, and even in conclaves. This sanative course of things, which we are here supposing to be in progress, tends always toward an accelerated movement, borne upon, as it is, by what we have already adverted to—namely, the universality and the *instantaneousness* of those means of communication among the nations, which mechanical agencies have lately realized; for that which almost annihilates time and space, robs fraud and wrong and treason of their main resources. Crime is exposed as soon almost as perpetrated; the criminal is outrun by the ministers of law; and if such a phrase might be allowed, Europe is now living in the perpetual glare of mechanical day-light—light everywhere diffused, and which is liable to no intermissions. Those, therefore—the conspirators against the rights and liberties of mankind—whose practices lead them to court the hour of darkness, will find themselves continually driven into narrower and still narrowing corners, until at length the world will rid itself of them for ever. (I. T.) Jesus.

J E S U S.

JESUS, the Divine Author of the Christian religion, was born at Bethlehem, a city of the tribe of Judah, about six miles south-east from Jerusalem. His mother was a Jewish virgin named Mary, the betrothed wife of Joseph, both in the humblest rank of life, though both of the royal race of David. The date of his birth is not mentioned in the sacred record; and there has been a difference of opinion among the learned who have engaged in the inquiry, respecting the precise period when it took place. It is now, however, generally agreed upon, that it must be fixed a few years earlier than is indicated by the epoch of our era, which, according to the common computation, corresponds with A. U. 754. We know that Jesus was born before the death of Herod the Great; and it appears from Josephus, that Herod died before the Jewish passover A. U. 750. From calculations founded on other parts of the gospel history, and particularly on a comparison between Luke, iii. 1 and 23, many have supposed that the nativity was in A. U. 747; and in this opinion some have been confirmed by the conjecture of Kepler, that the conjunction between Jupiter and Saturn, which took place in that year, was the star seen by the wise men; though it may be justly questioned how far the principles of scriptural interpretation admit of the supposition that the phenomenon referred to corresponds with the particulars mentioned by St Matthew. In regard to the day or month in which the Saviour was born, a subject to which the devotion of a large proportion of the Christian world has attached much importance, we have no means of accurate knowledge. The description given of shepherds watching their flocks by night is inconsistent with the idea that it could have been in December or January, or during the heat of the summer months; as we know that in these periods the herds were no longer left in the fields. At other times of the year the flocks might be turned out to pasture day and night in the south of Palestine; but there is no circumstance referred to by any of the evangelists to determine whether it was in spring or in autumn that Jesus was born.

The chronological error in the vulgar era, and in the season for celebrating the festival of Christmas, does not in any way affect the truth of the gospel history; and cannot indeed appear strange, when it is considered that several centuries elapsed before the method of computing time by the birth of Christ was introduced, and that the festival of the nativity was not observed in the primitive church. During the first three centuries, the Christians adopted the ordinary modes of reckoning time, which prevailed among the heathen around them. Different methods were afterwards employed; and it was not till the sixth century that a Roman abbot named Dionysius the Less was induced, by motives of religion, to have recourse to the expedient of determining dates by the number of years from the period when the Son of God was born of a woman. The commemoration of the day of the nativity was not generally observed throughout the Christian world till the fourth century. At that time the western church fixed upon the 25th of December, and their example was generally followed. Different causes have been assigned for the choice of this day. Sir Isaac Newton, in his work on Daniel, supposes that it was agreeably to the principle by which the chief feasts were fixed at the cardinal points, without regard to historical accuracy; as the annunciation at the vernal equinox, and St John the Baptist's day at the summer solstice. Hospinian and others have been of opinion that the festivities connected with the celebration of Christmas were intended to make up for the Saturnalia, conformably to the practice which had been acted upon from an earlier period, of smoothing the way for the conversion of the heathen, by

Jesus. presenting their idolatrous ceremonies under a new form. And there is not wanting reason to suppose, that from the winter solstice being observed as the birth-day of the sun, when that luminary, returning from the south, seemed to be restored to the world, the transition was suggested to the celebration of the birth of him who was the life and light of the world.[1]

The circumstances connected with the birth of Jesus corresponded in a remarkable degree with the predictions of the Jewish prophets respecting the Messias. He belonged to the tribe of Judah, and was of the house of David. Events, over which his earthly kindred had no control, fixed his birth at Bethlehem, from which place the promised Deliverer was to spring. The seventy prophetic weeks of Daniel were approaching to their termination. And so determinate were these and other predictions, that a general opinion prevailed, even in heathen countries, that the tide of time was bringing our race to a mighty epoch, and that a prince was to arise in the East who was to obtain the empire of the world.[2] The wisdom of Divine Providence was also shown in the appointed scene and season of the birth of Jesus. From the geographical situation of Palestine, forming a part of Asia, touching upon Africa, and connected by the Mediterranean with the whole of Europe, the Jews enjoyed the best opportunities of diffusing the knowledge of their principles. And the intercourse between remote nations, occasioned by the conquests of Alexander and the progress of the Roman arms, afforded increased facilities for propagating new opinions, while it forced upon men's notice the different forms of national worship, and led to an examination of the great principles of religious belief.

Soon after the birth of Jesus, his parents fled with him to Egypt, to save him from the fury of Herod, whose suspicions were awakened by the idea of a rival to his throne.[3] An uncertain tradition fixes the spot of the residence of the holy family at Matarea, near the ancient Heliopolis; and one of the apocryphal gospels contains various idle accounts of miracles which marked the presence of a superior being. From such traditions the Jews took occasion to circulate many ridiculous tales of magical arts learned by Jesus while in Egypt, which were frequently referred to by some of the early philosophic opponents of the Christian faith. The malignant insinuations of Celsus, however, and the absurd legends which long found currency among the Jews, are wholly inconsistent with the authentic narrative of the return from Egypt upon the death of Herod, when Jesus might still be said to be in infancy.

Upon their arrival in Palestine, Joseph was led to take up his residence in Nazareth, in Galilee. Here the opening character of Jesus engaged the love and excited the admiration of all who knew him.[4] And, even before his childhood was ended, in his twelfth year, when his parents carried him up to one of the annual Jewish feasts, we find him attracting the notice of the learned Rabbis, entering into discussion with them, and filling them with astonishment at his extraordinary knowledge and sagacity. It would appear that, according to the custom of his countrymen, he followed the trade of his foster-father. In Mark, vi. 3, he is spoken of familiarly as "the carpenter."[5] And Justin Martyr tells us, that while he sojourned on earth, he was employed in the ordinary occupations of a carpenter.[6]

Jesus. In this lowly situation, and in the midst of these servile employments, a character was silently maturing, such as the world had never before witnessed; and those lofty designs were conceived, the accomplishment of which was to give a new impress to the condition of society, and to alter the destiny of our race. Frequent attempts have been made to explain by the operation of natural causes, how, in circumstances so unfavourable, a character like that of our Saviour's could have arisen; and various theories have been framed respecting the manner in which the plan to which he devoted himself was suggested to his mind. The insufficiency of these attempts we shall afterwards consider. In the mean time, however, it may be remarked, that, though no explanation can be given, from circumstances merely external, of the growth of such a mind as that of Jesus, which must be sought only in the seed of the immortal plant itself, it is by no means inconsistent with the highest ideas that can be entertained of the divinity of his nature, to suppose a progression in the development of his humanity. External influences must to a certain extent modify the character of every man. We are told, accordingly, that "he *grew* in *wisdom*" as well as "stature." And the commanding situation and romantic beauty of the city of his dwelling, the instructions of his mother, intercourse with the heathen, which, from the proximity of Nazareth to Galilee of the Gentiles, must have been frequent, may have proved among the subordinate aids for awakening that sense of the loveliness and majesty of external nature to which we find so many references in his discourses, and that susceptibility of every tender emotion which his whole history manifested, and that enlarged philanthropy which looked beyond the distinctions of Jew and Gentile, of sect and class, of rank and station, and considered the whole human race as members of one great family, as children of the same heavenly parent. Such influences, however, are matter of conjecture rather than of positive knowledge; for no reference is made to them by any of the Evangelists. The piety of his mother and of Joseph renders it certain that he would from infancy be made acquainted with the Old Testament Scriptures; and these not only contain the germ of all that is pure and elevating in religious sentiment, but also are, more than any other study, calculated to awaken the curiosity and stimulate the powers of the opening mind. His conversation and discourses everywhere show that he must have made a constant study of the sacred records. It appears that he never attended any rabbinical school, nor did he receive a learned education.[7]

From the time when he appeared disputing with the Jewish doctors in the temple, we have no direct information respecting him till his thirtieth year, when we find him among those who presented themselves to John upon the banks of the Jordan to be baptized. The intervening period was no doubt employed in maturing the plan for the arduous undertaking to which he was prompted by the stirrings of the Divinity within him. The consciousness of his high vocation, however, to a career that was to attract the notice of the world, did not interfere with the pious observance of his filial duties, or the laborious discharge of the common offices of his early situation.[8] The baptism of John served as a consecration to his new office. The heavens were opened, the Holy Spirit

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[1] Schroekh's *Kirchengeschichte*, i, 403,

[2] Tac. *Hist.* v. 13; Suet. *in Vesp.* cap. iv.; Virg. *Poll.*

[3] Matt. ii. 13.

[4] Luke, ii. 52.

[5] Οὗτος ἐστι ὁ τέκτων ὁ υἱὸς Μαρίας. This passage seems to have been tampered with as early as the time of Origen, probably from a wish to do away the prejudice that existed in many minds against the idea of a Saviour in such a state of humiliation. There is another reading, ὁ τοῦ τέκτονος υἱὸς καὶ Μαρίας; but the weight of evidence is decidedly in favour of the former.

[6] Τέκτονικὰ ἔργα ἠργάζετο, ἐν ἀνθρώποις ὢν, ἄροτρα καὶ ζυγα. Tryph. 88. See also Theod. 3, 23; and Soz. 6, 2.

[7] Matt. xiii. 54; John, vii. 15.

[8] Luke, ii. 51; and Just. Mart. *ut sup.*

descended upon him, and a voice was heard from heaven declaring him to be the Son of God, and claiming for him the attention of mankind. Immediately after his initiation, he was impelled to retire into the solitudes of a wilderness, with a view, probably, of meditating on the work before him; and, by fasting and prayer, after the example of former prophets, to prepare himself for his great undertaking. A higher purpose was also accomplished during this retirement, an opportunity being afforded him for proving the purity and sinlessness of his nature, and establishing his fitness for the office upon which he had entered, by baffling the temptations of Satan.

After this mysterious conflict, Jesus returned to Bethabara, a place near to that part of the river Jordan over which the Israelites had passed under Joshua. It was here that disciples first began to gather around him; and few passages in history are more interesting than that[1] which tells of the individuals who first attached themselves to his cause; of their curiosity, their doubts, their conferences with him, the influence he gained over their minds, and their eagerness to communicate to others the wondrous tidings, that they had found the promised Messias in the person of Jesus of Nazareth. The first two individuals who joined themselves to him were disciples of John the Baptist, who pointed out Jesus when walking at a little distance, as the "Lamb of God who taketh away the sins of the world." Upon this they introduced themselves to his notice, and on his invitation accompanied him to the house where he lodged. What took place at this memorable interview, or how a solitary and almost unknown stranger attached to his cause the first two disciples, we are not informed; whether by some token of supernatural knowledge or power, or by the natural influence of a superior mind; the conviction was produced; and with it was imparted the spirit, which was at the foundation of the indefinite extension of the new cause, viz. the desire of imparting their own impressions of the new doctrines to others. One of the two individuals was Andrew, brother of Simon, who afterwards became so eminent in the primitive history of Christianity. "Andrew first findeth his own brother, and saith, we have found the Messias; and *he brought him to Jesus.*" These three were the converts of the first day; and in a short time, without any advantages of birth or station, or human learning, without the aid of powerful relations or influential patrons, he had a considerable number of attached followers, who listened to his teaching, and accompanied him from place to place. At the feast of the Passover, along with the rest of his countrymen, Jesus went up to Jerusalem, where he increased the number of his disciples by his doctrines and miracles. He seems to have continued in the land of Judea about six or seven months; when the success of his preaching, exciting the attention and envy of the Scribes and Pharisees, led him to withdraw into Galilee, where the power of the Jewish Sanhedrim was less to be dreaded. In passing through Samaria, where the political circumstances of the inhabitants freed them from some of the prejudices of the Jews[2] respecting the character of the Messias, he first openly and publicly proclaimed the great truth, that all distinctions of Jews and Gentiles and Samaritans were to be at an end; and that, without reference to time or place, or outward ceremony, the Deity was to be worshipped in purity of spirit, and in faith on the promised Messias.[3] He then visited the whole of Galilee, everywhere accompanying the instruction he gave, in synagogues, or in private houses, or in the open fields, with miraculous proofs of his divine character and commission. In Nazareth he was first subjected to personal violence, his townsmen taking offence at his lowly origin. To avoid their malice, he passed on to Capernaum, which henceforth became the place of his general residence, and from which, as from a centre, he visited the whole surrounding country. The first year of his ministry seems to have been attended with almost universal success. He met with no outward obstruction in his work, except in Nazareth; his approach was everywhere welcomed, and increasing multitudes followed him in his progress.

During the second year of his ministry, his followers became so numerous that he chose twelve persons who might assist him in his work, and be prepared to propagate his religion when he should leave the world. These he named Apostles, an appellation which was appropriated at that time among the Jews to certain public officers who were the ministers of the high priests, and who were occasionally despatched on missions of importance to foreign parts.[4] The number twelve had probably a reference to the twelve tribes, as the seventy whom he afterwards chose might be from the number of the Jewish Sanhedrim. The increasing success of Jesus raised up against him a host of enemies, and from this time he was continually subjected to the cavils of the Sadducees, and still more of the Scribes and Pharisees, whose objections were of such a nature as might be expected from unprincipled and hypocritical men, who witnessed with jealousy any proceeding likely to diminish their influence among the people, and who were inflamed with resentment at the exposure which was made of their true character.

It has already been observed that Galilee was the chief scene of our Saviour's ministerial labours. He did not, however, confine himself wholly to that province, but occasionally visited other parts. We find him at one time on the coasts of Tyre and Sidon; at another beyond Jordan; and at the passover he uniformly went up to Jerusalem. As the Evangelists do not relate events in chronological order, we are without any precise information as to the exact degree of success that from this period attended his labours; it seems probable that his followers continued to increase, and that a deep and general impression was made upon the public mind. His proceedings at last excited the attention of all classes in Judea. Herod Antipas was haunted with the idea that he must be John the Baptist restored to life, and was desirous to have a personal interview with him; and there is not wanting reason to suppose that he received the homage of princes more remote. The eyes of the chief men of Judea were now upon him. The subject of his miracles was discussed in the Sanhedrim, and frequent attempts were made to seize and bring him before the council, though without any settled purpose, perhaps, how they were to proceed against him. At last, after the restoration of Lazarus to life, which led to the conversion of a multitude of the Jews, a meeting of the Pharisaic party was held, when it was finally determined that he should be put to death. The result is well known. In the dead of the night he was surprised in the midst of his secret devotions, hurried before the Sanhedrim, and, after the mockery of a trial, in which even his judge acknowledged his entire innocence, he was adjudged to suffer death. He was then carried to the usual place of execution, on a small hill named Calvary, on the west of Jerusalem, a little without the walls,

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[1] John, i. 29, *ad fin.* [2] See Horsley's *Sermons*, vol. ii. p. 243. See also Neander's *Geschichte der Pflanzung*, u. s. w. i. 72.

[3] Our information as to the first year of our Saviour's ministry is derived almost exclusively from John. The other Evangelists confine themselves to his preaching in Galilee, with the exception of what took place at Jerusalem immediately preceding the crucifixion.

[4] Mosheim *De Rebus Christianis*, &c. i. 6.

Jesus. and there he was crucified. This dreadful scene was accompanied with signs and wonders which proclaimed the dignity of the sufferer. A supernatural darkness overspread the land of Judea, "and behold the veil of the temple was rent in twain, and the earth did quake, and the rocks rent, and the graves were opened." After his death his body was taken down from the cross, and laid in a tomb hewn out of a rock, after the manner of the Jewish sepulchres. Every precaution was used to prevent the removal of the body by the disciples. A great stone was rolled upon the door of the tomb, and a watch of Roman soldiers, consisting of sixty men, was appointed to guard it. This was on our Friday. The following day was the Jewish Sabbath; the stone remained in its place fixed and secure, and the soldiers continued their watch undisturbed. But on the morning of the third day, amidst a display of supernatural agency that mocked the precautions of the Jewish rulers, Jesus arose from the dead. After this he continued some time on earth, affording the most indubitable evidence of his identity, and of the reality of his resurrection from the dead, and instructing his disciples in the nature of the doctrine they were to teach mankind. At last, at the end of forty days, he led forth his disciples to Bethany, and there, while giving them his blessing, "he was parted from them, and carried up into heaven."[1]

The year of our Saviour's death cannot be exactly ascertained. Two extreme points, however, can be mentioned, within which that event must have taken place. The one is the fifteenth year of the reign of Tiberius,[2] in which John the Baptist began his ministry, and the other, the year in which that emperor died, when Pilate had left the province of Judea. As Jesus entered upon his ministry soon after the public appearance of John,[3] it would bring us to a near approximation to the date sought for, could we say how many passovers were celebrated by our Saviour. Even this, however, cannot be determined with certainty. The most probable opinion seems that of those who fix the number at three, and this would bring us to A. U. 783. Irenæus states that Jesus was forty or fifty years of age when he was put to death;[4] but it is generally agreed upon that his opinion was founded, not on authentic records, but to suit a fanciful theory.[5] Most of the Christian fathers assign only a single year to the ministry of Christ, and fix his death in A. U. 782. Their conclusions are drawn from an erroneous view of Isaiah, lxi. 1, and Luke, iv. 19.[6]

We have little authentic information respecting the character or history of Jesus additional to what is contained in the New Testament. The name Chrestus is mentioned by Suetonius; but it has been disputed whether he referred to Jesus.[7] Tacitus alludes to the fact of his death, and speaks of him as the founder of the sect of the Christians.[8] The chief notices of him by the fathers have been embodied in the preceding narrative. There is a passage in Josephus,[9] where his life and character are referred to in the following terms: "At that time lived Jesus, a wise man [if he may be called a man], for he performed many wonderful works. He was a teacher of such men as received the truth with pleasure. He drew over to him many Jews and Gentiles. [This was the Christ.] And when Pilate, at the instigation of the chief men among us, had condemned him to the cross, they who before had conceived an affection for him did not cease to adhere to him [for on the third day he appeared to them alive again, the divine prophets having foretold these and many wonderful things concerning him]. And the sect of the Christians, so called from him, subsists to this time." This remarkable passage is referred to by Eusebius,[10] and its genuineness was never called in question from his time till the sixteenth century, when Gifanius and Osiander refused to receive it. Since that period it has afforded matter for much controversy among the learned. In favour of the genuineness of the passage, it has been argued, that we have the undisputed fact that it is found in all the copies of the works of Josephus from the time of Eusebius. It also exists in a Hebrew translation in the Vatican; and there is an Arabic version preserved by the Maronites of Mount Libanus. In addition to this external evidence, it is urged that the number of Christians in the time of Josephus was too great to admit of the supposition that he should pass them over altogether unnoticed, an improbability which is increased by the fact that he makes mention of John the Baptist,[11] and of the death of "James, the brother of Jesus, called the Christ."[12] On the other hand, it is certain that Josephus was not himself a Christian; and yet the passage, as it stands in his writings, involves the profession of belief in the divine mission of Jesus. It is farther to be remarked, that this testimony in favour of Christ is not quoted by any of the apologists of Christianity who preceded Eusebius; and in particular, Origen,[13] while he refers to the allusion made by Josephus to the death of James, and to his account of John the Baptist, passes over in silence the passage in question, though it would have afforded a more decisive answer had it been contained in the copies of the Jewish historian then in circulation. The arguments on both sides appear plausible, and the difficulties upon either supposition cannot perhaps be removed but by the conjecture, that Josephus did introduce into his work a notice of Jesus, though without admitting him to be the Messias, and that some over-zealous Christian about the time of Eusebius had inserted some additional clauses. This opinion is now generally gone into by the continental critics. Those parts which are usually looked upon as interpolations are marked within brackets in the preceding extract.

It was scarcely possible that the appearance of so remarkable a character as that of our Saviour should not have induced many individuals, from various motives, to commit an account of him to writing. Accordingly, it appears,[14] that from the earliest period many histories of his life were in circulation. The words of St Luke seem to imply that these narratives were defective or erroneous; but there is nothing to prevent us from supposing that some of them might be the productions of men of good intentions, though deficient in the talents or information requisite for so important an undertaking. It was otherwise, however, in succeeding times. After the four gospels had been written by the Evangelists, and had been generally received as of divine authority in the Christian church, heretics and others, who departed from the true faith, had recourse to the expedient of forging gospels, epistles, &c. under the name of some of the apostles, or that of our Lord himself, to which they might refer in support of their tenets. These works were frequently formed out of the genuine gospels, with such additions and omissions as the purposes of the

[1] Luke, xxiv. 51. [2] Luke, iii. 1. [3] John, i. 19, 29, 35; ii. 1.
[4] Iren. ii. 22, 5; John, viii. 57. [5] Pisanski, De errore Irenæi in determinanda ætate Christi, 1778.
[6] Tertul.; Lact. *Instit.*; Aug.; Clem. Alex. i.
[7] In his *Life of Claudius*, c. xxv. Judæos impulsore Chresto assidue tumultuantes Roma expulit.
[8] Auctor nominis ejus Christus, qui Tiberio imperante per procuratorem Pontium Pilatum supplicio affectus erat. (Ann. l. xv. 44.)
[9] *Antiq.* xviii. 3, 3.
[10] *Hist. Eccles.* i. ii.; *Demonstr. Evangel.* iii. 5.
[11] *Antiq.* xviii. 5. [12] *Antiq.* xx. 9, 1. [13] *C. Cels.* [14] Luke, i. 1.

Jesus. writers required. There were not wanting members of the true church who followed the same practice, with the mistaken idea that the piety of the faithful might thus be promoted, or that an answer might be afforded to some of the objections of Jews and Heathens. In the second century, Irenæus[1] tells us that the Gnostics had an innumerable multitude of spurious and apocryphal books; and in the following age they were greatly increased. The greater part of these writings perished in the course of ages. Of such of them as remained, a collection was published by Fabricius, about the beginning of last century, in his *Codex Apocryphus Novi Testamenti*. A full account of them is given, with translations, in Jones' well-known work on the Canon. Several of them were republished in London some years ago, in a work entitled *The Apocryphal New Testament*.

That these works are not to be received as genuine, may be proved by their vast inferiority to the canonical gospels, and still more decidedly by the fact, that they were not recognised by the Fathers. In *The Gospel of our Saviour's Infancy*, there are some passages which are referred to by Eusebius, Athanasius, and Chrysostom, as containing some trifling particulars of true history connected with the life of Christ, but it is not ranked by them among the inspired writings. It is worthy of remark, that it was from this production, and from *The Gospel of the Birth of Mary*, and the *Protevangelion of St James*, that Mohammed derived all his knowledge of our Saviour's life. Indeed he does not seem to have been at all acquainted with the canonical gospels; and the legends of the East in general concerning our Lord are all from apocryphal sources.[2]

There is an account in Eusebius,[3] of a message having been sent by Agbarus, king of Edessa, who had heard of the miracles of Jesus, and who requested him to come and cure him of a malady with which he was afflicted. It is added, that our Saviour wrote to him a letter, in which he promised to send one of his disciples to heal him. A translation of this correspondence from the Syriac original, contained in the archives of the church of Edessa, is given by Eusebius. Additions were afterwards made to the story,—as that Thaddeus, one of the seventy, was deputed by Thomas, after the resurrection, to fulfil the promise of the Saviour; and Evagrius[4] mentions, that our Lord not only wrote a letter, but that he sent a handkerchief also, with his picture drawn upon it. There can be no doubt that the letters mentioned by Eusebius actually existed among the records of Edessa, and that they were seen by that historian. But, in addition to the external evidence from the letters themselves, the fact that they are taken notice of by no preceding Christian writer affords demonstration that they are forgeries, which owe their existence probably to the national vanity of some of the early Christians of Edessa. We are not informed that our Saviour ever committed anything to writing, and we may be assured that if he had, it would not have passed unnoticed by his first followers.

There is another statement contained in Eusebius, deserving of more attention. He mentions that Pontius Pilate, after the crucifixion of our Lord, wrote such an account of his character and miracles to the Emperor Tiberius, as induced that prince to propose to the senate that a place should be assigned to Jesus among the deities worshipped by the Romans, but that the senate opposed the wishes of the emperor. It was certainly the custom of the governors of provinces to write memoirs of the remarkable occurrences of the places where they presided; and there is nothing improbable in the idea that Pilate, who was convinced of the innocence of Christ, should send an account of him to Tiberius. It is certain also that Justin Martyr,[5] in his Apology for the Christians, presented to the Emperor Antoninus Pius, refers to the acts of Pilate, as containing an account of the circumstances connected with the crucifixion; and Tertullian,[6] towards the end of the century, appeals to the same records. Still, however, we conceive that the evidence for the existence of these acts is defective; and the proposal alluded to by Tiberius to the Roman senate, though mentioned by Tertullian, and repeated by writers who succeeded him, is irreconcilable with the character of Tiberius, and the state of the Roman empire at that period. At a later period, a spurious work, entitled *The Acts of Pilate*,[7] was circulated by the Jews, containing many slanders against Jesus; and it appears that acts of a contrary nature were fabricated by certain Christians, to do away the impression.[8]

From the time that the Jews returned from the Babylonian captivity, a belief in magic formed a borrowed part of the national character; and at an early period the natural expedient was resorted to by the enemies of Jesus, of disparaging his character, by representing him as a magician. It was believed among them that there was a mystic word which enabled those who had learned it to direct at will the current of events; and a foolish story was circulated as early as the second century,[9] respecting the means by which Jesus discovered and remembered this potent sign. Upon this fable a life of Jesus was ultimately constructed, entitled *Toldoth Jeschu*. The substance of this abominable fabrication is, that Jesus was born in adultery, the particulars of which are detailed with revolting minuteness; that he contrived to steal the sacred word, by pronouncing which he performed miracles at will, healed the sick, opened the eyes of the blind, raised the dead; by means of such works he gained over many converts, and would have been still more successful had not another Jew disabused the minds of his countrymen by learning the same word, and disclosing to the people how the same miracles could be performed. The work terminates with an account of the death of Jesus, and of his body being stolen away by his disciples. It was published, with a Latin translation and learned notes, by Wagenseil, in his *Tela Ignea Satanæ, h. e. Arcani et horribiles Judæorum adversus Christum Deum et Christianum religionem libri* ANEKΔOTOI, 1681. It can scarcely be believed that the more learned among the Jews gave credit to its mendacious absurdities; though they long encouraged its circulation, to inspire their brethren with a deeper contempt for Christianity and its followers.

The determination of the questions relative to the person and character and history of Jesus involves all the essential particulars connected with the *evidences* and *doctrines* of the Christian faith. But in an article like the present, we cannot enter fully upon the consideration of any of these important subjects. We shall merely offer a few remarks upon such particulars as depend upon elements of a historical nature, leaving the discussion of matters of doctrine for other departments of this work.

The existence of such a person as Jesus Christ has scarcely ever been seriously denied; and the general tenor of the narrative of the Evangelists, with the omission of the miraculous parts, has been received as substantially correct by many who refuse to acknowledge the truth of our religion. The evidences for the genuineness and authenticity of the four Gospels will be stated under the proper

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[1] C. i. c. 17. [2] Jones, vol. i. [3] *Hist. Eccles.* i. 13. [4] Evag. iv. 26. [5] *Apol.* i. [6] Tertul. *Apolog.* c. v. 21.
[7] This was during the persecution of Maximin. Euseb. *Hist. Eccles.* ix. 5.
[8] *Epiphan. Hær.* l. i. [9] Orig. *Contr. Cels.*

Jesus. heads, from which it will appear that no history whatever is supported by stronger external proof; and that were it not from internal grounds as to the nature of the facts recorded, and the consequences which flow from them, the truth of the narrative would never have been called in question. Even the miracles were admitted by the earliest opponents of Christianity, Celsus, Philostratus, and Hierocles. These individuals did not deny the reality of the works performed by Jesus; they only, upon internal evidence, objected to the idea that a person in circumstances so lowly should be supposed to be divine, or explained away the supernatural appearances by the supposition of the exercise of magical arts,[1] or maintained that the few miracles which were performed did not warrant the idea of a divine character.[2]

Different ground has been taken up by infidels in modern times, who, while they have been constrained to admit the truth of the general statements of the Evangelists, have rejected altogether the supernatural machinery. In setting aside the miraculous part of the gospel history, the chief difficulty has been found in giving a consistent view of the character of Jesus. If the miracles performed by Christ were not real, the conclusion seems irresistible that he must have been either a deliberate impostor, or a self-deceived enthusiast. By some writers, accordingly, Jesus has been held up to ridicule and contempt, as exhibiting many weaknesses, and even vices—as a pretended miracle-worker and false prophet. Several of the deistical writers of our own country took up this position, and were followed by Voltaire and other French authors. The anti-Christian views of Voltaire were adopted by Frederick the Great,[3] whose example and encouragement gave rise to the spirit which has unfortunately led so many of the theologians of Germany to exclude from Christianity every trace of supernatural agency.

The notices of the English deists of the last century, respecting the miracles and character of Jesus, in many instances at least, were little more than incidental, and formed merely a part of their general argument against the truth of our religion. In Germany the work has been more systematically pursued. With the characteristic industry of that learned people, the writings of the Evangelists have been considered in every possible form. Different theories have been framed as to the secret views of Jesus, as to the real causes of his success, and as to the true character of the alleged miracles which were performed. Voltaire, after our English authors, had endeavoured to account for the exalted morality taught by Jesus, by supposing that it was borrowed from the self-denying tenets of the sect of the Essenes.[4] The idea was followed out by various German authors; while the lofty theology of the Alexandrian Platonists, and the liberal spirit of Sadduceism, were referred to by others as sufficient to originate in an enthusiastic mind the system taught by Jesus. Some, like Edelmann, while they have not disputed that a virtuous Jew named Jesus actually existed, have refused to acknowledge the genuineness and authenticity of the Gospels. Reimarus, in a posthumous tract[5] on the object of Jesus and his disciples, while he acknowledges the excellence of the morals, and even of the doctrines, of the Gospel, accuses Jesus of not observing the rules which he prescribed, and of making use of his system as a means for promoting his political views; and while he does justice to many of the high qualities of Jesus, he represents him, upon the whole, as actuated by ambition, and as aiming at the establishment of his own power under the character of the triumphant conqueror to whom the Jews looked forward in their promised Messias. His arguments are chiefly founded upon the acknowledged ideas of the Jewish people respecting the Messias, upon the caution exhibited by Jesus in arrogating that character, and upon his entering Jerusalem in royal state, when he conceived that his cause was sufficiently advanced to insure his success; while the grief he exhibited in the garden of Gethsemane, and his exclamation on the cross, "My God, my God, why hast thou forsaken me?" are considered as tokens of his disappointed hopes. This view has been taken by other writers, with various minor modifications, and with different degrees of learning and presumption. Others have represented Jesus as the dupe of his own imagination,—as one who, by the dreams of a fond mother, and the workings of an unrestrained fancy, was led to believe himself to be the Messias; and who, partly by his superior knowledge of the occult qualities of matter, and partly by the sympathetic influence of a highly-wrought enthusiasm, favoured occasionally by accidental circumstances, performed many works that seemed to exceed the limits of natural causes, which were afterwards exaggerated into real miracles. Another class of the neologian school describe Christ as a pure and exalted character, who was animated with the desire of raising the condition of his degraded countrymen, and of promoting the general interests of humanity; and who, in the lowly situation in which he was placed, found no other means of accomplishing this end but by personating the character of the Jewish Messias. As the Jews expected miracles to be performed by their long-looked-for Saviour, Jesus accommodated himself to their views in this respect. According to this class of writers, he is supposed sometimes to have availed himself of fortunate contingencies, representing the restoration from a faint as a resurrection from the dead, as in the case of the daughter of Jairus, and of Lazarus, and sometimes to have succeeded, perhaps beyond his own expectations, by the aids of animal magnetism.[6] His appearance to his disciples after his burial has Jesus.

[1] Celsus.

[2] Hierocles.

[3] Frederick, while he treated with contempt the doctrines of the Gospel, acknowledged the excellence of its morality, which he considered (it is unnecessary to remark how erroneously) as essentially the same with that of the Stoics.

[4] *Dict. Phil.* art. *Essenes*. The untenableness of the theory had long before been well exposed by Prideaux, *Connections*, vol. ii. p. 284.

[5] This tract was published in 1788, by the celebrated Lessing, among his "Wolfenbüttel Fragments by an anonymous person." It is entitled *Fragment von dem Zwecke Jesu und seiner junger*. It is now universally ascribed to Reimarus, well known as an able critic, and the author of a work on natural religion. He was born at Hamburg in 1694, and died in 1765. He published nothing respecting his views as to the subject of revealed religion during his life, but he left various manuscripts of an anti-christian character, some of which falling into the hands of Lessing, who at that time had the superintendence of the ducal library at Wolfenbüttel, were published by him in the *Beiträge zur Geschichte und Literatur, aus den Schätzen der Hezoglichen Bibliothek zu Wolfenbüttel*. They excited great attention; and, more perhaps than any other work, led to the neologian spirit that has since so much prevailed in Germany. Various answers were called forth. Of these, one of the ablest was that by Reinhard, a celebrated German preacher, in a work entitled *Versuch über den Plan den der Stifter der Christ. religion zum besten der Menschen entwarf*. The main object of the author is to show that the mere plan for effecting the happiness of the species—a plan which he purposed to carry into effect, not by violence or force of arms (in opposition to the theory of Reimarus), nor by the influence of a secret society (in opposition to the wild imagination of Bahrdt), but by means of moral suasion alone,—a plan which no great man of antiquity had ever conceived, and which entered into no other religious system—proves Jesus to have been a messenger sent by God. This work by Reinhard is one of the most valuable contributions to the evidences of the truth of Christianity. It has been translated into French; and a translation of it into English has been published in America.

[6] A list of the writers who hold these opinions is given in Winer's *Biblisches Realwörterbuch*.

Jesus. been also explained away, as if it had been the result of natural causes; it being argued that the suspension from the cross for a few hours was insufficient to occasion death, though in a worn-out frame it might occasion a temporary swoon, from which he might be restored by the myrrh and aloes and odoriferous substances which his disciples brought to embalm him.[1]

In regard to the theory which is founded on the idea that Jesus was actuated by selfish or worldly or ambitious motives, it may safely be affirmed that it is altogether inconsistent with the facts connected with every part of his history. The whole tenor of his proceedings showed that his views were above this world. He used none of the arts necessary for gaining a party among his countrymen. He did not flatter one sect at the expense of another. He neither courted the favour of his countrymen, by inflaming their prejudices against the Romans, on the one hand; nor did he, on the other hand, artfully conciliate the favour of the Romans to be employed as a means towards attaining the sovereignty of Judea. He openly denounced the vices of the reigning sects; and though his benevolence led him to such a course of conduct as could not but excite the admiration of many among the lower orders, he made no attempt to render his popularity subservient to his personal interests; he shunned the demonstrations of popular favour, and unsparingly exposed the unworthy motives that led many to pay court to him. Not a single instance can be mentioned in which he had recourse to any means for establishing a temporal authority. His whole conduct showed that he was animated with more exalted aims. From the commencement of his ministry he asserted his divine commission, and spoke with undoubting confidence of the success of his cause. But the success of which he spoke was not in schemes of worldly greatness, but in the diffusion of truth and righteousness. He availed himself of every suitable opportunity for correcting the erroneous impressions that were entertained respecting the character of the Messias. And so far was he from entertaining views of personal aggrandisement in the character he assumed, that from the very first he intimated that the good he was to render to mankind was to be procured by laying down his life for them. And the tenor of the evangelical history proves, that in proportion to the increasing clearness with which he communicated to his chosen followers the information as to his divine character, was the expressness of his declaration that his death was at hand.

There is only a single instance that can be adduced in which there was any appearance on the part of Jesus, of the assumption of temporal authority, viz. in the case of his last entrance into Jerusalem. This has been represented by Reimarus as an unsuccessful attempt made by him, counting upon the support of the populace, to take possession of the temple and of the city. But such a view is inconsistent, not only with the proceedings of Jesus upon former occasions, but also with his conduct in Jerusalem at that very period. There was no concert between the people and Jesus or his apostles. The city of Jerusalem was filled with strangers from all parts, who had come up to attend the passover; the report of the resurrection of Lazarus had been widely circulated; when Jesus approached, curiosity assembled multitudes to behold him, and, in the enthusiasm of the moment, they rendered homage to him as a king. But Jesus did not avail himself Jesus. of the feeling that was excited. He addressed to the multitude nothing calculated to rouse their passions. The jealousy of the Roman governor, sufficiently awake to the danger of an insurrection,[2] took no alarm at the approach of the procession to the temple, and Pilate made no allusion to it when Jesus was brought before his tribunal. The same day that Jesus entered into the temple he voluntarily left it for Bethany, though it is obvious, that if he had entertained the views ascribed to him, he would have availed himself of the advantages it presented to him, as the citadel that commanded the whole of Jerusalem.[3] After this he openly returned to the temple on the following days; he made no appeal to the passions of the people, but continued to address to the chief priests such denunciations as could not fail to rouse those vengeful feelings of which he had foretold that he was to be the unresisting victim.

The attempt to prove that Jesus was merely an ambitious adventurer is now generally abandoned. But many, while they admit the excellence of the personal character of Christ, endeavour to account for the supernatural parts of the gospel history on what is called the principle of accommodation, supposing that Jesus suited his proceedings to the expectations of the Jews respecting the miraculous power of their Messias. But to act upon such a principle is surely inconsistent with the simplicity and integrity of a spotless character. It is admitted by the defenders of the hypothesis referred to, that we have in Jesus Christ a character which stands single and alone in the history of mankind, free from any defect, and combining every species of excellence. We have this same Jesus, without advantage of education or outward condition, introducing a system of religion and morals such as the world had never witnessed; the only system of positive religion that does not bear on its face evidence of its falseness; a system to which the most enlightened men in every age since its first propagation have yielded their homage; and a system of morals so pure in its nature, and so comprehensive in its requirements, that while the most extraordinary progress has been made in every other subject, it might easily be proved that all that ethical inquirers have attempted is an analysis of the principles of our nature, on which the rules of the New Testament are founded, or an application of these rules to the circumstances of mankind in new conditions of society. If such a system had been originated by an individual who made no claim to supernatural assistance, we would have been presented with a moral phenomenon altogether inexplicable. But this is not the state in which we find the question. Jesus declares that he received from God all that he reveals to man. Had he offered no proof of this assertion, his moral qualities, even supposing him to have been in error, might have remained unimpeached, and he might have moved our compassionate respect, as the self-deceived enthusiast of virtue or religion. But our Saviour not only demands credence on his own authority; he makes an appeal[4] to the miracles which he wrought, in proof of his divine mission. Now, the miracles which our Saviour refers to are of such a nature, that either they must have been performed or he must have lent himself to a deceit. There is no other alternative. He could not but know whether they were actually wrought, or whether they

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[1] See, in particular, the *Leben Jesu* by Dr Paulus of Heidelberg, who conceives that his opinion is strengthened by an attempt to prove (which he has endeavoured to do in a separate tract upon the subject) that only the hands of Jesus were nailed to the cross, his feet being merely bound to it by a strong cord. But even supposing this to have been the case, which we consider as by no means established, the evidence of actual dissolution is decisive. We have in the first place the testimony of the Evangelists, then the proceedings of the soldiers in general (John, xix. 33), and then the wound inflicted by one of them with a spear, which, from the account given of it, must have entered the heart itself (v. 34.)

[2] In proof of this, see Joseph. *Antiq.* xviii. 3, 2.

[3] Michaelis.

[4] John, xiv. 11.

Jesus. were only seeming and illusory And if the miracles were not truly performed, then we have the individual whose moral character stands in all other respects higher than that of any other of the children of men, and who was made the instrument of conferring the greatest boon that ever was made to mankind,—we have that individual guilty of an artful and criminal imposture.

In regard to the theory that the apostles filled up the picture of the character of Jesus from what they read in the Old Testament Scriptures respecting the Messias, it may be remarked, that the conception of such a character in such circumstances is a phenomenon as inexplicable upon ordinary principles as the actual existence of the prototype. And that four different writers, or that even two different writers, without having a common subject, should have given so many points of resemblance of such an extraordinary nature, and in so many varied circumstances, is altogether incredible.

Among those who admit the divine commission of Jesus, different opinions have been entertained as to the rank he holds in the scale of being. The general doctrine of the Christian church, as expressed in ancient creeds and in the confessions of reformed churches, is, that Christ exhibited in his person a union of the divine and human nature; that the second person in the Trinity was united to the man Jesus, who was God and man in one person. To avoid the difficulties which have been supposed to be involved in this mysterious doctrine, it has been maintained by some that the Son is not equal with the Father, and did not exist from eternity, but that the first created being, the highest angelic nature, was made flesh and dwelt on earth. The essence of this theory is, that the Son of God was a *creature*, but that he existed in a separate state previously to his manifestation in the form of man. It is variously modified according to the higher or lower character that is given to the Son of God; and is distinguished by the name of *Arianism*, from the individual who in the early part of the fourth century first brought the question into general discussion. According to a third class, Jesus Christ was a mere man, distinguished from other men only by being employed by God in making a revelation of his will to mankind, and superior in no respect to the prophets who appeared among the Jewish people, except in superior virtue, and in a more enlarged measure of divine countenance and assistance. This view, in its essential features, was embraced by the Ebionites, and also by Artemon and others during the second and third centuries; by Socinus in the sixteenth century, from whose name those who adopt this opinion are frequently named *Socinians*, though they assume to themselves the name of *Unitarians*; a title which is sometimes conceded by Trinitarians for the sake of distinction, though they equally hold the doctrine of the unity of the Deity. In America the name Unitarian is applied to all those who reject the doctrine of the Trinity. The differences of opinion respecting the person of Christ are connected with different views as to the object and nature of his commission. Trinitarians consider him as not only teaching a purer system of morality than the world had before known, but also as making an atonement for human guilt by his death; while Socinians and many Arians deny the doctrine of the atonement, and look upon Jesus merely as a teacher of religion and virtue.

The character of Christ, as exhibited in the Gospels, presents to us the only example, anywhere to be found, of the perfection of humanity; and the contemplation of it has ever been considered by his followers as one of the most edifying and delightful exercises of piety.[1] A constant regard to the will of God, and a delight in doing it, form the distinguishing features of his character. With this was connected the absence of all sordid, or selfish, or ambitious aims, and an enlarged and enlightened philanthropy. There is perhaps nothing more remarkable in the life of Jesus than the apparently inconsistent qualities which are blended together in one harmonious whole. We see in him the most unbending constancy united with great tenderness of feeling—hatred of sin, and compassion for the offender—a heart superior to all the allurements of pleasure, with a condescending indulgence for the innocent relaxations of life—a mind of universal philanthropy, alive to all the domestic charities—views that extended to the whole human race, and a generous compliance with national and individual peculiarities. It is difficult to conceive that the portraiture presented to us in the sacred history can be contemplated without benefit; but the chief benefit will be lost if it is forgotten that he whose life was the model of every virtue laid down that life for the sins of the world. Jesus.

Those who hold the highest ideas of the divinity of Christ, admit to the fullest extent that he was also man; and the curiosity is not unnatural as to the personal appearance assumed by the Son of God. Upon this subject no direct information is given in the New Testament. From incidental notices, it has been conjectured that he was of a robust frame, and that there was nothing particularly marked in his appearance;[2] but it may be doubted how far the passages referred to bear out these conclusions. There is better evidence that the mixture of divine benignity and commanding authority which he everywhere displayed in his character, were conspicuous also in his voice and aspect.[3]

The most judicious of the fathers agree that nothing was known of the personal appearance of Christ, though inquiry upon the subject was not prohibited. During the first ages of Christianity, the church, under persecution, required a model of patient endurance; and the general opinion of the fathers[4] during that time seems to have been, that the personal appearance of Christ corresponded literally with the description in Isaiah, liii. 2, 3. There was at the same time a prohibition, founded on the second commandment, against attempting to frame any pictorial likeness of the Son of God. We read, however, of pictures of Christ in the hands of one of the Gnostic sects.[5] Alexander Severus had his bust in the chamber set apart for his devotional exercises;[6] and Eusebius relates, that many among the heathens had pictures of Christ and of his apostles, which he himself had seen.[7] At a somewhat later period, when paintings began to be admitted into churches, the attempt to present a likeness of Christ was no longer considered as unlawful; and full scope being given to the imagination of the artist, attempts were made to embody the purity, and elevation, and loveliness of the Saviour's character, in lineaments of extraordinary beauty. Certain theologians justified the attempt by explaining the description in Psalm xlv. as literally applicable to Jesus. There is a minute description of the personal appearance of Christ by the Greek ecclesiastical historian Nicephorus, who flourished about the year 1330; and another in a letter purporting to be addressed by Publius Lentulus, governor of Judea, to the Roman senate. Both of these,

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[1] A catalogue of some of the most important treatises upon this subject in English is given by Bishop Newcombe, in the preface to his work on our Lord's conduct and character.

[2] John, xx. 15, and xxi. 4. John, xviii. 6; Matt. vii. 29; John, vii. 46, &c.

[3] Tertull. *De Carne Christi*, 9; *adv. Jud.* 14; Clem. Alex. *Paed.* iii. 1; Orig. *Contr. Cels.* li.

[4] Iren. i. 25. [5] Lamprid. c. 29. [6] L. vii. c. 18.

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however, are altogether without value. As the *prosopographia* in the pretended letter of Publius is from time to time brought before the public in various forms, without any hint as to its real origin, it may be proper to state, that there is most decisive evidence of its being a mere fabrication. No trace of it is to be found before the fourteenth century. No such person as Publius Lentulus was ever governor of Judea. From the style, it is probable that it was written by some monk in the middle ages.[1]

In regard to pictures which tradition has represented as having been made while our Saviour was on earth, in addition to that already mentioned as having been sent to the king of Edessa, there was another supposed to have been imprinted upon a handkerchief belonging to Veronica. The legend is, that when Christ was led to crucifixion, Veronica, who followed him, put a handkerchief to his face, on which Christ impressed his likeness. This holy relic is still exhibited at Rome on certain festivals.[2] Eusebius speaks of a statue of Christ erected by the woman who was cured of the issue of blood, and mentions that he saw it himself at Cæsarea Philippi.[3] Julian the Apostate is said[4] to have taken it down, and erected his own statue in its place. From the representations on some ancient coins, it has been conjectured that the pillar referred to was originally erected in honour of Hadrian.[5] In the Romish church it is believed that there existed a picture of Christ by St Luke, and that there was an image of him cut out by Nicodemus in cedar wood; but these traditions are without support from antiquity, and inconsistent with many passages in the writings of the fathers. A general resemblance is to be observed in all the pictures of the Saviour; but though this has probably arisen from admiration of one traditional model, there is no evidence whatever of its genuineness. After all our inquiries, while we are warranted in supposing that the benignant majesty which distinguished his character beamed forth in his countenance, yet, in regard to any thing more definite, we must rest in the conclusion of St Austin, "qua fuerit ille facie penitus ignoramus."[6]

Jewel.

(D. W.)

JESUS, THE SON OF SIRACH. (See ECCLESIASTICUS.)

JEWEL, JOHN, Bishop of Salisbury, and one of the fathers of the Protestant Church in England, was born May 24, 1522, at Buden, in the parish of Berry Narber in Devonshire. After attending various schools in that county, he was entered of Merton College, Oxford, in 1535, and passed under the care of John Parkhurst, afterwards Bishop of Norwich. After graduating as B.A. when only eighteen years of age, he began to teach, and soon became one of the most noted tutors in the university. At this time the Reformation was beginning to make head in England, but under the tyranny of Henry VIII. it was almost as dangerous for any one to vindicate as to oppose it. Jewel, a Protestant at heart, contented himself with inculcating the principles of the Reformation in his private lectures. On the accession of Edward VI. he openly declared himself a zealous Protestant; and when the famous Italian reformer Peter Martyr settled at Oxford as professor of theology, and began to hold public disputations there after the fashion of that age, Jewel became his secretary and intimate friend. The premature death of Edward, and the accession of his sister Mary to the throne, threw the chief power into the hands of the Roman Catholics for the last time in the history of England. So prominent a reformer as Jewel could not but be marked out for vengeance. Expelled from his college, he began to teach in the town, and his popularity with his scholars remained undiminished. Severer measures were then adopted; and the alternative was laid before him of submission or death. He hesitated, and yielded a little. At length a prey to keen remorse, and with little hope of security in compliance, he sought safety in flight. With difficulty he found his way to Frankfort, where he made a public confession of sorrow for his weakness in temporizing with Popery. On the invitation of Peter Martyr he removed to Strasburg, where he lived for a while and assisted his friend in the composition of some of his works. With the death of Queen Mary the sun began again to shine on the persecuted Reformers. Jewel returned to England, and in a short time was appointed to the see of Salisbury. The remainder of his life was spent in strengthening the outworks of English Protestantism, and in expounding the doctrinal system on which it is based. By tongue and pen he did his best to eradicate whatever relics of Popery continued to haunt his diocese. There was no effort of mind or body which he was not ready to make in furtherance of that aim. The zeal and unwearied apostolic self-devotion with which he wrought in the good cause at length destroyed his health, and cut short his noble career. In the course of one of his tours through his diocese, he died at the village of Monkton Farleigh, September 22, 1571, in his fiftieth year.

Jewel, though a keen partizan, was allowed by the men of every party in his own day to have possessed every virtue under heaven. His learning was as much beyond dispute as his virtue, and the imprint of both is stamped on every page of his voluminous works. By far his greatest achievement is his *Apology for the Church of England*, which was written in Latin, and published in London in 1562. This work, which is one of the ablest defences of English Protestantism, was attacked by a great many Popish writers. The *Defences*, in which its author replied to these attacks, added greatly to the value of the work, and gave it such a pre-eminence that by the orders of Elizabeth and James copies of it were chained in every parish church of England and Wales for the general behoof of the people. In many remote parishes these volumes were still to be seen since the beginning of the present century.

With the exception of some of his sermons, Jewel's writings are nearly all controversial. More fortunate than most works of their class, they are still highly valued for their views on the points at issue between the churches of Rome and England, as also on many of the special doctrines of the English Church itself. A complete list of his works is given in Wood's *Athen. Oxon*, and in the *Biogr. Britt.* The most detailed life of him is that by Dr Lawrence Humphrey, his successor in the diocese of Salisbury.

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[1] There are several manuscripts of this epistle, none of them, however, older than the fourteenth century. One of these was brought forward about the beginning of the century as newly discovered in the library of the Vatican, and treated as a matter of much importance. The subject was taken up in a work entitled "In αὐθεντια Epistolæ Publii Lentuli ad Senatum Romanum de Jesu Christ. scriptæ denuo inquirit J. P. Gabler," 1819, in which the whole question is fully discussed. An exposure of the fabrication is also to be found in the *American Biblical Repository*, vol. ii., p. 367.

[2] Boland, ad d. 4 Feb.

[3] *Hist. Eccles.* vii., 18.

[4] Soz. v., 21; Philostorg. vii., 3.

[5] Gieseler's *Kirchengeschichte*, i., p. 79.

[6] *De Trin.*, 4, 5.

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THE character and fate of this singular people, in their relation to the Christian faith, belong to other departments of this work. In the present article we shall confine ourselves to a brief outline of the leading events in their annals, as a part of general history. They derive their origin from Abraham, a native of Chaldea, who flourished about 2000 years before the Christian era. At that period the whole world was sunk in idolatry, and Abraham was chosen by the Almighty, that by him and his posterity the knowledge of the essential principles of true religion might be preserved on the earth, and the way prepared for the revelation of a more comprehensive system to mankind. Under the divine direction, Abraham, at an early period of his life, withdrew from his country and kindred, and from the infectious influence of their superstitions; taking up his abode in the country now known by the name of Palestine, a small stripe of land along the Mediterranean, naturally sterile and rugged, but capable of extraordinary fertility through attentive culture, and commanding advantages, by its local situation, for securing an easy intercourse with the whole habitable world. In the days of Abraham, part of it was altogether unoccupied, and the rest was inhabited by different small tribes of the Canaanites, who seem to have migrated from Arabia. Among these, Abraham lived as an Emir or chief of a nomadic tribe, moving from place to place, as the increase of his flocks and the condition of his dependents required. A similar course of life was pursued by his immediate descendants, who, amidst their increasing numbers and enlarged possessions, did not depart from the habits of pastoral simplicity; so that during the period of 215 years, from the time of the arrival of Abraham till the departure of Jacob into Egypt, little progress seems to have been made in the arts of civilized life. The migration referred to, of all the descendants of Abraham, was occasioned by the well-known promotion of Joseph in the court of the king of Egypt. The Egyptians at this period were living under a regular form of government, and had made considerable advances in the arts and sciences. Policy as well as habit led them to look upon the nomadic life with an unfavourable eye; and from this circumstance, as well as from the hereditary character of offices among the Egyptians, the two races were kept entirely distinct. A separate district of the country was assigned to the Israelites, where they retained to a considerable extent the character of a pastoral tribe; the Egyptian deserts, and the neighbouring country of Arabia Petræa, affording ample opportunities for indulging in their primitive customs. The ordinary influence, however, of a more civilized and powerful people upon their dependents or allies, by degrees became perceptible; and we find the Israelites beginning to practise some of the arts of the Egyptians, and falling gradually into their idolatry. Gratitude or contempt secured the descendants of Jacob from the jealousy that their increasing numbers was calculated to awaken, till the founder of a new dynasty perceived the full extent of the danger to which his usurped dominion was exposed, and, regardless of national obligations, formed a plan for the extermination of the dangerous visitors. The rigour with which his savage plan was carried into execution, led to events by which it was frustrated, and proved the occasion of the establishment of the Israelites as a separate and independent people. Under the visible interposition of the Most High, Moses, who had been marvellously preserved from becoming the victim of the royal mandate, gave a new aspect to the destinies of the race. He led forth his countrymen from the house of their bondage, delivering to them a body of laws and institutions, which not only gave an indelible stamp to the Jewish character, but exerted an influence that continues to be experienced throughout the Christian and Mahommedan world. Like other lawgivers, he appointed religious ceremonies to be mingled with political institutions, but with this remarkable difference, that while under other systems religion is used as a means for civil security, the institutions of political society were employed by Moses to give permanency to the doctrines and practices of a pure theology.

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The plan which had been entered upon by Moses for the introduction of the descendants of Abraham into the land promised to their progenitor, was carried into effect by Joshua, who succeeded to Moses; and who proceeded against the tribes which now inhabited that country, with a severity that can be condemned only by those who forget or deny the authority under which he acted, or the atrocious wickedness which warranted or called for the extremest manifestations of the divine displeasure. The command for the total destruction of the Canaanites, however, was only partially executed; and many of the evils which afterwards befell the Jewish people arose from the example of the families which had been spared with an ill-judged and presumptuous clemency. Many of the tribes also seem to have saved themselves by a timely flight, which it does not appear that the Israelites were called upon to interfere with. Procopius mentions that the peopling of Northern Africa by the Phœnicians took place in consequence of the flight of that people before the victorious Joshua.

Possession being taken of the land of Canaan, it was parcelled out among the twelve Israelitish tribes, which were to a certain extent independent of each other, though, descended from the same stock, and worshipping at the same shrine, and united by certain general interests, they formed but one nation. Their government was strictly theocratical, without, however, excluding the ordinary forms of earthly rule. During the life of Joshua, the supreme power was exercised by that individual, as it had been by Moses, under the sanction of divine appointment, with the assistance of certain ordinary magistrates. From the death of Joshua, during a period of 450 years, in the absence of a regular succession of recognised rulers, the civil constitution of the confederated tribes was fluctuating and uncertain. Their common origin and religion, the chief bonds of their union, often proved too feeble to withstand the influence of local interests and jealousies. Single tribes followed their own views, to the neglect of the common wishes or the common weal; leagues formed between two or more tribes for special purposes awakened the suspicions of their neighbours; these circumstances were aggravated by hereditary rivalries; and the government was preserved from dismemberment only by the rulers or Judges whom Providence upon great emergencies raised up to undertake the cause of the people, defending them from their enemies, or preserving them from intestine commotions.

At last the people, impatient of the uncertain government which seemed to be exerted over them, resolved upon the establishment of a monarchy, which might unite all in one peaceful kingdom. A member of the tribe of Benjamin, named Saul, was raised by common suffrage to the sovereignty, and held the sway over all the tribes of Israel about forty years. His reign was far from being either prosperous or happy; and though his bravery preserved the Israelites from external adversaries, he was deficient in that political sagacity which was necessary to consolidate the principles of the new monarchy. Upon his death, the tribes of Ju-

Jews. dah and Benjamin refused to acknowledge the authority of his son, and elected as his successor a youth named David, who had been marked out by the prophet Samuel as destined to kingly honours, and whose adventurous exploits, generous enthusiasm, and princely bearing, had endeared him to his tribe. His prudence proved equal to his valour and his piety; and in a short time he succeeded in uniting all the tribes in one kingdom, fixing his capital at Jerusalem. He was succeeded by his son Solomon, under whose reign the kingdom of Israel was carried to its highest degree of prosperity. The descendants of Abraham now formed the principal monarchy in Western Asia. From the Mediterranean Sea to the Euphrates, from the river of Egypt to Berytus, and towards the east to the Hagarenes on the Persian Gulf, all were subject to the sway of Solomon, under whose wise and peaceful rule trade flourished, commerce was extended, and the arts and sciences found patronage and protection. It often happens, that when a prince like David has settled a kingdom on solid foundations, his son is induced to indulge a taste for luxurious magnificence; and to this, as well as to his sense of religion, some have ascribed the building of the temple, the great event of his reign.

Upon the death of Solomon, the kingdom fell asunder under the feeble and impolitic sway of his son and successor Rehoboam. The causes of disunion lay deep in the character and situation of the different tribes; and, though counteracted for a time, they were ever ready to operate when occasion was afforded. The jealousy that subsisted between the twelve sons of Jacob seems to have been inherited by their descendants; but it was only among the more powerful tribes that such jealousies could lead to a dismemberment of the commonwealth. From the beginning a rivalry may be observed between the tribes of Joseph and Judah. The former inherited a double portion in the allotments to Ephraim and Manasseh, the two sons of Joseph; and their founder had been distinguished from his brethren by the blessings pronounced upon him. The tribe of Judah had the right of primogeniture, and the promised Messias was to spring from them. In this way the two tribes regarded each other with ill-concealed sentiments of hostility; and Shechem and Jerusalem, their respective capitals, were each the focus of a party ready to engage in active warfare. The impolitic exactions of Rehoboam, while they gave dissatisfaction to all his subjects, inflamed the Ephraimites to open revolt, which, fomented as it was by the ambition of Jeroboam, terminated in the establishment of a separate kingdom. This kingdom comprehended all the tribes, with the exception of the two southernmost (those of Judah and Benjamin), together with all the tributary nations as far as the Euphrates. The royal residence in the new kingdom was in Shechem, where the Mosaic ritual was superseded by a new mode of worship, and the link that bound Ephraim and Judah together finally severed.

The kingdom of Israel, as distinguished from that of Judah, had a distinct existence about 235 years, when it was invaded by Shalmaneser, who carried away the principal inhabitants into captivity. From that period all traces of the ten tribes as a distinct people are in a great measure lost. Colonists from Babylon and other eastern cities mingled with the Israelites who were left in the land of Palestine, and the mixed race were afterwards known by the name of Samaritans.

The kingdom of Judah enjoyed a somewhat longer existence than that of Israel. At last, however, about 135 years after the transference of the ten tribes to Media, the king of Babylon carried away captive the inhabitants of the land of Judah, which was left for a time wholly desert, or occupied only by wandering tribes.

During the captivity of Judah, the vanquished people seem to have enjoyed a more than usual share of the favour of their conquerors, and were considered more in the light of colonists than of captives. They were not, as they had been in Egypt, confined to a separate territory, but mingled freely with the Babylonians; being settled in thinly peopled districts, where, by a moderate degree of industry, they found an abundant sustenance. Upon the banks of the Euphrates they met some of the expatriated Israelites, who attached themselves to the tribes that had adhered to the pure worship of their fathers; and the name of *Jews*, from the larger tribe, was applied from this period to all who were recognised as the descendants of Jacob. The wisdom of many of the institutions of Moses now appeared, as they preserved the Hebrews a distinct people, notwithstanding the most intimate intercourse with another race, and secured their attachment to the great principles of monotheism in the midst of prevailing idolatry. Jews.

The captivity of the Jews continued till the year 536, when Cyrus ascended the Medo-Persian throne. This great prince had been foretold by the Jewish prophet Isaiah, as the man from whom deliverance was to come to the captive people; and in the first year of his reign he proclaimed a decree, permitting, or rather inviting, all the people of the God of Heaven, without exception, to return to Judea, and rebuild the temple of Jerusalem. About 50,000 availed themselves of this permission. They assembled at an appointed place, according to the usual mode of collecting a caravan, and proceeded under the conduct of Zerubbabel, who was nominated leader of the caravan, and governor of Judea. The return to Jerusalem took place about the close of the first year of Cyrus, after seventy years of captivity.

The building of a new temple, and the rebuilding and fortifying the city, were the two national objects which the restored captives had most at heart; and in the second year of their return the foundation of a new temple was laid. The jealousies and enmities, however, of the colonists at Samaria presented obstacles to the advancement of the work, and for a time it seems to have been abandoned. This lukewarmness on the part of the people called forth the indignant expostulations of the prophets Haggai and Zechariah, which were attended with such effect, that, by the joint application of Zerubbabel the governor, and Jeshua the son of Josedek the priest, the original decree of Cyrus was renewed by Darius, one of his successors, and the temple was finished without farther interruption. The obstacles towards restoring the city of Jerusalem were not so soon overcome. The fears of the Persian government were wrought upon by the representations of the Samaritans, as to the danger of the defection of the Jews if their city were again fortified; and thus, though Ezra was allowed by Artaxerxes Longimanus to take with him to Jerusalem as many of the Jews of Chaldea as were disposed to return, his powers, though considerable, did not extend to the fortifying of the city. It was not till the death of Zerubbabel, about twelve years after the return of Ezra, that Nehemiah was appointed his successor as governor of Judea, with authority to repair the city and rebuild the walls. This change in the policy of the Persians towards the Jews has been ascribed to the humiliating conditions of the peace which Artaxerxes was obliged to make with the Athenians after the signal defeat of his forces by Cimon, by which conditions no Persian army was to approach within three days' march of the sea. Being thus excluded from the line of sea-coast, it became an object to the Persians to have a fortified town like Jerusalem in their interest, which, without infringing upon the treaty with the Athenians, might serve as a pass for keeping open the communication between Persia and Egypt, which latter country had been reduced

Jews. anew under the Persian yoke. The extraordinary rapidity with which Nehemiah executed the important trust committed to him, the abuses which were introduced upon his return to Persia, and the steps which he took in consequence for the restoration of the Mosaic polity, and which he completed in the reign of Darius Nothus, are set forth in the book which bears his name, which, with that of his contemporary Malachi, closes the Old Testament canon.

From the time of the return from the Babylonian captivity, a remarkable change is observable in the character of the Jews, and in the features of their policy, civil and ecclesiastical. The infliction of the judgments threatened in their sacred books for their disobedience, seems to have impressed upon their minds a deeper reverence for the institutes of their Great Lawgiver; while the fulfilment of the predictions respecting their restoration to their own country led them to direct their views to the prophecies which spoke of the whole earth being brought to acknowledge the sovereignty of the God of Jacob. Of the tendency to idolatry, accordingly, for which they had hitherto been distinguished, we find few farther traces; and it was succeeded by a scrupulous adherence to the Mosaic ritual, on the observance of which they built their hopes of the accomplishment of the divine promises to their nation under the expected Messias. This change was connected with certain alterations in their institutions, which exercised a decided influence upon the destiny of the Jewish people in succeeding times. We refer to the establishment of the national councils known by the name of the Sanhedrims, and to the introduction of the synagogue worship. The precise period of their origin cannot be ascertained, but it seems not improbable that it was almost as early as the time of the return from Babylon, though a considerable period intervened before either system was in full operation. It has been conjectured that Nehemiah, in the conduct of his government, sought the assistance of a council or senate, consisting of the most influential individuals in Jerusalem; and that, in imitation of this national council, smaller senates were formed by degrees in each separate district, conducting the affairs of the community under the authority of the great Sanhedrim. These councils were intimately connected with the synagogues. As the Mosaic law was made to extend to all the actions of civil as well as to the duties of religious life, the Scriptures became of constant reference in each community. The people assembled to hear it read and explained as a religious exercise; and as it was the statute-book of the magistrate, its true meaning and right application to the circumstances which occurred became a matter of daily consideration. This gave rise to a class of men qualified for the important office of explaining the law. Skill in this department became the great distinction to which all paid reverential homage; and the direction of the worship of the synagogue, and the conduct of the courts of law, fell under the authority of the learned doctors or scribes, in whom were united the professions of law and of divinity. This was followed by a loss of power on the part of the priests, who became little more than the ministers of the sanctuary, without any authority as leaders of the people. Such was the great change effected in the course of a few centuries after the return from the captivity. The power of the priests passed into the hands of the rabbis; and instead of the schools of the prophets, and worship on high places, we have the Sanhedrims and the synagogues. The Jews who remained between the Tigris and the Euphrates, and those also who from this period began to scatter themselves throughout Egypt, Syria, and Asia Minor, and, at a later period, over Greece and Italy, and the other parts of the western world, adopted or carried along with them the synagogue service. While their personal interests prompted them to wander over different lands, a common feeling united them all to the country promised to their fathers, and to the hopes connected with its possession. These expatriated Jews conformed themselves to the regulations prescribed from time to time by the learned doctors of Judea; they contributed to the support of the services of the temple so long as it remained; and by these means, and by avoiding all intercourse by marriage with other nations, the Jews were distinguished as a separate people over all the world, and the spirit was confirmed which has preserved them from being confounded with others even to the present time. Jews.

After the death of Nehemiah, Judea was annexed to the prefecture of Syria, the administration of Jewish affairs being left to the high priests, subject to the control, however, of the provincial rulers. In this condition the Jews continued till the overthrow of the Persian empire by Alexander the Great, when Jerusalem became subject to the power of that mighty conqueror.

Upon the death of Alexander, the peace and security which the Jews had enjoyed under the Persian dynasty were changed for scenes of bloodshed and devastation. In the wars which took place amongst the successors of Alexander, Judea, from its situation between Syria and Egypt, became alternately the prey of each. In the words of Josephus, the Jews resembled a ship tossed by a hurricane, and buffeted on both sides by the waves, while they lived in the midst of contending seas. At first their country was allotted to Laomedon, along with Cœle-Syria and Phœnicia. But the ambitious views of Ptolemy Lagus, king of Egypt, being directed to the whole of Syria, he entered Judea, and choosing the Sabbath day for the assault of Jerusalem, he met with no resistance from the inhabitants, 100,000 of whom he carried off as captives, settling them in Cyrene and Alexandria; thus laying the foundation of the Jewish colony in Alexandria, which for 400 years holds a conspicuous place in the Jewish annals. With the exception of the period when Judea was overrun by Antigonus, it continued under the power of Ptolemy, whose policy towards the Jews was wise and liberal. During the reign of this prince, Simon the Just was high priest, who, according to Jewish tradition, was the last member of the great synagogue, and in this character completed the sacred canon. Ptolemy Lagus was succeeded by Ptolemy Philadelphus as king of Egypt. Under his reign the translation of the Hebrew Scriptures into the Greek (named the Septuagint, from an idle legend as to the number of individuals employed in the work) was probably begun, though not completed till a later period. During the wars of Antiochus the Great with the Ptolemies, the inhabitants of Judea were subjected to severe suffering. Their country was laid waste, and to which side soever victory inclined, they were equally exposed to injury. Though they had received many favours under the sway of the Ptolemies, the Jews espoused the cause of Antiochus, who showed his gratitude by lightening their burdens, by gifts towards defraying the expenses of their sacrifices, and by securing them in the peaceable observance of the rites of their religion.

A very different policy was pursued by Antiochus Epiphanes, who, in all his dealings with the Jewish people, was influenced only by his rapacity, and bigotry, and cruelty. The first act of his reign was to depose the high priest Onias, that the vacated office might be conferred upon Joshua, brother of Onias, who had bribed the king to this injustice by the promise of a large tribute, to enable him to pay which, certain privileges were conferred on him, to be employed in introducing Grecian customs among his countrymen, and in weaning them from their national pe-

culiarities. The new high priest assumed the Grecian name of Jason, allowed the services of the temple to fall into disuse, and established a gymnasium, where, under the pretext of practising athletic exercises, the Jews were won over to heathenism. Jason was soon supplanted in his turn by his brother Menelaus, who, in like manner, made it his aim to substitute Grecian for Jewish customs. In the mean time, the attention of Antiochus was attracted towards Egypt, which he invaded with a powerful army that was everywhere victorious. While there, exaggerated reports reached him of a revolt of the Jewish people, and his arms were immediately directed against Judea. Jerusalem was taken; 80,000 of the inhabitants were sold as slaves or put to the sword; and, while he plundered the temple of all its treasures, he showed his enmity against the Jewish religion by desecrating with every abomination all that the Jews esteemed most holy. After this, he anew directed his attempts against Egypt. For a time success seemed doubtful; but the weaker party made an appeal to Rome, and the firmness of Popilius Lenas compelled Antiochus to submission and retreat.

Disappointed in his designs against Egypt, Antiochus returned to his capital, where he issued a decree commanding all the inhabitants of his empire to worship the gods of the king, and to acknowledge no religion but his. It may be doubtful whether in this edict the sovereign consulted most his rapacity or bigotry. At that time the temples were not only enriched by the offerings of the votaries, but, from the security afforded by the character of their sanctity, were the great banks of deposit; and Antiochus seems to have laid the plan for plundering the temples throughout his dominions, after suppressing their worship. Among his heathen subjects, the decree met with ready obedience. The compliance in Judea, however, was not universal, and the partial opposition which was made led to those measures of frantic severity on the part of Antiochus that awakened into life the spirit of the Maccabees, whom God raised up among their degenerate countrymen to defend his cause, and give an example to mankind.

A Grecian named Athenæus, well acquainted with all the forms of heathen worship, was sent to Jerusalem to instruct the Jews in the religion they were henceforth to observe, with full powers to enforce compliance. He dedicated the temple to Jupiter Olympus; the statue of Jupiter (the abomination of desolation spoken of by the prophet Daniel) was set up on the altar of Jehovah; and throughout all Judea idol altars were erected, upon which, under penalty of the most barbarous tortures, the Jews were compelled to offer sacrifice. Circumcision, the keeping of the Sabbath, and other observances of the ceremonial law, were made capital offences, and all the copies of the sacred books that could be found were destroyed. Groves were planted and idolatrous altars erected in every city; and at fixed periods the citizens were required to offer sacrifice, and to join in the religious processions; and officers were sent into all the towns, attended by a military force, to command obedience to the royal edict. At first they met with no opposition; but the hour of resistance was approaching. We learn from the first book of the Maccabees, that when the officers of King Antiochus, in traversing Judea, came to the city of Modin to make the people sacrifice, they commanded Mattathias, a priest of the sons of Joarib, to *come first* and fulfil the king's commandment. "Mattathias answered with a loud voice, God forbid that we should forsake the law and the ordinances: We will not hearken to the king's voice to go from our religion, either to the right or to the left. Now, when he had left speaking these words, there came one of the Jews, in the sight of all, to sacrifice on the altar which was at Modin, according to the king's commandment. Which thing, when Mattathias saw, he was inflamed with zeal, and his reins trembled, neither could he forbear to show his anger according to judgment; wherefore he ran and slew him upon the altar. Also the king's commissioner, who compelled men to sacrifice, he killed at that time, and the altar he pulled down. Thus dealt he zealously for the law of God, as Phineas did unto Zambri the son of Salom. And Mattathias cried throughout the city with a loud voice, saying, whosoever is zealous of the law, and maintaineth the covenant, let him follow me. So he and his sons fled unto the mountains, and left all that they ever had in the city."

Such was the commencement of that noble stand which Mattathias and his sons made for the religion and liberties of their country. Mattathias was the son of John, the son of Simeon, the son of Asmoneus, from whom the family had the name of *Asmonean*. Different accounts have been given of the name of *Maccabee*, by which they are more generally known. The common explanation is, that it was from the four initial letters of the words which were displayed on their banner (Mi Chamoka Baalim Jahoh, who is like unto thee among the gods, O Lord). Others conceive that it was the surname given by Mattathias to one of his sons, on account of his valiant exploits,—*the Hammerer*.

Having fled to the mountains, Mattathias was soon joined by associates from all parts of the country, who needed only a leader to animate them to resistance. Mattathias lived but a short time to direct the energies of this devoted band; but upon his death he left fit successors in his valiant sons, who, during a period of twenty-six years, maintained a war with five successive kings of Syria, which terminated in the establishment of the independence of their country. Judas Maccabeus, the third son of Mattathias, was the first who undertook the management of affairs. His successes were for a time uninterrupted. From a petty revolt, the contest soon assumed the character of a mighty war; the chosen generals of Antiochus were defeated at the head of assembled hosts; in less than three years Jerusalem was once more in the hands of the Jews, its altars repaired, its temple purified, and the sacred services restored; and, soon after the death of Antiochus, the Syrians were compelled to conclude a peace with the Maccabee.

Had the Jews been united among themselves, they might now have defied the power of their enemies. But there were many elements of disunion in this ill-fated nation. The zealous attachment to their ceremonial and traditionary law, which animated the greater part of the followers of Judas, and which was one great cause of their success, was offensive to the party which had arisen with less rigid views, and who were afterwards distinguished by the name of Sadducees; and there was a numerous party, who, having conformed to the Grecian worship, were wholly in the interest of the Syrians. The Syrians were not slow in availing themselves of these internal differences, and war again began to rage. Though deserted by many of his followers, success still attended the arms of Judas, till he was slain in a furious conflict with the flower of the army of Demetrius, which with desperate resolution he had attacked near Azotus with only eight hundred men.

Judas was succeeded in command by his brother Jonathan. He fought at first with various fortune; but the prudence and enterprising valour of which he partook in common with the whole family were crowned at last with success. In the contests for the crown of Syria between Demetrius and Alexander Balas, the alliance of Jonathan was courted by the rival parties; and he was thus enabled to make terms most favourable for Judea. But in the wars that succeeded the death of Balas, he was treacher-

Jews. ously slain by Trypho, who, under professions of friendship, had tempted him to enter Ptolemais without a sufficient force for his protection.

Simon was now the only brother who survived of the house of Mattathias; but the fate of his family did not daunt him, and he at once accepted of the hazardous pre-eminence to which the suffrages of his countrymen called him. "Since all my brethren," said he, "are slain for Israel's sake, and I am left alone, far be it from me to spare my own life in any time of trouble, for I am no better than my brethren; doubtless, I will avenge my nation and the sanctuary, and our wives and children." The pledge thus given he soon fulfilled. With characteristic energy, he put the whole country in a posture of defence; and entering into a league with Demetrius, the rival of the perfidious Trypho, he secured such privileges for the Jews, that from this period, B. C. 143, they date their freedom from the Syrian yoke. At this time the Jews elected Simon ethnarch or prince, as well as high priest; the office to be hereditary in his family. The government of Simon was marked by vigour and wisdom. But, like the rest of his family, he was doomed to a violent death, being assassinated at an entertainment by his own son-in-law, who had entered into a plot with Antiochus king of Syria, for the extirpation of the Maccabean race. Two of his sons were murdered with him; but a third escaped to Jerusalem, where he succeeded to his father's government. This was John Hyrcanus, whose surname was derived from his valiant exploits in Hyrcania, with Demetrius king of Syria. The reign of Hyrcanus lasted thirty years, and was eminently prosperous. The kingdom of Judea was extended on every side. Samaria was reduced, and the temple on Mount Gerizim destroyed. The Idumeans were subdued, and became proselytes to the Jewish religion. A league with the Romans, which had first been sought by Judas Maccabeus, and was renewed by Simon, was now confirmed on terms most advantageous to the Jews in their relations with surrounding states; and the glory of the Asmonean princes was raised to its height.

About the time of Hyrcanus we first find mention made of the Sanhedrim or Great Council, which for a considerable period exercised a power, partly legislative and partly judicial, among the Jews. It consisted of seventy individuals, priests and men learned in the law. Some have conjectured that it owed its origin to the policy of Hyrcanus, who wished to avoid the appearance of exercising an unlimited authority, by an institution which might protect, while it seemed to limit, the new monarchy.

The sons of Hyrcanus were unworthy of the stock from which they sprung. The short reign of his eldest son Aristobulus, which lasted only a year, was darkened by monstrous crimes. By his orders his own mother was imprisoned and starved to death, and his brother Antigonus was assassinated. An agony of superstitious horror at the enormity of his guilt, terminated his miserable existence. His brother Alexander Jannæus, who succeeded him in the government, was a man of enterprising valour, but cruel, deceitful, and tyrannical. The greater part of his reign was occupied in quelling revolts among his subjects, occasioned partly by the turbulent spirit of the Pharisees, but chiefly by the oppressiveness of his own sway. Immediately before his death, which was hastened by intemperance, he urged his queen Alexandra to unite herself to the Pharisaic party, as the only means to preserve the kingdom. The policy was wise for the house of the Asmoneans, and was scrupulously followed by Alexandra. Her reign, which continued nine years, was conducted with prudence and vigour, and her kingdom preserved in tranquillity.

Upon the death of Alexandra, her two sons, Hyrcanus and Aristobulus, were both competitors for the vacant throne. Hyrcanus was deficient in all the qualities that were necessary for command, and would have yielded to his brother without opposition, had he not been urged by Antipater or Antipas (father of Herod the Great) to maintain his cause. According to Josephus, Antipas was of a noble family of Idumeans who had adopted the Jewish religion. His father had been governor of Idumea during the reigns of Alexander Jannæus and Alexandra. Antipas himself was educated in the Jewish court, where he attached himself to the interests of the eldest son, whom he looked upon as the successor to the throne. The arts of Aristobulus, who, in the prospect of his mother's death, had made himself master of several of the strongest fortresses of Judea, presented an unexpected obstacle to the hopes of the friends of Hyrcanus. The prize, however, was too important to be lost without a struggle; and Hyrcanus, under the influence of Antipas, engaged in a contest for the throne. It was continued for a considerable time with doubtful issue. At last the brothers submitted their claims to the decision of Pompey, now crowned with all the glories of the Mithridatic war. Pompey delayed from time to time pronouncing in favour of either party, till at last Aristobulus, disappointed in his hopes of the support of the Roman, took up his ground in Jerusalem, and prepared for war. Upon this Pompey marched against the Jewish capital, which, after a siege of three months, was taken by assault. Had it not been for the religious scruples of the Jews as to making resistance to the progress of the works of the enemy on the Sabbath, the fortress might have proved impregnable. The attachment of the Jews to their sacred ceremonies was strikingly evinced at this period in another respect. At the moment when the temple was taken, the priests were engaged in the daily sacrifices; and, amidst all the horrors which surrounded them, they proceeded in their solemn services unmoved, thinking it better, says Josephus, to suffer whatever came upon them at their very altars, than to omit any thing that their law required of them. The curiosity of Pompey led him to visit the whole of the sacred edifice, and he entered into the holy of holies. The sacred utensils of the temple he left untouched, and even the treasures, which amounted to two thousand talents of gold. He also gave orders for the purifying of the temple, and for the continuance of the divine service as before. He appointed Hyrcanus to the office of high priest, giving him at the same time the government of Judea, tributary to the Romans, but without the title or ensigns of royalty. The cities of Phœnicia and Cœle-Syria, which the Jews had conquered, were separated from Judea and joined to Syria, which was now made a province of the Roman empire, Judea being reduced to a subordinate principality. B. C. 63. Jews.

Aristobulus, his sons Alexander and Antigonus, and his two daughters, were carried away by Pompey as prisoners to grace his triumph, Hyrcanus being left as governor of Judea. This feeble prince was wholly under the influence of Antipater the Idumean, by whose instigation he had made the effort which gave him his present supremacy. Unfit himself to hold the reins of state, he intrusted every thing to this crafty and ambitious favourite, who appointed his own sons, Phasaelis and Herod, the one governor of Jerusalem, the other of Galilee, though both nominally under the control of Hyrcanus. Herod, at this time only twenty-five years old, commenced his government with a vigour and severity that bespoke the future tyrant. A band of robbers who infested his province were made the first victims of his cruelty; and when summoned before the Sanhedrim, who were jealous of the rising powers of Antipater and his sons, to answer for his stretch of authority, he entered the coun-

Jews.

cil in so menacing a form, that all, with the exception of one individual, were awed into silence. The attack which the discontented Jews were afraid to commence openly, they soon after attempted in secret, and the leading men among them entered into a plot for the destruction of the family of Antipas. The father was poisoned at an entertainment given by the high priest; and when Herod and Phasaelis escaped the snare which was laid for them, means were used to alienate from them the affections of Hyrcanus. These arts, however, were baffled by Herod, who contrived to increase his influence with the prince by marrying his grand-daughter Miriam or Mariamne. The enemies of Herod now openly espoused the cause of Antigonus, son of Aristobulus, who had lately effected his escape from Rome, and who had found a supporter of his pretensions to the Jewish throne in Pacorus, the Parthian leader. In the war which ensued, Hyrcanus, with the assistance of the sons of Antipas, was generally successful. But, under the pretence of coming to an amicable arrangement, Hyrcanus and Phasaelis were entrapped into the enemy's camp, where Phasaelis was put to death, and the barbarous punishment of cutting off the ears was inflicted upon the aged governor by his unfeeling nephew Antigonus.

The discovery of this treachery aroused the energies of the surviving brother to the uttermost. Having placed his family, and whatever of value he could collect, in Massada, a fortress on a mountain near the Dead Sea, he sailed to Italy to implore the assistance of the Romans. In all the changes which had taken place at Rome, it had been the policy of Herod to ingratiate himself with the successful party. And it is a sufficient proof of the arts and talents of this extraordinary man, that he enjoyed the favour of Julius Cæsar, and Cassius, and Mark Antony, and that he was ranked as one of the friends of Augustus and Agrippa. At the present time Antony was in power at Rome. And when Herod asked merely that the brother of Mariamne should be placed on the throne of Judea, as uniting by his descent the claims both of Hyrcanus and Aristobulus, Antony named Herod himself the king. Before the end of the year Herod was again in Judea, raised a large body of soldiers, relieved his friends at Massada, and was in readiness to take the field against Antigonus. The war continued about three years, in the course of which Jerusalem again stood a long siege. When it was at last taken, the Romans, exasperated at the obstinacy with which it had been defended, would have made a general massacre, and reduced the city to ashes, had they not been restrained by Herod, who complained that "they were going to make him king of a desert." The pusillanimity of Antigonus upon his surrender subjected him to the scorn of the Roman general, who sent him in chains to Antony, under the contemptuous name of Antigona, as if he were unworthy to bear that of a man. Antony, at the cruel but perhaps politic solicitation of Herod, gave order for his execution as a common malefactor, by the rods and axe of the lictors. With Antigonus ended the Asmonean dynasty, after it had subsisted 126 years. Josephus expatiates with a natural pride upon the merits of this illustrious house, as distinguished by their descent, by the dignity of the pontificate, and by the great exploits of their ancestors.

Upon the accession of Herod to the Jewish throne, his character began more fully to develope itself. By one of the first acts of his reign, the whole of the members of the Sanhedrim were put to death, with only two exceptions. One exception was in favour of Sameas, the individual formerly referred to as standing alone in arraigning Herod to his face. If there was any generosity in the conduct of Herod towards Sameas, he forfeits the admiration it might have excited, by his unworthy jealousy of Aristobulus, the brother of his wife Mariamne. When the popular feeling was manifested in their admiration of the rightful heir of the Asmoneans, Herod saw in him a dangerous rival to his power, and by his order the youthful high priest was put to death. The mother of Aristobulus appealed to the justice of Antony to avenge the murder of her son. Herod saw his danger, and secured his safety by the homage of a personal interview. The battle of Actium put an end to his farther hopes from Antony, and his crown and even his life were exposed to a new jeopardy. He resolved therefore once more to have recourse to the expedient of a personal interview; he presented himself before Augustus upon his arrival in Egypt; and the arts which had formerly prevailed with Roman generals were still successful. But the qualities by which he was able to attach to himself many illustrious friends, and the munificent acts and proud and princely undertakings which shed a barbaric splendour over his reign, formed no atonement for the many deeds of blood by which he had arrived at his guilty pre-eminence. His crimes, however, were not allowed to pass unpunished. He regarded not how much misery might be endured by others, that his own passions might be indulged; and in those passions his guilt found its avengers.

Jews.

When he left Judea to plead his cause before Antony, he gave the extraordinary injunction, that if he were condemned, Mariamne should be put to death, to prevent the possibility of her ever being the wife of another. And during his absence at the time when he paid his court to Augustus, he gave the same instructions; his love being such, that he could not think of Mariamne but as his own; if the name of love can be applied to that combination of tyranny, and pride, and selfishness, and lust, which filled his guilty bosom. The fatal secret had been communicated to the queen during his first absence, and upon his return she upbraided him with his barbarous cruelty. The jealousy of the tyrant was awakened in a moment, and, wild with rage, he rushed upon her with his sword, asking if such a secret could have been revealed except by a lover. But the paroxysm passed away, and his suspicions were forgotten in his efforts to soothe the resentment of his injured queen. Upon his second return he found that his secret had again been disclosed; and, goaded on by the enemies of Mariamne, he issued orders for her execution. Remorse and despair now took possession of his mind. He fled from all society, and, under a complication of mental and corporeal suffering, he sunk into a state of insanity. The derangement was temporary, though traces of it were discoverable to the end of his life.

As the sons of Herod by Mariamne grew up to manhood, attempts were made to poison the mind of their father against them; and the obvious interest with which they were viewed by the Hebrew nation awakened his jealousy. After a succession of scenes, in which the tyrant and the father strove for the mastery within him, he appeared as the accuser of his own sons, first before Augustus, and then before the deputies Saturninus and Volumnius; and the sanction of the Roman authority being obtained, the unhappy brothers were strangled by the orders of the unhappier father. Macrobius has preserved a saying of Augustus upon hearing of the unnatural conduct of Herod, in allusion to the Jewish faith, "that he would rather be Herod's *sow* than his *son*." Antipater, his son by a former marriage, who had instigated the proceeding against his brothers, was himself found guilty of a plot to poison Herod. Sentence of death was immediately pronounced against him, but the tyrant's own death prevented it from being carried into effect.

Amidst the dark shades of the character of this extraordinary man, the splendid acts of his administration

Jews. are not to be forgotten; the fortresses by which he sought to give security to his kingdom; the harbours he constructed; the cities he built; the magnificent palace he reared for the royal residence; and the temple which he restored to almost its original greatness. The rebuilding of the city of Samaria, the building of the city and harbour of Cæsarea, with the rebuilding of the temple, must be allowed to be monuments of a princely and patriotic mind.

Upon the death of Herod, Palestine was divided amongst his three surviving sons, Archelaus, Antipas, and Philip. Archelaus was appointed ethnarch or governor of Judea, Idumea, and Samaria, which formed the largest part of the province. Antipas was named tetrarch of Galilee, and Philip tetrarch of Trachonitis. Archelaus followed in the footsteps of his father, and being without his talents or his arts, he was deposed by Augustus in the tenth year of his reign, in consequence of repeated complaints from his subjects, and banished to Vienne in Gaul. The part of Palestine which had been under Archelaus was now reduced into the form of a Roman province, being placed under the superintendence of a Roman governor, subordinate to the prefect of Syria. No fewer than three of these subordinate governors were appointed in succession towards the close of the reign of Augustus. During the reign of Tiberius there were only two, Valerius Gratus, A. D. 16, and Pontius Pilate, A. D. 27. Pilate seems to have been the first who took up his residence at Jerusalem, those who preceded him having dwelt at Cæsarea. The condition of the Jews under the Roman governors was miserable in the extreme. The extortions of the publicans, whose office it was to collect the revenue, were excessive; and the whole of their proceeding was vexatious and oppressive. It was vain to hope for redress from the governors, whose avarice and injustice were proverbially great. The very fact of paying tribute to a heathen government was felt to be an intolerable grievance. And the Roman soldiers quartered over the whole country, though they prevented a general insurrection, yet, by their very presence, and by the ensigns of their authority, exasperated the minds of the Jewish people, and led to many tumults, and seditions, and murders. A numerous party existed in Judea, whose religious prejudices were opposed to the idea of paying taxes to a foreign power, and who cherished the vain hope of restoring the Jewish kingdom. Attempts were made by different individuals, and particularly by Judas the Gaulonite, to instigate the Jews to a general revolt, which were repressed as they arose. But the fanatical principles were widely spread, and led to excesses, to which, in no small degree, may be ascribed the final destruction of Jerusalem. The party was distinguished by the name of Zealots.

The removal of Archelaus was not connected with any act on the part of the Romans towards his brothers. Trachonitis continued under Philip till the time of his death, when it was annexed to the province of Syria. Herod Antipas continued tetrarch of Galilee till after the accession of Caligula, who, upon the discovery that he had entertained treasonous designs, deprived him of his tetrarchate, and banished him to Lyons, in Gaul.

The period at which we are now arrived is by far the most important in the Jewish annals, or rather in the annals of the world. A short time before the death of Herod the Great, Jesus Christ, the promised Messias, was born at Bethlehem, one of the cities of Benjamin. He commenced his public ministry about the 30th year of his age, and was put to death by the sentence of the Roman governor, Pontius Pilate. The circumstances connected with his life and death and resurrection belong to Christian rather than to Jewish history.

Agrippa, a grandson of Herod the Great, having ingratiated himself with the Emperor Caligula, was appointed tetrarch of Trachonitis, upon the death of his uncle Philip; and upon the banishment of Herod Antipas, the tetrarchy of Galilee was added to the dominion of Herod, and ultimately he was named king of the whole territory that had belonged to his grandfather. This prince, upon his death, left a son, also named Agrippa. He was represented to Claudius as too young to be appointed to such a kingdom, and Palestine was again placed under a Roman governor. A considerable extent of territory, however, was ultimately given to young Agrippa; but Judea and Samaria were reserved as a Roman province. Jews.

The policy of the Romans led them to give toleration to their subject provinces in all matters connected with their national worship; and, from Pompey to Tiberius, countenance was given to the celebration of the Mosaic ritual. It was otherwise with Caligula, under whose reign was laid the foundation of those dissensions between the Jews and Romans which led to the utter destruction of the Jewish polity. The insane vanity of Caligula prompted him to enforce divine honours from all his subjects, which threatened the worst consequences to the Jewish people in every part of the empire. The Jews of Alexandria were the first who suffered. By their refusal to comply with the imperial edict, a pretext was afforded to the Grecian party in the city to commence a prosecution against them. The miserable Jews resolved upon sending a deputation to Rome to implore the clemency of the emperor. This deputation was headed by Philo, the greatest of all the uninspired Jewish writers, who has left an account of his interview with Caligula, and of the uncertain respite which was granted to his fellow-citizens. The governor of Syria received orders to place the statue of the emperor in the temple of Jerusalem; but he was induced, by the spirit of calm but determined resistance threatened by the whole nation, to delay the execution of the order till he received farther instructions from the emperor. There is a difference in the account of the manner in which Caligula acted upon this occasion, by Philo and Josephus; it is certain, however, that the Jewish nation remained in a state of suspense and fear till the death of the tyrant.

The worst evils, however, endured by the Jews at this period were not directly from the emperors themselves, but from their provincial governors, who, without exception, seem to have been men insensible to the claims of justice, and actuated solely by a spirit of violence and rapacity. Gessius Florus is represented by Josephus as spoiling whole cities, and ruining entire bodies of men; as giving security to robbers and lawless men when made a sharer in their depredations; and finally, as aggravating the oppressions of the people, to instigate them to open rebellion, that he might escape the danger of a representation of his crimes being made to the emperor. It was natural for the Jewish historian to represent the revolt which terminated in the destruction of his country, as originating in the injustice of their enemies; and it must be allowed, when we contemplate the proceedings of the Romans, that if ever there was a case in which revolt was justifiable, it was in that of the Jews. It may be doubted, however, whether they can be looked upon with that generous sympathy which is always awakened by the history of a people nobly uniting in the assertion of their rights and liberties. Judea, at this period, was torn by factions, a spirit of insubordination and fanaticism, chiefly connected with views of their promised Messias, pervaded the great body of the people; and miserable as was their condition under the oppressions of the procurators, it is impossible not to perceive, in perusing the works of their own historian, that their greatest sufferings were occasioned by the unsettled and violent spirit that reigned among themselves.

Jews. The commencement of the war was connected with circumstances which took place in Cæsarea. The Syrian party in that city had been favoured by the Roman emperor, and they abused the advantage which this circumstance gave them, in provoking and harassing the Jews, till at last there was a violent collision, and the Jews were driven out of the city. The leading men among them appealed to Florus, who, instead of affording them redress, cast them into prison. The news of this indignity kindled a flame in the Jewish capital; and the excitement among the people was such as to give Florus the pretext which he had long desired, of letting loose the soldiery upon the citizens. Great cruelties were inflicted, and no distinction was made between the innocent and the guilty. The influence of Berenice, sister of Agrippa, who was in Jerusalem at the time, and the arrival of Agrippa himself from Egypt soon after, promised to restore tranquillity. They both seem to have been sincere in their efforts towards a pacification, and for a time happy results followed the soothing counsels of Agrippa. It was, however, but for a time. All over Judea there were spirits determined not to allow so favourable a pretext for war as had been afforded by Florus, to pass away; and Agrippa, soon seeing that his attempts at mediation were to be in vain, withdrew to his own kingdom, and left Jerusalem to its fate. This was in the year 66. Hitherto the people professed that it was against Florus, and not against the Romans, that they had taken up arms. The distinction would not probably have been acknowledged at Rome, and the Jews did not allow the question to be tried. Eleazar, the son of Ananias the high priest, persuaded the people to reject the offerings which were made by the emperor to the temple, and which had been received since the time of Julius Cæsar; and about the same time the fortress of Massada, near the Dead Sea, was taken, and the Roman garrison put to the sword. Allegiance to the Romans was now in effect renounced, and from this period we may date the commencement of the war.

Eleazar took possession of Acra and the temple; and receiving numerous reinforcements of Zealots or Siccarii from different parts of the country, he not only resisted the assaults of the Romans and of the soldiers of Agrippa, but soon sallied out and made himself master of the whole city. He granted a safe passage to the Jewish soldiers who were against him, and to the troops of Agrippa; but a different fate awaited the Roman garrison. They had capitulated on condition that their lives were to be spared. But the moment they yielded up their arms, the followers of Eleazar commenced an attack, and, with the exception of their leader, they were all put to the sword. This monstrous breach of treaty was on a Sabbath day; and the minds of all those who had not as yet joined in the revolt were filled with gloomy forebodings of the evils which were now inevitable. But the Jews were not the only guilty parties in the deeds which darken the annals of these dreadful times. On the same day of the massacre of the Roman garrison, the Jewish inhabitants of Cæsarea, amounting to 20,000, were put to the sword. Upon this the fire spread at once over all Judea, and an attack was simultaneously made upon the neighbouring territory of Syria. Cestius Gallus, the prefect of Syria, took immediate measures for chastising this presumption. He ordered the twelfth legion into Galilee, and soon afterwards he himself entered Judea with an army of about 10,000 men. He advanced without opposition to Jerusalem, and, from the state of parties in the city, there seems little doubt, that if he had shown common prudence, or common bravery, it would soon have been in his power. But a severer doom was in reserve for it. Cestius, to the surprise of all, in a few days raised the siege, withdrew his troops, and commenced a retreat, which the pursuit of the Jews soon changed into a general flight, in the course of which he lost more than half his army. The Jews only lost a few men. Jews.

The news of this defeat was received by Nero with such alarm, that he immediately appointed Vespasian, who was considered as the most experienced general in the empire, to quell the insurrection. Without the loss of an hour after his appointment, Vespasian despatched his son Titus to Alexandria, whence, with the sixth and tenth legions, he was to proceed to Judea. Vespasian himself advanced to Syria.

Upon the retreat of Cestius, many Jews departed from Judea, as from a foundering bark, that was soon to go down in darkness and death. The Christians, we are informed by Eusebius, about this time, also remembering the prophecies of our Lord, retired to the town of Pella to avoid the approaching calamities.

The Jews who remained in their own land were diligent in putting all their strong places in a state of defence.

Vespasian opened his first campaign in Galilee in the spring of 67. His army consisted of about 60,000 men, horse and foot, including auxiliaries. On the first assault he took and burned Gadara. He then presented himself before Jotapata, which was commanded by Josephus, who afterwards wrote the history of the war. After a siege of forty days, the town was taken and destroyed. Above 40,000 men were killed during this siege. Josephus surrendered at discretion, and continued during the remainder of the war a prisoner at large among the Romans. In his history, accordingly, of this miserable period, we have the account of an eye-witness. The fact that the capture of Jotapata was the chief event of the first season, proves that the Roman had met no unworthy foe.

In the spring of the following year, Vespasian commenced by reducing the whole of Peræa, it not being his policy to march directly upon Jerusalem. He then advanced from Cæsarea towards the south, laid waste Judea and Idumea, secured Samaria, and then drew back to Cæsarea, to be in readiness to march with all his forces against the capital itself.

Vespasian had now made all his preparations; he had occupied two seasons in clearing the whole territory round and round, that nothing might interpose to break his onset; Jerusalem itself stood like an isolated tower, against which all the engines of destruction were arrayed; the force of Rome was drawn back to Cæsarea, that it might be sent off with an irresistible shock; but at that critical moment the moving power of this machinery of desolation took another direction, and a period was given to the Jewish people to repent,—or to fill up the measure of their iniquities. Upon arriving at Cæsarea, Vespasian received intelligence which fixed his whole attention upon Rome. Nero was dead, and the fate of the empire was in balance. A more important prize than Jerusalem was now presented to his view, and, called to the purple by the voice of his soldiers, he set sail for Italy, leaving his son Titus to conclude the war.

Throughout the protracted period during which Vespasian had been devastating Judea, Jerusalem, instead of making preparations to withstand the approaching attack, was the scene of contentions so ferocious, that the advance of the Romans was longed for by the great proportion of the inhabitants, as the only earthly means for their deliverance from the terrible evils under which they were suffering. There were three factions within the walls, animated against each other with sentiments of the deadliest hate, and often engaging in actual conflict. Eleazar had seized the temple, and kept himself in strength there with 2400 men. John,

Jews. the rival of Josephus, had his position in the inner court of the temple. He had a party of 6000. Simon, the son of Gioras, called Simon the assassin, occupied the upper city. His force was the largest, consisting of 10,000, and 5000 Idumeans. Such was the position of the three factions when Titus took the command, and the miseries of the siege itself scarcely exceeded what had been endured amidst the daily encounters of the Jewish soldiery. Death was become so common a spectacle, that it was viewed without emotion. The feelings of kindred were dried up; a callousness of heart seized upon all; the interest in life itself seemed to be extinguished.

At last, about the beginning of April of the year 70, the tide of war took the direction of Jerusalem; and Titus, with the Roman host, advanced from Cæsarea through Samaria, and encamped under the walls. The contending chiefs, when it was too late, entered into negociations for uniting their forces against the Romans. Their mutual hatred, however, was never laid aside, nor did they repose confidence in each other, though they fought with the valour of desperation against the common enemy.

The city was fortified by three walls of prodigious strength. The one built by Agrippa was seventeen and a half feet broad, the stones thirty-five feet long, and so compacted as not to be easily shaken by the battering rams. The walls were everywhere guarded by towers, at intervals of about 350 feet, of solid masonry, and of great height. The tower Psephina, opposite to which Titus encamped, was 122 feet high; it is said to have commanded a view of the whole territory of Judea to the border of Arabia and to the Red Sea; and there were other towers of scarcely less imposing appearance, and of equal strength. Above the whole city stood the temple, the walls of which were in no place lower than 500 feet. It covered a square of a furlong each side, and was of such strength as to be supposed impregnable. Some of the stones employed in the work were seventy feet square;—and not one of these was to be left upon another.

At first the Jews made some sallies, so vigorous as to astonish the Romans themselves. Had the parties within been united, and had the time from the commencement of the war been employed in putting the city in a state of complete defence, it might have withstood the whole Roman power for years. But the day and the hour of its overthrow had been fixed in the counsels of heaven.

After strenuous fighting for every inch of ground, two walls were successively abandoned by the Jews. But the heights of Zion, the Antonia, and the temple, still remained, which might be considered the strength of Jerusalem; and so hopeless did every attempt seem to take any of them by storm, and so paralysing were the desperate efforts of the Jews upon the Roman power, that Titus found it necessary to blockade and starve the city and garrison. The inhabitants of Jerusalem now saw their enemies "*casting a trench round about them, and compassing them round and keeping them in on every side.*" The wall, which was nearly five miles in circumference, was completed in three days. The horrors that ensued are beyond description. Even before this time the evils of famine had begun to be experienced. In the extremities of hunger, many ventured out of the city to gather herbs. Strict orders were given by Titus that such individuals should be seized upon, and an example made of them, to the terror of the besieged. Those who were found with arms were crucified, sometimes to the number of 500 in a day; and the soldiers used to expose them in mockery to those upon the walls, nailed in different postures. At last wood was awanting to place the bodies upon, and room on which to erect the crosses. When the wall was completed, there was no longer the possibility, at any risk, of finding sustenance from without, and the ravages of hunger became inconceivably great. Whole families perished. Houses were filled with dead women and children, the streets with aged men. The young had not strength to bury the dead. Many died in the attempt to give burial to others, and many repaired to the tombs to wait for death. There were no more tears seen, nor cries heard. They sat with dry eyes, and mouths drawn up into a bitter smile. A deep silence was spread over the city, forming a horrible kind of night. The only noise was from those who were engaged in the work of plunder, whose mirth it was to try their swords upon the bodies of the dead; but if any one begged them to put an end to their misery, they would not kill them. The dying turned their eyes to the temple, as if to complain to God that these wicked men were suffered to live. Everything was eaten; their girdles, the straps of their sandals, the remains of old hay, the refuse of the dunghill. Scenes still more horrible discovered the depth of dreadful meaning in the words of our Saviour: "*Behold the days are coming in which they shall say, blessed are the barren, and the wombs that never bare, and the paps that never gave suck.*" And the predictions of Moses were fulfilled even to the letter: "*The tender and delicate, which would not adventure to set the sole of her foot upon the ground for delicateness and tenderness, her eye shall be evil towards her husband, and towards her son, and towards her daughter, and towards her young one that cometh out from between her feet, and towards the children that she shall bear; for she shall eat them for want of all things secretly in the siege, and straitness wherewith thine enemy shall distress thee within thy gates.*"

Jews.

The cup was now full, and "for the elect's sake the days were shortened." The fortress of Antonia, after many furious assaults, was taken and destroyed; and, on the 17th of July, Titus advanced as far as the temple, where the perpetual sacrifice ceased for want of a sufficient number to offer it. Still the Jews refused to surrender, and the works of the Romans proceeded. On the 8th of August, Titus attacked the second court of the temple. The walls could not be beat down, from the size of the stones, and the defence of the Jews prevented the scaling of the galleries. Fire was therefore set to the doors, which soon spread into the temple itself, and reduced the splendid edifice into a heap of ruins. Still the upper city held out. But at last a breach was effected, and on the 8th September the whole of Jerusalem was in the hands of the Romans, and orders were given by Titus for demolishing the city and temple.

Three forts in Judea still held out against the Romans, Herodion, Massada, and Machaeras. Two of these made a long and vigorous defence, but before the end of the year 72 Judea was in a state of entire subjugation. Contrary to the usual policy of the Romans, the territory was not shared among military colonists. All the lands were exposed to sale. In the northern districts the chief purchasers were Syrians. Individuals among the Jews themselves bought considerable properties in the south; the proceeds were reserved for the imperial treasury; and a capitation tax was imposed upon the Jewish people throughout the empire, and exacted with the most galling severity, for restoring and adorning the Roman capitol, which had been destroyed in the civil wars some time before the fall of Jerusalem.

From the time of the destruction of Jerusalem by Titus, there is no longer any connecting tie in the history of the Jewish people, except their imperishable love to the religion of their fathers. Scattered abroad in almost every country of the world, in every variety of outward condition, their fate presents matter for a subordinate chapter in the history of other nations, rather than a separate subject of history. We are presented with a mass of materials,

Jews. to which the ordinary rules of historical arrangement, by epochs and by countries, do not apply. The condition of the Jews from this date varies in different kingdoms, and even in different parts of the same kingdom at the same period, and is so intimately connected with the varieties of national policy, and with local and temporary causes, that it cannot perhaps be fully understood in all its parts, except when viewed as incorporated with universal history. There are, however, a few general heads, under which the more important particulars connected with their destiny may be classed; the classification must indeed be imperfect, from the discordant and impracticable nature of the materials with which we are presented; still, however, there is one principle which gives a unity to them all. And in the absence of the definite lines which limit historical narrative in other instances, we must be more forcibly struck with the peculiarities of this singular race, among whom the want of a native country has formed a bond of connection more powerful than all the ties of country to other tribes; while the efforts made to sever them from their religion has made them cling to it with an energy that seems to have incorporated itself with the very essence of their being. The circumstances which preserved the Jews as a separate people after the termination of the temple worship, were similar to those which operated during the time of the captivity, with the addition of the rabbinical system, which was now in full operation. In whatever country a few families of Jews were collected into one place, the worship of the synagogue brought them into religious fellowship; and pride in their privileges as God's peculiar people, a principle of honour in not deserting a persecuted cause, revenge against a world from which they received so much injustice, combined with never-abandoned hopes of blessings yet in store for themselves or their children, and the magic influence of associations connected with their ancient ritual, have perpetuated the Jewish name in every country where cupidity has allured or cruelty banished any of the members of the race.

There is little that is interesting in the history of the Jews for near forty years after the destruction of their city. The ruins of Jerusalem were occupied by a Roman garrison, to prevent any attempt to rebuild it; and the tax imposed by Vespasian continued to be exacted by his immediate successors, who exhibited considerable jealousy of the Jews, and often subjected individuals among them to great hardships and indignities. Upon the whole, however, the race seems to have enjoyed considerable security; and though forbidden to approach Jerusalem, large communities were suffered to be formed in Palestine.

In the beginning of the reign of Trajan, a spirit of restlessness and sedition again began to appear among this unhappy people in all quarters of the world. When the emperor was engaged in the war with Parthia, the hereditary enmity of the Jews and Greeks in Egypt broke out in hostilities, in which were shed oceans of blood. No effective attempt seems to have been made for some time on the part of the Romans to put an end to these commotions. At last, however, Hadrian interposed, and inflicted on the miserable Jews signal punishment. About the same period, A. D. 116, the Jews of Mesopotamia, whom the victories of Trajan had subjected to the Roman instead of the Parthian sway, rose in unsuccessful rebellion against their new masters. In the following year Trajan died, and, under his successor Hadrian, the Mesopotamian Jews were again left to the sway of their ancient monarchs.

The accession of Hadrian was not likely to prove advantageous to the Jews in general, as it had accidentally been to those of Mesopotamia. He had indicated his sentiments towards them by his proceedings in Cyprus and Egypt before the death of Trajan; and when he succeeded to that prince, he issued an edict forbidding circumcision, the reading of the law, and the observance of the Sabbath; and he announced his purpose of establishing a Roman colony on the ruins of Jerusalem, and of erecting a temple to Jupiter on the place where the temple of Jehovah had stood. To this new city was to be given the name Ælia Capitolina, from his own prænomen, and from the dedication of the capital to Jupiter. For a time the Jews submitted, with ill-concealed purpose of resistance, to the authority of Hadrian. But in the year 129 we find the whole of Judea once more in a state of rebellion. The leader of this new revolt was Barchochab, which, in the Syriac, signifies the son of the star. He assumed the character of the Messias, pretending that he was the Star of Jacob foretold by Balaam, who was to deliver the Jews and subdue the Gentiles. Little is known of his previous history. According to report, he had been at one time a robber; and his conduct shows that he must have been a man thoroughly conversant with scenes of blood and rapine; while the devotedness of his followers, and the vigorous and for a time successful resistance he made to the Romans, evince him a man of talent and energy. The war against Barchochab presents a repetition of the scenes of that of Titus. Success at last declared wholly in favour of the Romans, and, about the year 134, Judea was again made desolate. About a half million fell by the sword in the course of this war, besides those who perished by fire, famine, and sickness. Those who escaped were reduced to slavery by thousands. Such as could not be thus disposed of were transported into Egypt, and Palestine was almost wholly depopulated. The Jews were now forbidden to enter Jerusalem, or even to look upon it from a distance; and the city, under the name of Ælia, was inhabited by Gentiles only, or such Christians as renounced the Jewish ceremonies. Jews.

However severe the Romans might be in the wars which they carried on against the Jews, they seem to have been ready to lay aside their resentment when the occasion passed away; and under Antoninus Pius we find the Jewish people again restored to their ancient privileges, with a prohibition merely against proselytizing. They were still excluded from Jerusalem, but they were permitted to form and to maintain considerable establishments both in Italy and in the provinces; and while they were exempted from many expensive and burdensome offices, they enjoyed municipal honours in common with other citizens. The erection of new synagogues was permitted in the principal cities; and the Jews were allowed to celebrate the solemnities of their religion without molestation.

At this period we find the eastern and western Jews divided under two great spiritual monarchies, viz. the patriarchates of Tiberias and Babylon. The origin of both is involved in considerable obscurity. In regard to the former, viz. that of Tiberias, the tradition among the Jews themselves is, that the Sanhedrim, after moving from Jerusalem, settled at Jamnia, and finally fixed their abode upon the banks of the Lake Genesareth, where their supremacy was acknowledged as of divine appointment, their chief or president exercising the authority of a spiritual head over the Jews in the provinces of the Roman empire. He was acknowledged as their patriarch or pontiff. An annual contribution was raised for him by the dispersed brethren, and his legates or apostles visited every synagogue, bearing his mandates, and deciding in all questions that were brought before them. To this new form of government a legal sanction was given by the Roman emperors, and it continued in existence till about the beginning of the fifth century. As the law was still made to extend to every moment of time, and to every

Jews. variety of thought and action, with a burthensome and perplexing minuteness, and no memory could retain the multitude of statutes which were prescribed, and difficulties were constantly arising as to the duty required in new combinations of circumstances, the Jewish lawyers continued to possess an unbounded power over the consciences of the people. And as it was indispensable that all the rabbis should agree in their decisions, reference was constantly necessary to the spiritual patriarch, so long as the traditionary law was not committed to writing, and was to be found only in the living decision of the patriarch and his senate. The publication of the Talmud, though it exalted the character of the special patriarchs by whom the work was undertaken, was calculated to diminish the influence of the patriarchate. It took away the necessity of appeal from the inferior courts, by affording the means to every rabbi to give a just decision. This must be considered as the chief cause of the fall of the patriarchate of Tiberias, which took place about the beginning of the fifth century; though other circumstances contributed. The exportation of the annual tribute from Rome was prohibited by the Emperor Honorius; by a law of Theodosius the title of prophet was taken from the patriarch Gamaliel; and upon the death of that individual, though the office was not abolished, its authority being destroyed, no successor was found, and the power which had been exercised by the patriarchs passed into the hands of the rabbinical aristocracy.

The power of the patriarch of the West was of a spiritual nature; but in the East, the office corresponding to the patriarchate involved a mixture of temporal authority. The Babylonian Jews are those inhabiting between the Tigris and the Euphrates. During the wars between the Jews and Hadrian, this colony was greatly increased by fugitives from the West. In their early history, and till a considerable time after the introduction of rabbinism, the Babylonian Jews were less distinguished from the people among whom they lived than their brethren in the West. So long as the temple remained, it formed a bond of union between the two classes, as they all contributed regularly to its support. In addition to this religious tax, they paid another to the kingdom to which they belonged. A system of taxation was organized for this latter purpose, which was intrusted to a chief person among themselves, named the Resch Glutha, that is, a chief of the colonists, or, as he is usually called, Prince of the Captivity. The office of this individual was at first wholly of a temporal nature, and all that related to matters of faith and worship was regulated by the decisions of the Sanhedrim at Jerusalem. After the destruction of Jerusalem an attempt was made to throw off the dependence upon the schools of Palestine, which was frustrated for a time by the arts of the patriarch and his senate. By degrees, however, the inconvenience of a constant reference to a distant country, and the growing celebrity of the schools of Nisibis and Nahardea, enabled the Resch Glutha to establish his independence. He formed a court after the model of that at Tiberias; and, under the prevailing belief that he was the lineal descendant of David, he succeeded in establishing his claim to a spiritual, in addition to his temporal authority. He exercised a power almost despotic over the Jewish people; and, though a vassal of the king of Persia, he maintained an almost regal state. The rabbis were in complete subjection to him; and from his being able to bring his power as a temporal prince to bear upon his ecclesiastical mandates, his influence over the Jewish community was greater than that of the Nasi. From our ignorance of the state of the East beyond Persia, the extent of his dominions cannot be ascertained. His subjects consisted of shepherds, husbandmen, artisans, and merchants; of the latter many were wealthy. They do not seem to have been subjected to persecution, and, in the enjoyment of peace, the interests of learning flourished. Schools rose rapidly in different parts of his dominions; and to one of these we are indebted for the Talmud of Jerusalem, which has exercised such an influence upon the Jewish people in all succeeding times. The increasing number of the schools, and of the learned men proceeding from them, gradually lessened the influence of the Resch Glutha, though the office continued in existence till the middle of the eleventh century, when it was suppressed by the tyranny of one of the caliphs. Jews.

The establishment of Christianity as the religion of the Roman empire, the irruption of the northern nations, and the rise and progress of Mahommedanism, had all a marked influence upon the condition of the Jews. The first Christian emperors conducted themselves towards the Jewish people with a lenity and forbearance that was not always agreeable to some of their subjects. Under Constantine the right of the Jews to the privileges of Roman citizenship was fully recognised, while the rabbis had the same exemption from civil and military offices as the Christian clergy. Christians, however, were prohibited from becoming Jews, while converts from Judaism were protected from the resentment of their countrymen. Under Constantius the Jews of Palestine subjected themselves to the severity of the laws by their interference in the contests between the Arians and Athanasians. Several of their cities were destroyed, and the law of Hadrian was renewed, by which they were forbidden to approach Jerusalem. The hatred of Julian to the Christians disposed him to view their enemies the Jews with a favourable eye. He entered into a correspondence with the patriarch of Tiberias, and wrote a friendly letter to the Jewish community, in which he promised to put them again in possession of Jerusalem, and to restore their temple. At last an edict was issued for the rebuilding of the sacred structure, and instructions were given to Alypius, prefect of Syria, to carry it into effect. Jerusalem was once more filled with Jews, who assembled from all sides, emulous to give their aid in an undertaking which was to prove a new era in their history. Materials for the vast fabric were collected, and the mountain was purified from the abominations of idolatry. But when the workmen proceeded to dig for a foundation, they were surprised by a subterraneous explosion, in which some perished, while the rest took to flight in dismay. Though a difference of opinion has existed as to the character of the igneous irruption, the evidence that the work was in fact suspended is of the strongest nature, and the truth of the predictions of Scripture was fully maintained. The death of Julian prevented the renewal of the attempt, and put an end to all his schemes for the benefit of the Jewish community. His successors showed in general a tendency to favour the Jews as useful subjects, and frequently protected them from the violence of the people, though in some instances the bigotry of the more powerful prelates prompted to measures of severity. It must be added, that the blind zeal of the Jews often rendered them the just objects of the popular indignation.

Upon the division of the Roman world, the condition of the Jews in the eastern empire became less favourable than that of their brethren in the West. For a time, indeed, they continued to enjoy the rights of Roman citizens according to the law; but under Justin I. they were pronounced as belonging to the same class with heretics, and consequently disqualified for civil and military offices. The laws of Justinian were framed for persecuting them into proselytism. By the imperial edicts the duties of citizens without the honours were rigorously exacted. In mixed marriages, the education of the children was confined to the Christian parent: if the children grew up unbelievers,

Jews. they were deprived of their inheritance; and in law-suits, except in cases where both parties were Jews, their testimony was inadmissible. Another law was passed by this emperor, in consequence of a division among the Jews themselves, which, had it been observed, might have been followed with serious consequences to Judaism. Upon the suppression of the patriarchate, the power which had been enjoyed by that spiritual chief was divided among the primates or chief rabbis of the separate Jewish communities. The power of the rabbis arose principally from the respect in which the Talmud was held, and from the right which they enjoyed of expounding the sacred volume. From policy or habit their instructions were conveyed in ancient Chaldaic; and as this ceased to be understood by many of their hearers, who adopted the language of the country in which they settled, a very general wish prevailed for a change in this custom, and for a translation of their Scriptures. This alarming spirit of innovation was resisted by the rabbis; and the contending parties resorted to the extraordinary expedient of referring the cause to the Christian emperor. The decision of the emperor was in favour of the rights of the people. In the edict which was issued, the fullest license was granted for reading the Scriptures in the vernacular tongue; the Mischna was declared to be of human composition merely, and full of such errors as belong to all the works of men; and the hope of the emperor was expressed that the perusal of the Scriptures in a known language might lead to the conversion of many to the Christian faith. It is probable that this intimation awakened the suspicions of the people, who do not appear to have availed themselves of the permission that was given them.

In the western empire, upon the irruption of the barbarous tribes, the Jews suffered less than their Christian neighbours. Ready to accommodate themselves to every change of circumstances in the pursuit of gain, we find them following in the rear of conquering armies, or retreating before advancing hosts, contriving in one form or other to make their harvest of traffic in both cases, and frequently growing rich amidst the general ruin. In all the kingdoms which rose up out of the ruins of ancient Rome, the Jewish people formed a part; but our information respecting them for a considerable period is far from being complete. In the absence of a literature of their own, we know of them only by ecclesiastical writers, who take notice of them chiefly as the objects of the converting zeal of the catholic church. The success of the Christian priesthood among their barbarous invaders inspired them with hopes of gaining converts among the Jews. But the circumstances of the two classes were altogether different. Among the heathen, when a prince or a successful warrior was converted to the faith, he carried along with him all his subjects, or his companions in war. But the Jews moved in masses only in matters connected with their own religion; in every other respect they were wholly independent of each other. Their conversion, therefore, could only be the effect of conviction on the part of each individual. The character of the Christian clergy did not fit them for so arduous an undertaking. Their ignorance and frequent immorality placed them at a disadvantage in regard to the Jews, who were in possession of the Old Testament Scriptures, and had arguments at command which their opponents could not answer. Besides, there were no inducements of a worldly nature at this period to influence the Jews to exchange their religion. They had no wish for the retreat of the cloister, nor did they stand in need of protection for deeds of violence and rapine. Their habits were of a description altogether different from those of the monk or brigand. The attempts of the clergy, however, were unremitted, and threats and blandishments were alternately resorted to, and the struggle was constant between Catholicism and Judaism. In the political contests between the Arians and the Catholics, the Jews, as they had done in Asia, took advantage of the divisions, naturally ranging themselves on the side of the Arians, and they found their advantage in this alliance. The Gothic tribes, however, were soon brought over to the orthodox belief, when the Jews stood opposed to the united body of Christians, till the appearance of a new religion wrought a diversion in their favour. Jews.

The rise and progress of Mahommedanism proved, upon the whole, highly advantageous to the Jewish people. Equally descendants of Abraham with the followers of the prophet, they had in so far a common cause against idolators, and against the defendants of the Christian doctrine; and this for a time made them forget the points of difference. In the new impulse given to trade by the progress of the Moslem arms, the Jews, ever awake to their own interests, took their advantage. In the wide extent of conquest, new wants were created by the advance of victorious armies, kingdoms which had long ceased to hold intercourse with each other were brought into union, and new channels of commercial intercourse were opened up; and, leaving the pursuits of agriculture, which were placed at a disadvantage by the policy of the caliphs, the Jews became the merchants by whom the business between the eastern and western world was conducted. In the court of the caliphs they were favourably received; and for centuries the whole management of the coinage was intrusted to them, from the superior accuracy and elegance with which they could execute it, and from their opportunities, by the extent and variety of their commercial relations, to give it the widest circulation, and at the same time to draw in the previous issues of other mints. Nor did they flourish only in commercial greatness. Not a few of them distinguished themselves in the walks of science and literature. They became eminent in astronomy, astrology, medicine; the principal translations by which the Arabians became acquainted with the discoveries and theories of Grecian and Roman authors were conducted by them, though their chief attention was directed to the Talmud, and to the literature connected with it.

Wherever the Moslem arms extended, we see the Jews for a time in a prosperous condition, though with various exceptions, in different countries and under different caliphs. In North Africa, in Egypt, in Persia, we find Judaism in a more favourable state than formerly; and in Spain, the Jews rose to a height almost as great as that of the Moors themselves. In that country their religion enjoyed full toleration, and the Arabico-Jewish literature forms an important chapter in the history of learning from the seventh till the twelfth century.

There is a tradition, that during this period a Jewish kingdom was established on the shores of the Caspian, named Khazar. The inhabitants of the territory consisted indiscriminately of Jews, Christians, and Moslemites, drawn to the spot by the advantages which the situation of the country presented for trade. A king of the country (740) was converted to the Jewish faith, and for some time the affairs of the nation were conducted by a Jewish prince, with the assistance of a council, whose members were of different religious persuasions. A period of only a century and a half is fixed for the succession of Jewish princes, though at a later date a considerable part of the population consisted of Jews.

About the same period a combination of circumstances proved favourable to the condition of the Jews throughout Christendom. Charlemagne protected their interests. He is said to have had a Jewish merchant always near his person, and the correspondence between that great monarch and Haroun Alraschid was under the care of a Jew,

Jews. The immediate successors of Charlemagne followed the same line of policy. France numbered the sons of Abraham as the richest of her merchants. Their fame as physicians was also widely spread; and their intelligence and activity commended some of them to high political offices.

But a time of change was approaching; and we have now to trace a gradual decline in the Jewish character and condition, till at last we find that unhappy people trampled upon, crushed, butchered, proscribed, in almost every country in Europe. The special causes of the persecutions to which the Jews were subjected were different in different countries, and it would far exceed our limits to trace them minutely. Throughout the greater part of Europe, however, we witness the advances of a similar process. We find the Jews abhorred by the superstitious on account of their religion, envied by the powerful on account of their riches; and, amidst the contempt and injustice to which they were subjected, courting, if not meriting their fate, by crouching before and cozening their hated oppressors. In many parts of Europe they were not allowed to possess land, and were forbidden to aspire to offices of trust or honour. The injurious effects of this exclusion were soon manifest in their character and habits. Shut out from all the paths which lead to distinction, the aspiring aims of honourable ambition, and the ennobling feelings connected with the love of country became strangers to their bosoms. Their efforts were limited to the accumulation of wealth; and in the decay of commerce during the middle ages, their minds were debased by the petty details of the lower species of traffic, which was all that was now open to them. Their ambition being thus fixed upon one subject, they soon mastered all the degrading arts of accumulating gain; and, prohibited from investing their gains in the purchase of land, they found a more profitable employment of it in lending it at usurious interest to the thoughtless and extravagant. The effect of this was inevitable. At a time when commercial pursuits were held in contempt, the assistance of the Jews became indispensable to the nobles, whose hatred rose in proportion to their obligations; and, where there was the power, the temptation to cancel the debt by violence became often irresistible. The Jews had no means of resisting such injustice, and their only revenge was in the exaction of more exorbitant terms when the necessitous again had recourse to them. The meanness and injustice of which they were thus unquestionably guilty inflamed the public feeling against them, till every atrocity was considered as justifiable when directed against a Jew.

In the Germanic empire the rights which the Jews had enjoyed under the ancient Roman law were to a certain extent continued to them; and though they gradually became the objects of aversion to all classes, the imperial protection and the papal ordinances preserved them from general attack till the time of the Crusades. It was at Trêves that the suggestion was first made to the fanatical multitude proceeding under Peter the Pennyless to take possession of the Holy Land, that they should fall upon the enemies of the cross living among themselves. The choice of death or of conversion was given to the miserable Jews of that city, and only a few escaped alive from the general massacre. Fathers presented their breast to the sword after putting their own children to death, that they might be rescued from the danger of being trained up as Christians; and wives and virgins sought for refuge from the brutality of the soldiers by throwing themselves into the river with stones fastened to their bodies (1096). Similar scenes were repeated in Cologne, Mentz, Worms, and in all the cities on the Rhine; and the progress of the armies was marked by the blood of the Jews till they reached the plains of Hungary. Upon a moderate computation, not fewer than 17,000 are supposed to have perished. The minds of those who escaped were filled with consternation; and their synagogues resounded with their appeals to the justice and mercy of the God of their fathers, who seemed to have forsaken them who refused to forsake Him. Many fled to Silesia, Moravia, and Poland, where they laid the foundations of great communities. A few, however, still continued to cling to the land that had given them birth; and we find them again in sufficient numbers to excite the persecuting zeal of the second Crusaders (1146). Upon this occasion the greater part saved themselves by a timely flight. Forty years later, the Emperor Frederick gave his protection to his Jewish subjects till the tempest of the third Crusade swept past. Disastrous as the period of the Crusades was to many of the Jews in Germany, there were some of them who yet contrived to reap a golden harvest. A demand for money was created for the support of so numerous armies. Many chiefs parted with their estates to enable them to proceed with their retainers to the Holy Land; and in the transfer of property which thus took place, as well as in the trade that was occasioned by the fitting out or march of numerous hosts, many Jews accumulated great wealth. Jews.

From the time of the Crusades, the condition of the Jews in Germany continued unsettled and degraded. History is full of instances of the injustice which they suffered from the rapacity of princes, and from the tumultuous assaults of the people. From certain states and cities they were interdicted altogether. In others, however, they had a right of residence, and a particular quarter of the city was assigned to them. But the privileges conferred upon them often proved the occasion of new injuries. They were frequently expelled from the streets to which they had a legal right, in order that a sum of money might be extorted from them for permission to return to their own dwellings; the popular fury was ever ready to break out against them; and needy princes held out the threat, that unless their coffers were replenished by contributions from the Jews, an incensed populace would be let loose upon them. Upon other occasions, the necessity of their conversion was insisted upon, and they were compelled to pay large sums to avoid the misery of being forcibly baptized. Reports were continually circulated to their disadvantage. Stories were told of Christian children having been found murdered in the house of a Jew, or of their own children being prevented by cruel threats from adopting the Christian faith, or of their stealing the consecrated host to crucify afresh the Son of God. And such fabrications had the effect of subjecting the Jews to the cruelty of lawless mobs, of circumscribing their rights, and of placing their lives and fortunes at a miserable uncertainty. Enthusiasts arose, who considered themselves commissioned by Heaven to proclaim war against the unhappy people. A nobleman named Rhindfleish, in the thirteenth century, proceeded through many of the most populous towns in Germany, followed by a multitude, who destroyed whole communities. A peasant named Armleder followed a similar course (1337), till his atrocities awakened the tardy justice of the emperor, by whom he was put to death. In 1346, the Flagellants came into a collision with the Jews of Frankfort, which terminated in a battle between the other citizens and their Jewish neighbours. A few years later, the whole of Europe being desolated by a plague, in Germany it was believed that the Jews had thrown poison into the public wells. The result was terrible. At Basle the Jews were brought into a vessel on the Rhine, which was set on fire, their children being spared that they might be educated as Christians. It would be tedious to enumerate the various forms in which the Jews met their death in other cities. But from Switzerland to Silesia the land was drenched with innocent blood, and even the interference of the emperor and the pope proved long insufficient to put an end to the atrocities that were perpetrated.

Jews. Feelings of humanity, as well as the interests of his kingdom, led the Emperor Charles IV. to grant to certain states and cities privileges which they had long in vain petitioned for; and in the Golden Bull the condition of the Jews was determined in such a way as preserved them from the hazard of the massacre of whole communities, though it left them still exposed to the evils of individual oppression and injustice.

Though thus subjected to every variety of inhumanity and injustice in the German empire, they were still permitted to remain in the country; and in some states and cities considerable immunities were possessed by them. It was otherwise in France, Spain, and Britain, from which countries, after being subjected to the most galling persecution, they were ultimately driven into banishment. In France the condition of the Jews had always been more precarious than in Germany; and from the tenth century we see them gradually and rapidly declining from a learned, and influential, and powerful class of the community, to miserable outcasts; the common prey of clergy, and nobles, and burghers; and existing in a state worse than slavery itself. Even in this wretched situation, though deprived of every thing else, and denied the common rights of humanity, they were still possessed of gold. This was at once their strength and their weakness; though hated by all, all were dependent upon them; and, possessed of a large proportion of the wealth of the kingdom, they had articles of value in pawn from all classes of the community. They suffered here, as in Germany, by popular violence; and the proceedings of the princes were if possible more arbitrary and tyrannical. The archives of the kingdom, however, contain evidence of usurious extortion so monstrous as loudly to call for legal interference, though not certainly in the way in which it was actually made. The edicts which terminated in their final expulsion from the kingdom began with Philip Augustus. He issued an ordinance for the relief of those who were indebted to the Jews. According to it, all the pledges in their hands were to be restored. Among these a golden crucifix and a Gospel being found, the popular suspicion was awakened, and all the Jews of Paris were sent into banishment. The necessities, or cruelty, or superstition of succeeding kings varied the modes of Jewish persecution. Louis VIII. annulled all interest on debts due to the Jews. Under Louis IX. an edict was promulgated for the destruction of the Talmud. By other laws, Jews were forbidden to hold social intercourse with Christians; and no punishment was to be inflicted upon a Christian who killed a Jew. As in Germany, monstrous tales were spread abroad, and believed, of their sacrilege and cruelty. They were accused of throwing poison into rivers, of practising magic, of holding correspondence with infidel kings. They were proscribed, hunted down, burnt to death. Yet still they sought to live in the land that oppressed them, paid a price to live in it,—and their revenge upon their oppressors was to drain them of their gold. At last, in the latter part of the reign of Charles VI. (1594), they were commanded to quit the kingdom. This sentence was rigidly put into execution; and the greater part of the exiles withdrew to Germany, Italy, and Poland.

The time of the introduction of the Jews into England is unknown. Traces of them are discoverable before the Norman invasion; after which event a considerable addition was made to their numbers. William II. found in his Jewish subjects so great a source of profit, that he refused to allow them to become converts to Christianity. The Jews flourished accordingly under his reign; they increased in numbers and in opulence in various cities throughout the kingdom, and the greater part of Oxford is said to have belonged to them. It is somewhat remarkable, however, that their only burial-place was in London, and it was not till the time of Henry II. that they were allowed the privilege of interring their dead elsewhere. Though favoured for a time by the English monarchs, from the advantages they derived from them, the Jews became the objects of popular hatred, partly from motives of superstition, and partly from the odium that at that time was generally attached to the practice of lending money upon interest, as well as from the rigour with which this practice was exercised by them. The first general display of the public hatred was in the reign of Richard I. On the day of the coronation of this prince, some Jews, contrary to an express prohibition, were discovered as spectators of the ceremony. An attack was made upon these individuals, which terminated in a general assault upon the Jews. Their houses were plundered, and in many instances committed to the flames. Richard in vain attempted to repress the tumult, which continued to rage two days. Similar outrages ensued in Norwich, Stamford, and in several other towns. Knights who were proceeding to the Holy Land considered themselves justified in robbing the rich Jews, to aid them in their pilgrimage. And, in many cases, those who had borrowed money from their Jewish neighbours stirred up the people to a tumultuous onset, as the easiest way of cancelling their debts. In York the Jews took refuge in the castle, and made a vigorous resistance; but finding their situation hopeless, they devoted themselves to a voluntary destruction. They first destroyed everything of value that belonged to them. After this their chief with his own hands murdered his wife and five children, and then submitted to death himself. Their dead bodies were thrown over the ramparts. The example was followed by five hundred others. In the mean time, those who were indebted to the Jews proceeded to the cathedral, where the bonds were kept, and committed them to the flames. During the two following reigns, the history of England abounds in instances of the oppressions to which the Jews were subjected, and of the vast sums extorted from them by the necessities of the monarchs; though privileges were occasionally conceded to them, in such forms as insured a profitable return. The tyrannical proceedings of King John in reference to the unhappy race are well known, and in particular the anecdote of his ordering that a rich Jew of Bristol should lose a tooth daily till he paid 10,000 merks. The Jew lost seven teeth before he yielded. Their situation was in no degree improved under Henry III. Though various decrees were issued in their favour, the superstitions of the clergy and the people, and the necessities of the government, subjected them to every varied form of contumely and wrong. After the king had repeated his extortions so frequently that the Jews made the vain threat of leaving the kingdom, he sold to his brother all the Jews in his realm for 5000 merks, with full power over their persons and property. At last, in the succeeding reign (of Edward I.), an edict was issued (1290), without any known pretext afforded by their conduct, for their expulsion from the country altogether; and, after having been deprived of all their possessions, the wretched race, amidst the mockery and triumph of the common people, proceeded to the shore, and finally left the island. The exiles amounted to 15,000, or, according to others, to upwards of 16,000.

Jews.

The history of the Jews in the Spanish peninsula forms one of the most interesting and affecting chapters in the strange vicissitudes of that ill-fated race. During many centuries their situation, both in Spain and Portugal, was more favourable than in any other European country. The political influence which they enjoyed with the Moslems commanded for them the respect of the Christians, if it increased their hatred; and after the decay of the Mahommedan power, their superior education, their talents for affairs, their wealth and their industry, in a country where

Jews. the lower orders were sunk in the deepest degradation, while the nobles were engaged almost wholly in war, rendered them too important a class of the community to allow their rights to be rashly interfered with. The protection which they enjoyed arose in no small degree from the policy of the sovereigns, who found their Jewish subjects invaluable, not only to themselves individually in various departments, as physicians or ministers of finance, but also to the country generally, from the life which their industry gave to trade, and from the unfailing certainty with which recourse might always be had to them upon every occasion when money was required. The nobles, and even the priesthood, were by no means insensible to the latter of these advantages; and when, in some instances, the sovereigns, forgetting their true interests, prepared to make the Jews the subjects of their extortion, we find the clergy overcoming their superstitious feelings, and interfering in their behalf.

The political or rather legal position of the Jews in Spain varied in different periods, and even at the same time in different parts of the country. In the most favourable circumstances, they were considered as belonging to the king directly, and indirectly to his greater vassals; and thus they enjoyed the right of self-defence, and could claim the protection of their liege lords when unjustly attacked. In all their greater communities they had their own courts of law, which enjoyed a certain jurisdiction both in civil and criminal affairs. They could possess landed property, though many efforts were made to restrict this right, which induced them here, as in other countries, to engage in the practice of lending money upon interest. The rate of interest was fixed by the law; and we do not find charges of chicanery and extortion brought against them similar to those made against their countrymen in France, or England, or Germany. Among their other privileges, they could not be imprisoned on account of debt, and, with certain limitations, their evidence was received in courts of justice. In Portugal they enjoyed similar privileges as in Spain.

The superior character of the peninsular Jews proved that these advantages were not unworthily conferred. They held a much higher rank than in the other parts of Christendom. Not compelled to have recourse to arts that sunk them in their own esteem, they maintained a generous rivalry in the liberal use they made of the wealth which they acquired in the walks of honest industry. Their literature betokens no ordinary progress in civilization. Their acquaintance with Arabic put them in possession of all the treasures of that language. Their poets, grammarians, mathematicians, naturalists, are of no mean reputation. And their astronomers were in so great renown, that some of them were employed by Alphonso the Wise in the construction of his celebrated Tables. The study of mental science was also cultivated with no ordinary care, though the pursuits of science, whether natural or metaphysical, were ever more or less connected with their theology. Three epochs have been marked in the progress of the philosophy of the Jews of Spain. In the first, we have the endeavour to connect the discoveries of science with the doctrines contained in the Talmud, and to present the peculiarities of Judaism in a philosophic form. In the second, we find the spirit of rabbinism lording it over the efforts of philosophic genius. In the third, a contest was carried on, sometimes under the forms of philosophy, between the advocates of Judaism, and those who endeavoured by the force of argument to gain converts to the Christian faith.

The point at which the star of the fortunes of the Spanish Jews might be said to culminate, was in the thirteenth century, during the reign of Alphonso X. From that period the superstitions of the people were more bitterly directed against the unfortunate race, and in the succeeding reigns constant attempts were made to diminish their privileges, while local outbreakings of popular dislike subjected individuals and whole communities to severe suffering. Alphonso XI. though himself favourably disposed towards them, was compelled (1325) to yield in various particulars to the feeling that began to be expressed against them. In this reign they were enjoined to confine themselves to particular streets, at the greatest distance from the churches; and thenceforth particular districts were known in every city where a community existed as the Jews' Quarter. The greatest misery, however, to which they were subjected arose from attempts for their conversion. A proselytizing spirit had manifested itself in various forms from an early period. An institution was erected in Aragon in 1250, for the express purpose of training men to enter into controversy with the Jews; but, not trusting to the mere force of argument, the rabbinical writings were frequently subjected to a censorship, by which whatever was supposed to be injurious to the interests or hurtful to the feelings of churchmen was cancelled. Such instances of intolerance, however, afforded but feeble presage of the fearful hurricane that at last arose. Jews.

The attack commenced in Seville in 1391, where the minds of the citizens were inflamed by a sermon which an archbishop delivered in the cathedral. Individuals among the Jews were insulted and plundered. The attempts made by the civil authorities to restrain the popular fury increased its violence, till at last a general attack was made upon the Jews' Quarter, and of 7000 families upwards of one half were put to death, while the remainder sought for safety by a pretended conversion to Christianity. The example was followed in Cordova, Toledo, Valencia, and in all the cities where the greatest communities of the Jews were to be found. Many thousands were butchered; not a few left the kingdom, seeking for refuge in Italy, Turkey, and the states of Barbary; and it is calculated that 200,000 were forced into a profession of Christianity. The condition of these converts, or pretended converts, was truly deplorable. Subjected to the suspicions of the Christians, and to the hatred of those of their countrymen who continued stedfast to their ancient creed, many of them found their situation altogether insupportable, and became voluntary exiles. Not a few returned to the profession of Judaism, choosing rather to brave all the horrors of persecution than to submit to the odium of a suspicious apostacy.

The government showed its disposition to protect those who did not depart from the Jewish religion; several of the princes were opposed to extreme measures; and affairs began to wear a more favourable aspect. But the calm was only temporary. The sincerity of the whole of the Jewish converts, or, as they were called, the *New Christians*, began to be questioned. The honour of the church was considered as at stake; and, by the influence of Alphonso of Godeja, a bull was obtained from Pope Sixtus IV. for the institution of the inquisition, effectually to prevent a return to Judaism. The queen, the Jews, even the Cortes, resisted the introduction of this dread tribunal; but the priesthood prevailed. The tribunal was opened in Seville, and invested with full power to summon every individual suspected of secret attachment to Judaism. The unsparing energy with which it was to proceed was marked by the fact, that in a short time Seville numbered more prisoners than inhabitants; and in the course of a single year, in that city and in the immediately surrounding country, upwards of 2000 were put to death, several were imprisoned for life, and 17,000 were subjected to corporal punishment. At last a large stone building was constructed for containing a multitude

of prisoners, combustible materials were placed around the outside of the walls, while the wretched inmates were left to perish by a slow death. Four inferior inquisitions were erected in other quarters, and each tribunal received the strictest injunctions to use every effort to preserve the church from the stain of a return to Judaism. The different signs that were supposed to indicate a secret attachment to the abjured religion were defined by law; and wherever any one of them was observed, the individual was to be brought to trial. A free pardon was offered to those who confessed their guilt, if they evinced the sincerity of their contrition by revealing the names of such as had shared with them in their deceit. The rabbis were forced, upon their oath, to declare if they knew any who secretly adhered to the hated worship. Death was the punishment of concealment. The fiercest civil war, the wildest incursion of barbarous hordes, could not have occasioned the deaths of so many innocent men, or annihilated so many sources of advantage to the kingdom. The impolicy was not less infatuated than the injustice and cruelty were monstrous.

Hitherto the persecution had been confined to those who were suspected of insincerity in their profession of the catholic faith; it was now to be extended to wider limits. The arms of Ferdinand and Isabella had been prosperous against the Moors, and the soil of Spain was freed from the infidel race. The inquisition gave the horrid promise of torturing the new Christians into sincerity, or of destroying them by death; and nothing now remained but the expulsion of the Jews to deliver the kingdom from every taint of heresy. The ambition of the crowned heads became alive to the glory and advantage of reigning over a land purified from all admixture of error, and in 1492 the order was given, that within four months every Jew should leave the country. Upon the issuing of this memorable edict, the minds of the unhappy people were filled with astonishment and horror. From the one end of Spain to the other, the voice of lamentation was lifted up. But superstition is inexorable; and the appeal to the justice or mercy of Ferdinand or his queen was alike in vain. The decree was passed, and it was not to be recalled. The Jews now acted worthy of the high character which they had sustained in Spain for nearly a thousand years. The resource of apostacy still remained; but the temptation was spurned, and the sincerity of their attachment to their faith was shown by their preferring it to everything. Upwards of 300,000 left all that was dear to them on earth, and went forth in search of lands where they might be allowed to worship the God of their fathers in peace. But misfortune continued to follow them on their path. The account of their sufferings is heart-rending; our limits permit us only to mention in general, that the richer part of them withdrew first to Portugal, where the Jewish faith had been hitherto tolerated. But the contagious influence of the proceedings in Spain extended to the sister kingdom; and the wretched exiles, after being made the objects of new forms of cruelty and injustice, were at last expelled from that kingdom also. Others, who directed their course for the states of Barbary and Morocco, were subjected to the horrors of shipwreck and pestilence; some were set ashore on desert islands by the inhuman shipowners, and some were sold as slaves. Some went to Italy, where the hardest fate of all awaited them, in the cruelty with which their own countrymen refused to receive them. Thousands lay perishing for hunger on the shore, till even the pope (Alexander VI.) interfered by a sentence of banishment against the resident Jews. But, notwithstanding all the sufferings to which they were exposed, and which so materially diminished their numbers, flourishing communities were formed by the offspring of the exiles in Barbary, Turkey, Italy; and this perhaps more than any thing else evinces how great multitudes had been sent into banishment.

In Spain there were now no professed Jews. There were still, however, many secret adherents of the proscribed faith. Of these, many were so dexterous in the concealment which they practised, as to escape every effort for their detection; and some of them were seated as judges in the very inquisition that had been instituted for their destruction. Others, however, were less successful, and against them horrible cruelties were exercised under the Emperor Charles V. and by Philip II. and III.

The policy of the Spanish government was extended also to Naples, from which city the Jews were expelled by Charles V. The example, however, was not followed in other parts of Italy. In that country, from the time of Charlemagne, the legal position of the Jews was nearly the same as it was in Germany. They were placed under the protection partly of the popes and partly of the emperors, to both of whom they were bound to do homage. Here, as elsewhere, they were chiefly engaged in money-lending and in petty traffic. Their head-quarters was Rome, but numbers of them were to be found in all the other principal cities. The conduct of the popes varied in reference to the Jews, according to their personal character. Paul IV. was the first who shut them up in a confined quarter in Rome, called the Ghetto. By other popes they were compelled to assemble regularly in a church at stated periods, where sermons were preached for their conversion. They were subjected to many other galling interferences till the time of Sextus V. who annulled most of the vexatious regulations of his predecessors, and restored them to some degree of liberty.

The changes effected upon the character and condition of the Jews by the restoration of letters, and by the movements occasioned by the reformation, were less than upon any other portion of European society. There were indeed individuals among them who made noble use of the newly-discovered art of printing, and who were distinguished in the walks of literature and philosophy. But the great proportion of the people, excluded from all share in the government of the countries in which they lived, viewed the mighty changes which were taking place without interest or advantage. The great events that were stirring other men's minds into activity, freeing them from the shackles of ancient prejudices, and opening new views of human affairs, were looked upon by the Jews as a spectacle in which they had no concern. Their spirit was even more concentrated upon their individual gains and their national hopes; and in the progress of the human mind, and in the new views that were continually opening up, they saw nothing more than the fluctuations of a wild uncertainty, that wedded them with a deeper pride to the contracted principles of their unchanging rabbinism. On the other hand, the benefit of more enlarged views that began to be entertained upon the subject of liberty, and respecting the rights of citizens, were not for a long period extended to them; and it is not till within the last fifty years that an instance has been afforded of the full concession of the privileges of citizenship to a Jew.

Still the progress of civilization was silently preparing the way for greater justice being done to this people; and their conduct, in circumstances where they were allowed scope for the development of their better qualities, tended greatly to the removal of the predjudices that existed against them. In no history have we more remarkable illustrations of the great truths, that to enslave is to degrade, and that to render men useful citizens, it is essential to bestow upon them the rights of citizens.

Upon the revolt of the Netherlands, many of the Portuguese Jews (a name applied to all the Jews of the Spa-

Jews.

nish peninsula) took refuge from the persecutions of Philip II. and III. in that country. The distinctions on account of religion were to a certain extent removed, and the Jews of Amsterdam, Rotterdam, and Antwerp, vied, in the highest qualities of commercial greatness, with the citizens of the new republic. They were afterwards joined by many of their countrymen, but of a lower order, from Germany and Poland. Offshoots from the new community in Holland grew up in circumstances scarcely less favourable in Denmark and Hamburg. The continued persecution of the new Christians in Spain drove other Jews to seek their fortune in the Spanish and other colonies in the New World. They settled in the Brazils, and in some of the West India islands, with various fortunes; but many distinguished themselves by their regularity, and enterprise, and wealth, in such a way as to produce an impression favourable to their European brethren.

The recognition of the independence of the United States in America may be marked as the epoch that secured to the Jews the prospect of their being admitted to the full privileges of citizenship, and freed them from the disabilities that had been so long considered as inseparable from their religious condition. The fundamental principle of the new republic involved the treating of the Jews upon the same terms as the other inhabitants. It was not acted upon, however, throughout all the states, till the year 1822. They are now distinguished in no respect, except their religion, from any other part of the population. They have synagogues in New York, Philadelphia, Charlestown, Richmond, and the principal cities of the United States.

The movements in America were intimately connected with the changes which soon afterwards took place in France; and to this may in some degree be traced the new policy that was observed in that country in reference to the Jews at the beginning of the revolution. Notwithstanding the edict of exclusion by Charles V., some Portuguese Jews had been allowed by Henry II. to settle in Bordeaux and Bayonne; and at a later period, the conquest of Alsace, and other changes, added some of their communities to the French dominions. The condition of these communities was taken into consideration in 1789, without any thing, however, being done in that year. But in 1791 they were admitted to equal rights as citizens. In 1806 a sanhedrim was assembled by Bonaparte at Paris; and, upon satisfactory answers being returned to certain queries proposed to them respecting their civil institutions, and their views as citizens and subjects, a plan for the organization of the Jews throughout the empire was adopted. The abuse made of their privileges in some of the provinces of the Rhine, led subsequently to partial restrictions in regard to money lending; and an effort was made to turn their attention to agricultural pursuits. The privileges conferred by Bonaparte were not interfered with upon the restoration of the Bourbons; and, since the revolution in 1830, the Jewish rabbis, as well as the clergy of the different Christian sects, receive a stipendiary allowance from the state. Though by no means approving of such a measure, we conceive it to be worthy of remark, that the minister by whom it was proposed supported it upon the ground that they had shown themselves deserving of the patronage of the state, having, during the preceding quarter of a century, acted in such a way as to give the noblest refutation to all the slanders of their enemies.

At a national assembly held in 1796, they were declared as in every respect citizens of the Batavian republic; and the union of France with Holland led to the removal of every disability of the Dutch Jews.

In Germany little change had taken place in the condition of the Jewish inhabitants for many centuries. The diet of Frederick the Great (1750), for the regulation of his Jewish subjects, was of the most intolerant description. The severest measures were resorted to for preventing their increase beyond a fixed number. They were excluded from all civil offices, and from many departments of lucrative and honourable employment, and subjected to an unequal load of taxation. Their condition in other parts of the empire was not more favourable till towards the end of the last century. Various circumstances contributed about that period to a decided improvement. Among these, the writings and character of Moses Mendelsohn may be mentioned as having had considerable effect in elevating the character of the people in the general opinion. An edict of toleration was published by the Emperor Joseph II. The most important part of it perhaps consisted in the attention it directed, and the support which it promised, to elementary education, and to its throwing open the schools and universities of the empire to the Jews. Freedom of residence and of trade was also granted to them. They were no longer excluded from public places of amusement; and they were permitted to wear certain decorations, and might be created barons. The influence of Bonaparte was exerted for the advantage of the Jews in many parts of the German states; and from 1809 to 1813, we find ordinances issued for the melioration of their condition, admitting them to civil rights, and abolishing odious distinctions. By an act of the congress of Vienna in 1815, the diet is pledged to turn its attention to the melioration of the state of the Jews; and it may be safely affirmed that their condition has of late years been of progressive advancement. In the Rhenish provinces of Prussia, some restrictions have taken place in their privileges, by disqualifying them for certain civil offices; and, in 1822, their learned men were excluded from holding offices in schools or universities. In the free towns, commercial jealousy more than feelings of a religious nature still places the Jews in some respects at disadvantage.

In Switzerland, the privileges which the Jews enjoyed during the reign of Bonaparte have been done away. In Italy also their condition is less favourable than formerly. In the ecclesiastical states they are again shut up in the Ghetto, and 300 every Sabbath are obliged to hear a sermon for their conversion; in 1829 a proposal was made for banishing them from the dominions of the pope, which, however, has not been carried into effect.

The greatest accumulation of the Jews in any one point is in the countries of ancient Poland, now divided amongst the emperors of Russia and Austria and the king of Prussia. Their state has long continued fixed. They form the middle class between the nobles and the serfs, occupying all the common branches of traffic. The rabbinical spirit exists here in greater severity than in any other country. The Austrian emperors have shown a laudable zeal for the melioration of the condition of their Jewish subjects. The Emperor Nicholas of Russia, though his attention has been directed to the subject, has shown a less enlightened spirit.

In England the Jews again obtained a legal re-establishment under the protectorate of Cromwell, and have ever since maintained their footing. A bill for their naturalization was passed in the year 1753; but the prejudices against the measure were so strongly expressed, as to lead to its repeal in the following year. They are still excluded from civil offices, and are subjected to certain restrictions that interfere with some departments of their trade; but their rights have of late years been made the subject of discussion, with every prospect of a favourable issue. (D. W.)

It is only necessary to indicate the changes which have

Jews. taken place in the civil condition of the Jews since the above was written. In Spain and Portugal their rights are still denied them with all the exclusive rigour of the middle ages. In Spain, where every man must belong to the Romish Church, their existence only is tolerated; and even in Portugal, where the Church of Rome has not the same constitutional power, protection alone is guaranteed. In France Napoleon III. has left unchanged the arrangement of 1831, which introduced the rabbis into the circle of religious pensionaries of the state. The affairs of the French Jews are managed by a general consistorium at Paris, and their schools in Algiers enjoy the same privileges with those at home. Nowhere is their social position higher than within the realms of France. In Holland and Belgium the only remaining restrictions were swept away by the revolution of 1830. The Belgian government now undertakes the expense of Jewish education, and follows the example of France in treating them with favour, although, as in Maestricht in 1840, the popular prejudice against the race occasionally breaks out into open violence. In Denmark, since 1814, Jews have been eligible for communal magistracies; and in 1850 the special prerogative of the crown to sanction their intermarriage with Christians has been dispensed with, on the condition that the children are educated in the Christian faith. In Sweden the favourable disposition of the government in 1838 was checked by popular indignation, in which the artizans of Stockholm were particularly prominent. In Norway the law of 1814, which forbade the toleration of their worship, has been gradually relaxed, until, in 1851, the parliament, with the consent of the king, placed them on the same footing with the various sects that do not belong to the national church. In Russia, which contains about two-thirds of the entire Jewish population of Europe, their position is very various. In the Polish provinces their numbers often exceed those of the Christian population; and in some of the smaller towns they stand so high in influence that, for the sake of convenience, the rest of the population has found it advisable to hold the Christian Sabbath on the Saturday. In Old Russia their residence is fettered with intolerable conditions. Great anxiety is manifested by the government for their conversion to the Greek Church, and in 1842 important exemptions from taxation were, by an imperial ukase, made venal with apostacy. Within the last ten years, however, a severer regimen has been adopted, partly on account of the known sympathies of the Jews with all the revolutionary outbreaks in Poland, and partly on account of their participation in the smuggling trade of the frontier. Chiefly on the latter account they were interdicted, in 1843, from settling within a certain distance from the Austrian and Prussian boundaries, and all who were settled within the proscribed limits were compelled to sell their houses, and remove to the interior. Another ukase of September 1843 ordained that, in the deficiency of Russian subjects, they should be subjected to military service, instead of purchasing exemption by a heavy tax. More oppressive was the legislation of the 1st October 1846, which fixed the right to wear a long beard, a caftan, girdle, and cap of sable at 50 rubles yearly, and doomed all to wear a Christian dress except children under ten, or old men above sixty, who could not pay that sum. In 1850 an equally oppressive ukase forbade altogether the practice prevalent among Jewish women in Russia of cutting off their hair at their marriage, and wearing their head covered. A mitigation of some of their burdens was granted in 1851; a capitation tax, levied on Jews who came from Austria into Poland, was repealed, and the price exacted for a safe-conduct to all who quitted the Russian dominions for Gallicia was also abated. In the late war with Turkey Jews were compelled to enlist in the Russian militia when the regiments of the interior were drafted south, and melted away in the Crimea. In Turkey they enjoy, in an equal measure of bondage and contempt, all the privileges accorded to foreign nations under the sway of the sultan. In Italy the ban of the middle ages still hangs over the Jewish people; only in Parma and Tuscany is there any alleviation of their lot. At Ancona, in 1843, a promise was given that the power of the Inquisition over them should cease, and their position beyond the pale of civil society otherwise amended. In Rome they are still confined to the Ghetto, and must pay 800 scudi yearly for the wretched solace of papal protection. It is due to the republic of 1849 to state that this odious tax was formally annulled during the short period of its power; but on the restoration of the pope it was again imposed, and the old law, which forbade the employment of Jewish females in Christian households was, in 1851, revived with heavier penalties than before. The emancipation of the Jews in Sardinia, which was promised in 1848, has not yet been carried out at least to its full extent. In Switzerland the prevailing liberalism of their institutions has not prevailed so far as to affect the social position of the Jews. So late as 1839 they were forbidden to enter the canton of Basle except on market-days, and Jews in the service of Christian merchants received only a few days' notice to quit the province. Lucerne followed the example, and expelled them from the public market in 1850. A second time, in 1851, the canton of Basle repeated its odious decree; and, in spite of the remonstrances of the French, the penalty for employing a Jewish servant was fixed at 300 francs. In Germany their condition varies very much, each principality enacting laws more or less intolerant, according as the government controls, or is controlled by the invariably unfriendly voice of the people. In Austria the decree of Joseph is still in force. Their removal from one province to another is at the option of the emperor, and trade itself is loaded with restrictions which prevent them from ever reaching the position of a native craftsman or merchant. Only in some parts are they permitted to rent or purchase land beyond the space occupied by their own dwellings. In Hungary alone the Magyar nobles have allowed them the free privileges of unrestricted trade. After the commotions of 1848 the Jewish capitation tax was mitigated to all except the residents of Vienna; but in Hungary their share in the revolutionary movements of that year became the occasion of a heavy exaction, ostensibly to be devoted to the cause of Jewish education. Popular hatred, however, avails far more than legislative enactment effectually to isolate the Jews from the commercial and literary circles of the kingdom; and few years pass without some flagrant act of expulsion or exhibition of petty tyranny, from which there is no redress and no protection. In Prussia there has been no recent legislation of any consequence. Their admission as teachers in the gymnasia, and physicians in the army, has been several times proposed by government and abandoned. Commercial jealousy is still powerful enough to procure their expulsion from the exchange, and popular hatred to debar them from the public gardens of the great cities. In the free towns their condition is scarcely much higher than in the most rural districts. In Frankfort the decree of 1824, which excluded them from practising as physicians or advocates, and interdicted them from trading in raw material, or employing any assistants except those of their own faith, was slightly modified in 1849, and a revision of questionable tendency was made in 1851. In Lübeck their equalization with the other citizens has been only promised; and in Bremen they must, as clients, pay a price for their protection. In Hamburgh they have since 1849 been admitted to civic privileges; and in 1851 their marriage with Christians has been legalized, leaving it to the parents to decide in what faith the children shall be educated. In Britain the admission of Jews to parliament has been keenly agitated, but hitherto the Upper House has negatived the decisions of Jews.

the Commons in their favour. The question excited much interest by the election of a Jew as one of the members of parliament for London, who still holds his election, but has not been permitted to take his seat. Comparatively little is known of their condition in the countries of the East. Wherever Islamism prevails they are the helpless victims of studied insult and oppression. In Persia their fate is wretched in the extreme. In Syria the sudden disappearance of a clergyman in 1840 revived the old outcry that the Jews mingled Christian blood in their Pascal ceremonies, and Damascus became the scene of a persecution, which quickly spread to the other towns of the Ottoman empire. The intervention of their British compatriots has, however, availed to procure their protection from the Porte.

The probable number of the Jews has been the subject of frequent but not very successful conjecture. The most cautious estimate is about six millions; but, as their numbers are very great in lands where there is no census, it is scarcely possible to say whether this falls far short of the truth or not.

JEW'S HARP, or JEW'S TRUMP (Fr. *Trompe*). A small musical instrument, known for centuries all over Europe, and consisting of a metal frame with two branches, between which a slender tongue of steel, fastened at one end, and free at the other, is made to vibrate by twitching with the finger, while the frame is held between the teeth. The English name "Jew's trump," seems to be merely a corruption of the French words *jeu* and *trompe*. Prefixed to the Rev. Patrick Macdonald's *Collection of Highland Airs* (1781) there is a Dissertation by the Rev. Walter Young, in which he states that the natives of the island of St Kilda "being great lovers of dancing, have a number of reels, which are either sung, or played on the Jew's harp, or trump, their only musical instrument" (p. 11). In the Himalaya journals, published a few years ago, one of the travellers mentions that he procured a Jew's harp from Tibet. At the commencement of the present century this instrument was improved, and several Jew's harps were combined. No. 30 of the *Leipzic Musical Gazette* (1816) contains an account of the compound Jew's harp, with pieces of music suited for it. The original little instrument has, in modern times, suggested a variety of large and important musical instruments in which the sonorous bodies are vibrating tongues of metal. See HARMONIUM, and article MUSIC. (G. F. G.)

JEYPOOR, a considerable raj, or native state, of Rajpootana in Hindustan. This state, anciently called *Amber*, is about 150 miles in length, and 140 in breadth, having an area of 15,251 square miles. It is in general an extensive plain, though in the north and north-western parts are insulated peaks and clusters of hills here and there rising above the general level. The population is a collection of various races, of which the most numerous are the Minas, supposed to be the aboriginal possessors of the country. Next, and nearly equal in number, are the Jats, who are extensive holders of land, and the most industrious and skilful agriculturists. Brahmins are numerous, being in greater proportion to the rest of the population than in any other state of Rajpootana. Rajpoots, the ruling class, though inferior in number to the Minas and Jats, are conjectured to be still capable of mustering 30,000 men in arms. Of less important tribes the chief are the Banias, Dhakurs, and Gujurs. The aggregate population has been estimated at 1,494,598. The revenue of Jeypoor, independent of the possessions of feudal chiefs, is returned at L.458,395. Under a treaty concluded in 1818 the country became tributary to the East India Company. In 1842 a large arrear of tribute had accumulated, the whole of which was remitted, and the annual tribute thenceforward reduced to L.40,000 per annum. The corruption and intrigue introduced into the administration, rendered it necessary, in 1835, to move a British force into Jeypoor, for the purpose of redressing the wrongs and correcting the abuses which had brought the country to a state exhibiting an empty treasury, desolate palaces, a ferocious populace, and a rabble army. The measures of the British government speedily introduced a better state of things. The prince having been poisoned by his prime minister, a regency was appointed during the minority of the infant successor; financial reforms were commenced, and an approximation made to something like the administration of justice. In 1851 the young chief completed his eighteenth year. He had been initiated into public business, and the British authorities, entertaining a favourable opinion of his general fitness for the duties of his station, he was allowed to assume the reins of government, and exhorted to continue the beneficent system of administration under which his dominions, during his minority, had attained so high a degree of prosperity. Jeypoor, the capital of the country, is distant 850 miles N.W. from Calcutta. Lat. 26. 56., Long. 75. 55.

JEZIREH-EL-OMAR (the ancient *Bazebda*), a town of Asiatic Turkey, on a low sandy island in the Tigris, 120 miles E.S.E. of Diarbekr. The island is about 3 miles in circumference and is almost entirely occupied by the town, which is surrounded by a low stone wall, now very much fallen into decay.

JEZREEL, a town of Issachar, where the kings of Israel had a palace, but after the terrible end of Jezebel and the house of Ahab, the court seems to have fled from the place. In the days of Eusebius and Jerome it was still known by the names of *Esdræla* and *Stradela*. After a lapse of seven centuries, it is mentioned in the history of the Crusades under the name of *Parvum Gerinum*, the *Zerin* of the Arabs. Zerin is situate on a rocky brow at the N.W. termination of Mount Gilboa, and consists only of twenty ruinous huts.

JHALAWAN, a province of Beloochistan, lying between N. Lat. 26. and 29., and E. Long. 65. and 67. 30. It is bounded on the N. by the provinces of Sarawan and Kelat, E. by Cutch-Gundava and Sinde, S. by Las and Mekran, and W. by Mekran and Sarawan. It is 200 miles in length from N. to S., by 150 in breadth, and has an area of about 20,000 square miles. It is mountainous, barren, and very thinly peopled, the entire population being estimated at not more than 30,000.

JHANSI, a considerable town of Hindustan, in the province of Bundelcund. It has a strong citadel, situate on a hill which commands the town. It has a manufactory of bows, arrows, and spears, the principal weapons of the Boondela tribes. The town is situate amidst groves of fine trees, and is surrounded by a good wall. On a rock overlooking the town is a fortress or castellated residence of the rajah. The streets and bazaars are clean and orderly. The territory of which this place is the capital, was formerly part of the possessions of the Boondela rajah of Oorcha; subsequently it fell into the hands of the peishwa, and was assigned to the administration of one of his officers in the character of soubahdar. In 1804 a treaty of defensive alliance was concluded by the British with the then soubahdar as a tributary of the peishwa. In 1817, consequent on the cession to the East India Company of the peishwa's rights in Bundelcund, a second treaty was concluded by the British government with the soubahdar of Jhansi, by which he was acknowledged hereditary ruler of the territory. The revenue of the rajah amounted in 1848 to L.61,198. The town of Jhansi is in N. Lat. 25. 28., E. Long. 78. 38. (E. T.)

JHUJHUR, a petty native state in Hindustan, within the Delhi agency, and subject to the control of the lieutenant-

Jhylum || Jidda.

governor of the N.W. provinces. It has an area of 1230 square miles, and a population of about 110,000. This principality was assigned by Lord Lake to Nijabut Ally Khan, of the Bhuraitch family, in consideration of his services against the Mahrattas from whom it was taken; and in 1806 the grant was confirmed in perpetuity by the governor-general to Fyze Ally Khan; the present Nawaub, and grandson of the original grantee, succeeded in 1835.

JHYLUM, Jelum, Behut, or Vidusta, the ancient Hydaspes, a large river of Hindustan, which has its rise in the S.E. corner of the valley of Cashmere, in the great Himalaya ridge of mountains. It is there called Vidusta, and passes through two lakes E. and W. of the town of Cashmere. It is joined, 10 miles below the town, by the Little Sinde, and receives many small rivulets in its course through the valley and hills, which it enters at Baramoola; and, 4 miles below Moozufferabad, it receives the Kishungunga from the N.; its course thus far being nearly W. From this it takes a great curve southwards to the town of Jhylum, where, in the middle of October, it was found to be 150 yards wide and from 12 to 16 feet deep. In its course through the hills this river is very rapid, and from 100 to 200 yards broad. It is not fordable at any season, though in many places nearly so, as men and horses cross with ease, having only 15 or 20 yards to swim. After a course of 450 miles, it joins the Chunab at Trimmoo Ghat, 18 miles below Jhung, and 45 above Moultan, in which it loses its name. These joint streams, called the Chunab or Chunha, receive the Ravee 48 miles lower down, near Fazilshah and Ahmedpoor, from the eastward, and pass 4 miles N. of Moultan, retaining the name of Chunab to within 7 miles of Ooch, where they are joined at Sheeneebukree by the Gharra, or joint streams of the Beyah and Sutledj, 65 miles below Moultan, and 40 miles below Buhawulpore. From this point to Mittenda Khot, where they fall into the Indus, about 76 miles, these five streams take the name of the Punjnud. The Indus and the Punjnud, or the five rivers, run parallel to each other for this distance, which is about 10½ miles. The whole of this space is one complete sheet of water during the rains and hot season, and appears as one river. The greatest breadth between the Jhylum and the Indus appears to be 114 miles from Attock to Jellalapore Ghat. The whole course of the Jhylum, including its windings, may be estimated to exceed 450 miles.

JIDDA, or Djidda, a seaport town of Arabia on the Red Sea, 64 miles W. from Mecca, of which it is the port; N. Lat. 21. 29., E. Long. 39. 15. It stands on a gentle elevation, rising from the sea, while the surrounding country is a bare desert. Jidda, as respects cleanness and regularity of plan, is superior to most eastern towns. The streets, though unpaved, are comparatively well laid out and wide. The houses are built of coralline stone, from the shores of the Red Sea, and from the perishing nature of this material, are not very durable. In the suburbs, the houses are mere huts constructed of reeds and bushwood. The principal street of the town runs parallel with the shore, and as it contains most of the public buildings, and is much frequented, it presents a very gay appearance. The public buildings comprise numerous khans and mosques, the governor's house, citadel, custom-house, and a rude stone structure, which every true Mohammedan believes to be the tomb of Eve. A wall encloses the town proper and protects it from the incursions of the warlike Bedouins who infest the neighbourhood. It has six gates, one each towards the N., E., and S., and three towards the sea. Of the latter, only the central one is public, the other two being used only on certain occasions. The Eastern, or Mecca gate is open only to Mohammedans, and through it bands of pilgrims pass daily for the Holy City. Jidda is said to be very unhealthy, arising, no doubt, in part at least, from the great scarcity of fresh water. There are only two good wells in the town and neighbourhood, and these being available only to the rich, the poorer classes are obliged to use the brackish water found some 15 feet below the surface, or the stagnant rain water collected in pools and cisterns constructed for that purpose. Jionpoor.

Jidda has long been famous as the commercial emporium of Arabia, and indeed is solely dependent for its existence upon its trade. Situate about the middle of the E. coast of the Red Sea, only about 120 miles distant from the opposite shore of Nubia, and within two days' journey of Mecca, it is peculiarly fitted for the importation of foreign goods as well as for the exportation of home produce. The harbour, however, like most of the other ports on the Red Sea, is inconvenient, and the entrance rather intricate. On account of the shallowness of the harbour, large ships are obliged to discharge their cargoes in the offing about 2 miles from the shore. The imports from Egypt and Abyssinia comprise corn, rice, butter, sugar, clothing, oil, tobacco, musk, and incense; from India, muslins, shawls, spices, and cocoa-nuts; while the Malay Islands and the Mozambique coast send hither slaves. The imports are conveyed by ships to Suez, whence they find their way to the Mediterranean ports, or by caravans to Mecca and Medina, from which cities they are dispersed to Syria, Asia Minor, and Turkey. Dates, and the celebrated balm of Mecca, are brought from the interior for shipment. Next to grain, the most important article of trade is perhaps coffee, which is obtained in large quantities from Mocha. The number of vessels belonging to the port is estimated at about 250. The government of Jidda is in the hands of the Pasha of Egypt, and the town is garrisoned by Egyptian troops, amounting usually to about 400. The population is very fluctuating; the permanent population does not probably exceed 10,000, while, on the arrival of the merchant fleets, and during the feast of Ramadthan, there may be as many as 20,000 strangers within its walls.

JIONPOOR, or Joanpore, a district of Hindustan, in the N.W. provinces, included principally between N. Lat. 26. and 27. It is bounded on the N.W. by the territory of Oude; on the N.E. by Azimghur; on the E. by Ghazeepoor, and on the S. by Benares and Allahabad, and embraces an area of 1552 square miles, with a population of 798,503. It is well watered, and extremely fertile; and the soil is under good cultivation, and well covered with wood. The inhabitants are Mohammedans and Hindus; the latter preponderating in the proportion of 15 to 1. Of the Hindus there was one tribe amongst whom the practice of female infanticide greatly prevailed; but, by the humane influence of the British government, it has been altogether abolished. This district came into the possession of the British in 1775, as forming part of the Benares zemindary.

Jionpoor, the chief town in the above district, and formerly the capital of an independent principality. It is situate upon the banks of the Goomty. The fort, which is built of solid stone-work, was founded in 1370 by Sultan Feroze III. of Delhi, and named after his uncle and predecessor, whose name was Joana. He ordered a Hindu temple to be levelled, and erected the fort around the ruins of it. After his return to the capital, he collected numerous artificers, and persons of every description, and sent them to inhabit the new city, which was completed in twelve years. On the subversion of the empire of Delhi by Timour or Tamerlane, Khuaje Jehan, a governor of the eastern districts, assumed the royal dignity, and he made Jionpoor his capital. He was succeeded in 1399 by his son Mobarik Shah, whose successor was Sultan Ibrahim. During his prosperous reign of forty years he spared no expense to strengthen and improve the fortress and city, and Jionpoor became one of the most celebrated cities of Hindustan, famed for religion and learning. Jionpoor was again annexed to the empire of Delhi in the year 1478 when the

Jitomir ‖ Joan, Pope.

reigning prince was overthrown. Many of the mosques, and some of the caravanseries and colleges built at that period, are still in existence. The fortress is built upon a high bank of the River Goomty, so named from its meandering course. It is built of solid stone, and rises considerably above the level of the surrounding country. It was frequently taken in the contests between the Afghans and Moguls, and much dilapidated; but about the year 1570 it was thoroughly repaired by a nobleman from the court of Akbar, who was governor of Bengal. It was also during his time that the celebrated bridge of Jionpoor was built, which has now stood 280 years, and still remains a monument of ancient magnificence and of architectural skill. In 1773, when this bridge was submerged during the rainy season, a brigade of British troops sailed over it. Such is the strength and solid construction of this bridge, that it suffered no damage from the violence of the current. The town surrounds the fort on three sides, and contains a good bazaar and a number of brick houses. The surrounding country for several miles is covered with the ruins of tombs and mosques. Of the latter there are several in a good state of repair, namely, the Jamai Musjed, which is very handsome, and is built of stone. The travelling distance from Benares is 42 miles, and from Lucknow, 147 miles. E. Long. 82. 44., N. Lat. 25. 45. (E. T.)

JITOMIR, or SHITOMIR, a town of West Russia, capital of the government of Volhynia, on the River Teterev, a tributary of the Dnieper, 370 miles S.E. of Warsaw, in N. Lat. 50. 15. and E. Long. 28. 40. The buildings of the town are the governor's house, a carmelite convent, and several Greek and Roman Catholic churches. The manufactures are confined to hat-making and tanning, but there is also a considerable trade carried on in woollen, linen, and silk goods, as well as in Hungarian and Wallachian wines, tallow, and salt. Four annual fairs are held here. The population of the town is composed of Poles, Jews, Russians, and a few Wallachians. It is the see of both a Greek and Roman Catholic bishop. Pop. (1850) 17,131.

JOAN, POPE, a person, supposed to have been of the female sex, who was for many centuries believed to have occupied the Papal throne between the years 855 and 857. The fable of Pope Joan long held its ground in the annals of the Romish Church as a piece of authentic history. It is only within recent times that it has been finally condemned to take its rank with many other once popular myths in the *chronique scandaleuse*. The common version of the story is as follows:—A young Englishwoman of extraordinary beauty went to reside with her parents at Fulda in Saxony. She was loved by a monk belonging to a convent of that city. To enjoy each other's society undisturbed, it was planned between them that she should assume male attire, and apply for admission into the convent as a neophyte. As she possessed a very extraordinary share both of learning and talent, she easily imposed upon the unsuspecting abbot, and was admitted. Time wore on, and the lovers, tired of their convent life, concerted a plan of flight. They escaped in lay costumes to England, where they remained for a time. From England they passed into France, from France into Italy, and from Italy to Greece. In the course of these wanderings they visited the chief seats of learning in Europe, and became profoundly versed in all the science of their age. Having mastered the Greek tongue in Athens, they were preparing to turn their faces northwards when the lover monk was suddenly taken ill and died. Joan, still in male attire, set out for Italy, and, fixing her abode at Rome, opened a school of philosophy there. Her repute for eloquence, learning, and piety, attracted crowds of students, and even the most celebrated professors were seen on the benches. Meanwhile the pope, Leo. IV., died, and Joan, unanimously chosen in his room, ascended the throne with the title of John VIII. She lived discreetly for a time, and was held in high esteem for her piety and the purity of her life. But at length she fell as she had fallen before; and one day, while walking in solemn procession from the Vatican to the Lateran, she was seized in labour, and, to the horror and scandal of the multitude, gave birth to a child. The circumstances of such an accouchment soon proved fatal both to the mother and her offspring. Joan, Pope.

The first writer who mentions this piece of ecclesiastical scandal was Marianus Scotus, a Scottish monk, who settled at Fulda in 1058, wrote a *Universal Chronicle*, which comes down to 1083, and died at Mayence in 1086. In his chronicle he states the simple facts, "Leo the pope died on the 1st of August. To him succeeded John, who, as is asserted, was a woman, and sat for two years, five months, and four days." The MS. of this work fell, in 1559, into the hands of John Herold a Calvinist, who, in consigning it to press, omitted, either through carelessness or dishonesty, the words *ut asseritur*, and thus changed his author's hearsay into a direct and positive assertion. As time wore on, the simple phrase of Marianus began to grow into a perfect romance. An anonymous chronicle in the library of St Paul at Leipzig, which comes down to 1261, mentions the fact of a female pope of learning and beauty, who during her papacy gave birth to a child; and states that the name and date of this pope are both unknown. A few years later Martinus Polaccus, archbishop of Cosenza, and author of a *Chronicle of Popes and Emperors*, coming down to the year 1277, gave an enlarged version of the story, which, however, it was reserved for our countryman, John Bayley of Suffolk, in his *Scriptores Majoris Britanniæ*, to adorn with all those minute details which were long received as the proofs of its authenticity. All these chroniclers, and a great many more whom we have not named, who borrowed the story from them, were quite without motive in telling the story according to their respective versions of it. These versions differ from each other solely in so far as one chronicler is more credulous or more conscientious than another, more literal or fanciful and inventive in his turn of mind. But the outburst of the Reformation introduced a new element. The Protestants brought forward the tale to prove the fallibility of the self-styled infallible church. Consequently it was their interest to uphold its authenticity. The Catholics were now, for the first time, alive to the necessity of disproving it. Many a fierce controversy now took place between the champions of the respective churches, and every big tome on the one side called forth a still bigger one on the other. The truth was beginning gradually to clear itself from the mass of error in which it was involved, and the *coup-de-grace* was at length given to the whole dispute by a French protestant minister, David Blondel. With a clearness of logic, and a just appreciation of the real nature of historical evidence, which seem to have been greatly wanting to his predecessors, he demonstrates the absence of all good foundation for the story, the utter weakness of its early years, the suspicions which stand around its cradle; and, instead of discussing how far Pope Joan was believed, or generally recognized in this or that century, shows that by her own contemporaries she was never heard of at all. Blondel's book called forth a host of answers from eminent men of his own church, and he was himself persecuted and abused in many ways for preferring truth to the interests of party. Bayle soon after appeared, and strengthened the position of Blondel with impregnable defences. Leibnitz and Eckhardt followed on the same side. With them the controversy may be said to have come to a close, and Pope Joan to be finally convicted of being an impostor, or rather a nonentity. The grounds on which this conclusion is arrived at may be briefly stated. In the first place, 200 years elapsed between the era of the supposed pope and the

Joan ‖ Job.

date at which her name is first mentioned by any historian. In the next place there were at Rome, during the time assigned to her Papacy four persons, who each in succession sat on the papal throne, and left behind them many and various writings. Had they ever heard of the story, it is impossible to believe that they should each and all have passed it over in silence as they have done. In the third place, all the contemporary writers, without a single exception, attest that, immediately on the death of Leo IV., the papal chair was offered and accepted by Benedict III. At the same time, though the story of Pope Joan is given up by all historians alike as a fable, it is impossible that it should have found believers and upholders for so many centuries had there been nothing in the annals of the church to give a sort of colour to it. Many conjectures have been advanced upon the subject, of which by far the most plausible is that of Biancho-Giovini, who proves clearly enough that the papal chair was often virtually occupied by a woman. Pope John X., elected in 914, owed his elevation entirely to his mistress Theodora, whose beauty, talents, and intrigues had made her mistress of Rome about the beginning of the tenth century. At a late period Theodora's daughter, Marozia, wielded a similar influence over Sergius III., and finally raised her son by that pope to the pontifical throne, with the title of John XI. At a still later period, John XII. was so completely governed by one of his concubines, Raineria by name, that he entrusted to her much of the administration of the holy see. These, and other instances of the same kind that might be adduced, account satisfactorily enough for the origin of the fable of Pope Joan. (See Panvinio's edition of *Platina;* Bianchi-Giovini's *Esame Critico degli atti e Documenti relativi alla favola della Papessa Giovanna*, Milano, 1845; *North British Review*, vol. xii.)

JOAN OF ARC. See ARC, *Joan of.*

JOANNES or MARAJO, a large and fertile island on the N. coast of Brazil, province of Para, situate between the estuaries of the Amazon and Para rivers. It is about 120 miles in length from E. to W., and 90 from N. to S. Pop. about 20,000.

JOB, BOOK OF, so called from the name of the patriarch whose inner history and outward fate it depicts. Various questions have been agitated in regard to it, and, from its almost isolated position in the Scriptures, these have afforded ground for much ingenious and plausible conjecture. The points of principal interest are—the reality or fiction of the history, the age of the author, and the nature of the piety and ethics which the book is designed to inculcate. All these questions are very much interwoven with each other; and so clearly do the various answers reflect the mind and foregone conclusions of the critic, that the treatment of the book may be regarded as a testing-point, not only in criticism, but in religion. In regard to the nature of the book, as historical or dramatic, Spanheim has expressed the extreme on one side, when he said, that "unless it contained a true history, the author was guilty of deception" (*ni historia sit, fraus scriptoris*). Luther has expressed the golden mean of opinion, when he said "that he counted Job to be a true history; but that everything happened and was said just as it is represented, he did not believe; but, on the contrary, he held that some able, pious, and learned man had reduced it to its present order." Numerous later critics, however, recoiling from its exhibition of the supernatural, even under circumstances of pain and desertion which render God and invisible agency a necessity of the human mind, have resolved the narrative into a pure poetic fiction. The same anti-supernatural spell which dissolves the superhuman agencies into mists of the brain, constrains them at the same time to witch away Job (the assailed) and his assembled comforters out of the world of history. The first of these views involves us in too many unnatural suppositions; but the last—irreconcilable as it is with the spirit of ancient times, in which every myth had at least its nucleus in a man—is totally irreconcilable with the personal allusions to the patriarch in other portions of Scripture, where he is classed with Noah and Daniel,—they victorious over the destructive forces of nature, he a conqueror in the alembic of spiritual powers. That much has been done by the author in the grouping of the materials of the old tradition, and in moulding the conversation of the speakers into their present dramatic form, so that each shall typify a distinct mode of human thought, and that their opinions shall stand out in clear contrast with the address of Elihu and of God, need not be denied. This leads directly to the question of the author, his age and country. There are four groups of hypotheses on this subject which claim to be considered. By some the author is supposed to have lived in patriarchal times, before the establishment of the Mosaic economy; by others he is regarded as contemporary with Solomon; while a third school fixes his *floruit* in the time of the exile; and a fourth professes to detect indications of modes of thinking prevalent in an age still later. The first of these, viz., the critics who assign the composition to anti-Mosaic times, err in too rashly confounding the author with his hero. They found their argument chiefly on the spirit and life of patriarchal times which animate the book, on the peculiar aspect which the religious teaching exhibits, and especially the absence of all reference to sacrifice or the Mosaic ritual. What may be called the Arabism of the language has also been adduced in support of this view; and, from the occurrence of quaint old phrases, the book has been thought to recede back to the early times when the separation of the dialects had only begun, but was far from being complete. To this latter argument, however, it is enough to answer that these antique phrases were ever the cream and sparkle of Hebrew poetry, if anything can be called antique in languages which exhibit so little of progress or of decay. To the former argument it seems sufficient to urge the possibility of an author, with the fixed habits of the nomad Arabs before his eyes, thoroughly to catch and appreciate the distinctive features of patriarchal life, if not also of patriarchal religion. In strange contrast with this opinion stands the estimate of those who hold the author to have been some prophet of the exile, or one flourishing after the restoration. Of course, to maintain such a theory the reference to Job in Ezekiel must be rejected as spurious; but it is not so easy to destroy the marks of imitation in passages copied from this book into the pages of Jeremiah, and even found in a number of the early psalms. On philological grounds, this theory is singularly inappropriate. If written in the exile, its composition is unique in the history of ancient literature, being pure in an age of Chaldaeism, and vigorously masculine in an age of sinking nationality and of poetry still plaintive and touching, but essentially artistic and feeble. The main defence of such a notion rests in the supposed Persian origin of the doctrine given in Job in regard to Satan and the angels. It has, however, been abundantly shown that the representation there given is not necessarily Persic; but, on the contrary, so thoroughly consistent with the whole teaching of Hebrew Scripture, that it is scarcely possible to tell who are most in the wrong,—those who, assuming Job to have been written in the days of Solomon or the exile, detect points at variance with the world's *earlier* beliefs; or those who, with Herder, Eichhorn, and Ewald, grant the antiquity of the book, but challenge the orthodoxy of its Satanology on the ground of *later* revelations. In favour of the only remaining opinion, which assigns the composition of the book to the days of Solomon, very much may be adduced, although there is little in the evidence that comes home to the mind with anything like resistless force. The spirit and power of its poetry marks a time of general vigour, and the age of David

Job.

Job. and Solomon was the golden age of Hebrew nationality and song. In the Psalms of David, too, there is a kindred strain of thought and expression (Psalms cii., civ., cvii., cxlvii.); and passages are imitated in all the boldness of their original passion—not feebly borrowed or extracted, as in the psalms of the exile and by the later prophets. In the Book of Proverbs, however, we find still closer affinities. The same features in the portrait of Wisdom, and in the representations of the abode of the dead, are to be found prominent and peculiar in both, while a host of common words and phrases point very expressively to a nearly contemporary age. Some weight is also due to the existence in Job of geographical allusions and descriptions of natural history with which the age of Solomon was at least the first to be familiar since the elder and simpler days of the patriarchs. We have thus the materials for fixing within certain wide limits the date of the book. The home and person of the poet are questions that admit of various and almost endless conjecture, since we are not constrained to identify his native country with the scenes which he familiarly depicts. Some have supposed him a foreigner—an Arab, perhaps, who may have wandered into the country, but who still thought and wrote somewhat aside from the ordinary ceremonial life of the Hebrews; and others think it more probable that he was an Israelite who had wandered forth from his native land to settle in Idumæa or Egypt. Why it could not have been written by a Hebrew who remained at home,—marked, as it is, by the peculiar Hebrew ideas in regard to God and the unseen world, and displaying very little knowledge which the keen spirit of a prophet might not easily acquire under the guidance of that God, who not only inspires his servants by his breath but tutors them for their inspiration by his providence,—it is somewhat difficult to see. Several recent critics imagine it to have been written by a philosopher at the court of Solomon. With regard to the ethics of the book, and its relation to the great central doctrines of the cross and immortality, various theories are held according as the solution of the problem discussed is found in the remarks of one or other of the speakers. In consideration, however, of the successful rebuke which Job administers to his friends, and his own deep repentance in the presence of God for the rash words which he had spoken, it is scarcely credible that we should look for anything but broken fragments of truth in the passionate outbursts of folly which too frequently mar the speeches of either party. The knot is first untied in the remarks of Elihu, who, as the forerunner and vindicator of God, stands alone unrebuked. The Divine address adds only majesty and power to his appeal. All agree that the object of the book is the solution of the question how the afflictions of the righteous can be consistent with God's justice, and some regard the knot as not unloosed but merely cut. In cutting it, too, they think the whole doctrine of sacrifice and atonement is snapped in two. Stoic philosophy, according to Ewald, is all that is inculcated, and blind resignation to the will of fate. With the prologue and epilogue before us, in which the veil of God's designs is lifted, it is impossible to acquiesce in such a view. Nor did Job seek or obtain a Stoic's reward. Still it must be confessed that in the disposal of that solemn question of God's government, the Book of Job does not furnish a theodicee for the sufferers of all time. Whatever weight be given to the passage (xix., chaps. 23-29) where Job appeals to his Redeemer acquittal, the burden of the doctrine of retribution is throughout more entirely thrown on the present life with its social changes than would be thought of now, when the judgment hereafter has been fully revealed. Nor is it difficult to see how this should happen. The ethics of the future life were then deeply veiled, and the existence of the soul after death was known in too shadowy a form to throw much weight into the balance when high moral problems were to be solved. Hence the mind of the poet is recalled from wandering into the region of the future in search of a solution; and in the present moral government of God, joined to his eternal existence, the ever-immortal soul finds an equally sure basis on which to rest its hopes. If the existence of God and of the soul after death be granted, then, although Job's language may not disclose a belief in a bodily resurrection, he loses nothing by fixing his faith on the instances, sometimes clouded, but often clear, of God's present retribution. Faith in a moral government hereafter is firmest when the two existences are viewed not in their contrast, but in their similarity. Many commentators, however, and with greater justice, regard this passage as showing Job's confidence in a bodily resurrection. (See article *Hiob*, by Delitzsch, in *Herzog's Cyclopædia*; and for a list of commentators on the book, see Kitto's *Biblical Cyclopædia*.)

Joel ‖ Jogues.

JOEL, one of the twelve minor prophets, the son of Pethuel. Of his birth-place nothing is known with certainty; the pseudo-Epiphanius affirms that he was a native of Betha, in the tribe of Reuben. From the local allusions in his prophecy, we may infer that he discharged his office in the kingdom of Judah. Various opinions have been held respecting the period in which he lived. It appears most probable that he was contemporary with Amos and Isaiah, and delivered his predictions in the reign of Joash, between 877 and 847 B.C. This is the opinion of Credner, Winer, Movers, Ewald, Delitzsch, and others.

The style of Joel, it has been remarked, unites the strength of Micah with the tenderness of Jeremiah. In vividness of description he rivals Nahum; and in sublimity and majesty is scarcely inferior to Isaiah and Habakkuk. The canonicity of the book has never been called in question. Consult *A Paraphrase and Critical Commentary on the Prophecy of Joel*, by Samuel Chandler, 4to, London, 1745; *Die Weissagung des Propheten Joel, übersetzt und erklärt*, von F. A. Holzhausen, Göttingen, 1829; *Charakteristik der Bibel*, von Dr A. H. Niemeyer, Halle, 1831, vol. v., pp. 295–302; Dr Hengstenberg's *Christology of the Old Testament*, &c., transl. by Dr P. Keith, Washington, 1839, vol. iii., pp. 100–141.

JOGHIS, a sect of religious persons in the East Indies, who never marry, nor hold any private property, but live on alms, and practise strange severities or mortifications. They are subject to a general, who sends them from one country to another to preach. They are, properly, a kind of penitent pilgrims, and supposed to be a remnant of the ancient Gymnosophists. They principally frequent such places as are consecrated by the devotion of the people, and pretend to live several days together without either eating or drinking. After having gone through a course of discipline for a certain time, they look upon themselves as impeccable, and privileged to do any thing; in consequence of which they give a loose rein to their passions, and run into all manner of debauchery.

JOGUES, or YUGS, certain ages, eras, or periods of extraordinary length in the fabulous chronology of the Hindus. They are (see Halhed's *Preface to the Code of Gentoo Laws*, p. xxxvi.) four in number, viz.:—

1. The Suttee Yug, or age of purity, which is said to have lasted three millions two hundred thousand years; and they hold that the life of man was extended in that age to one hundred thousand years, and that his stature was twenty-one cubits.

2. The Tirtah Yug, in which one-third of mankind was corrupted, they suppose to have consisted of two millions four hundred thousand years, during which men lived to the age of ten thousand years.

3. The Dwapaar Yug, in which half of the human race became depraved, endured one million six hundred thousand years, during which the life of man was reduced to a thousand years.

Johanna

4. The Collee Yug, in which all mankind were corrupted, or rather lessened (for that is the true meaning of the word *Collee*), is the present era, which they suppose ordained to subsist four hundred thousand years, and of which nearly five thousand are already past. The life of man in this period is limited to one hundred years.

Some account has already been given of the Indian chronology (see articles CHRONOLOGY and HINDUSTAN), and it is therefore unnecessary to recur to the subject in this place. But we may nevertheless subjoin Dr Robertson's observations on the above periods, from the Notes to his *Historical Disquisition concerning India*. "If," says he, "we suppose the computation of time in the Indian chronology to be made by solar or even by lunar years, nothing can be more extravagant in itself, or more repugnant to our mode of calculating the duration of the world, founded on sacred and infallible authority. From one circumstance, however, which merits attention, we may conclude that the information which we have hitherto received concerning the chronology of the Hindus is very incorrect. We have, as far as I know, only five original accounts of the different Jogues or eras of the Hindus. The first is given by M. Rogers, who received it from the Brahmins on the Coromandel coast. According to it, the Suttee Jogue is a period of one million seven hundred and twenty-eight thousand years; the Tirtah Jogue is one million two hundred and ninety-six thousand years; the Dwapaar Jogue is eight hundred and sixty-four thousand. The duration of the Collee Jogue he does not specify (*Porte Ouverte*, p. 179). The next is that of M. Bernier, who received it from the Brahmins of Benares. According to it, the duration of the Suttee Jogue was two millions five hundred thousand years; that of the Tirtah Jogue, one million two hundred thousand years, that of the Dwapaar Jogue is eight hundred and sixty-four thousand years. Concerning the period of the Collee Jogue he is likewise silent (*Voyages*, tom. ii., p. 160). The third is that of Colonel Dow; according to which the Suttee Jogue is a period of fourteen millions of years, the Tirtah Jogue one million and eighty thousand, the Dwapaar Jogue seventy-two thousand, and the Collee Jogue thirty-six thousand years (*Hist. of Hindost.*, vol. i., p. 2). The fourth account is that of M. Legentil, who received it from the Brahmins of the Coromandel coast; and as his information was acquired in the same part of India, and derived from the same source with that of M. Rogers, it agrees with his in every particular (*Mém. de l'Académie des Sciences pour* 1772, tom. ii., part i., p. 176). The fifth is the account of Mr Halhed, which has been already given. From this discrepancy, not only of the total numbers, but of many of the articles in the different accounts, it is manifest that our information concerning Indian chronology is hitherto as uncertain as the whole system of it is wild and fabulous. To me it appears highly probable, that when we understand more thoroughly the principles upon which the factitious eras or jogues of the Hindus have been formed, that we may be more able to reconcile their chronology to the true mode of computing time, founded on the authority of the Old Testament; and may likewise find reason to conclude that the account given by their astronomers of the situation of the heavenly bodies at the beginning of the Collee Jogue, is not established by actual observation, but the result of a retrospective calculation."

JOHANNA, HINZUAN, or ANZUAN, one of the Comoro islands, situate in the Mozambique Channel, between Africa and Madagascar. It is of an irregular triangular form, 24 miles in length by 18 in breadth, and is highly picturesque. Its highest peak, in S. Lat. 12. 15., E. Long. 44. 29., rises about 6000 feet above the sea-level. The soil is fertile and well watered, producing cocoa-nuts, limes, oranges, yams, rice, millet, &c. Pop. about 20,000.

JOHANNISBERG, a village of Germany, duchy of Nassau, near the E. bank of the Rhine, 12 miles W. of Mentz. Its vineyards produce the finest of the Rhenish wines.

Johannisberg

JOHN THE BAPTIST, the forerunner of the Lord, was the son of Zacharias and Elizabeth, the latter "a cousin of Mary," the mother of Jesus, whose senior John was by a period of six months. The exact spot where he was born is not determined. The rabbins fix on Hebron, in the hill-country of Judæa; Paulus, Kuinoel, and Meyer, after Reland, are in favour of Jutta, "a city of Judah." His father, while engaged in burning incense, was visited by the angel Gabriel, who informed him that in compliance with his prayers his wife should bear a son, whose name he should call John, and who should, by his pure life and fervid preaching, prepare the way for the long-expected Messiah. Zacharias unbelieving receives a sign, which acts also as a punishment—his tongue is sealed till the prediction is fulfilled by the event. Six months after Elizabeth had conceived she received a visit from Mary, the future mother of Jesus. On being saluted by her relation, Elizabeth felt her babe leap in her womb, and, being filled with the Holy Spirit, she broke forth into a poetic congratulation to Mary, as the destined mother of her Lord. At length Elizabeth brought forth a son, whom the relatives were disposed to name Zacharias, after his father;—but Elizabeth was led to wish that he should be called John. The matter was referred to the father, who signified in writing that his name was to be John. This agreement with Elizabeth caused all to marvel. Zacharias now had his tongue loosed, and he first employed his restored power in praising God.

John the Baptist.

As a consequence of the lofty parental influences under which he was nurtured, the child waxed strong in spirit. The sacred writer adds, that "he was in the deserts till the day of his showing unto Israel." The apocryphal *Protev. Jac.*, chap. xxii., states that his mother, to rescue her son from the murder of the children at Bethlehem, fled with him into the desert. She found no place of refuge; the mountain opened at her request, and gave the needed shelter in its bosom. Zacharias refusing to disclose their retreat was slain by Herod. At a later period Elizabeth died, when angels took the youth under their care. In the fifteenth year of the Emperor Tiberius, John made his public appearance in the wild mountainous tract of Judæa, exhibiting the austerity, the costume, and the manner of life of the ancient Jewish prophets (Luke iii.; Matt. iii.).

The burden of John's preaching bore no slight resemblance to the old prophetic exhortations, whose last echo had now died away for centuries. He called upon the Jewish people to repent, to change their dispositions and affections, and thus prepared the way for the great doctrine promulgated by his Lord, of the necessity of a spiritual regeneration. The reason assigned by him for entering on his perilous office was that the kingdom of God was at hand, and the high moral tone of his teaching shows, that in the true prophetic ardour no blot of sensuous expectation defaced the meaning of the expression.

The more than prophetic fame of the Baptist reached the ears of Jesus in his Nazarene dwelling, far distant from the locality of John (Matt. ii. 22-23). The nature of the report—namely, that his divinely-predicted forerunner had appeared in Judæa—showed our Lord that the time was now come for his being made manifest to Israel. Accordingly he comes to the place where John was then baptizing, in order that thus he might fulfil all that was required under the dispensation which was about to disappear. John's sense of inferiority inclines him to ask rather than to give baptism in the case of Jesus, who, however, wills to have it so, and is accordingly baptized of John. Immediately on the termination of this symbolical act, a divine attestation is given from the opened vault of heaven, declaring Jesus to be in truth the long looked-for Messiah.

John, St.

The relation which subsisted between John and Jesus, after the emphatic testimony above recorded had been borne, we have not the materials to describe with full certainty. It seems but natural to think that John would forthwith lay down his office of harbinger, which, now that the Sun of Righteousness himself had appeared, was entirely fulfilled and terminated. Such a step he does not appear to have taken. On the contrary, the language of Scripture seems to imply that the Baptist church continued side by side with the Messianic, and remained long after John's execution. Indeed, a sect which bears the name of "John's disciples," exists to the present day in the East, whose sacred books are said to be pervaded by a Gnostic leaven. They are hostile alike to Judaism and Christianity, and their John and Jesus are altogether different from the characters bearing these names in our evangelists. Though it has been generally assumed that John did not lay down his office, other explanations may be given of the facts. John may have ceased to execute his own peculiar work, as the forerunner, but may justifiably have continued to bear his most important testimony to the Messiahship, of Christ; or he may even have altogether given up the duties of active life some time, at least, before his death; and yet his disciples, both before and after that event, may have maintained their individuality as a religious communion. Nor is it improbable that some misconception may have had weight in preventing the Baptist church from dissolving, and that with a view to remove some error of this kind that John afterwards sent the embassy of his disciples to Jesus. The manner of John's death is too well known to require to be detailed. He reproved a tyrant for a heinous crime, and received his reward in decapitation. Josephus, however, assigns a purely political cause for his execution, but there is no contrariety between his account and that given in the New Testament. Both may be true: John was condemned in the mind of Herod on political grounds, as endangering his position, and executed on private and ostensible grounds, in order to gratify a malicious but powerful woman.

The castle of Machærus, where John was imprisoned and beheaded, was a fortress lying on the southern extremity of Peræa, at the top of the Lake Asphaltites, between the dominions of Herod and Aretas, king of Arabia Petræa, and at the time of our history appears to have belonged to the former (Lardner, vi. 483). At the time of the tragedy, Herod was on his route towards the territories of Aretas, with whom he was at war. Bishop Marsh (*Lecture* xxvi.) remarks, that the soldiers, who are said to have come to John while baptizing in the Jordan, are designated by a term which denotes persons actually engaged in war, not merely soldiers. In the same way, the officer sent to bring John's head bears a military title. These minute indications afford a very strong evidence of the credibility of the sacred narratives. We also see a reason why Herodias was present on this occasion, since she was Herod's paramour, and had, "like another Helen," led to the war.

JOHN, *St, the Apostle*, was the son of Zebedee, a fisherman, and of Salome. It is probable that he was born at Bethsaida, on the Lake of Galilee. His parents appear to have been in easy circumstances; at least, we find that Zebedee employed hired servants, and that Salome was among the number of those women who contributed to the maintenance of Jesus. We also find that John received Mary into his house after the death of Jesus. Since this house seems to have been situated at Jerusalem, it would appear that he was the owner of two houses. John's acquaintance, also, with the high-priest seems to indicate that he lived at Jerusalem, and belonged to the wealthier class. On the banks of the Jordan the Baptist directed John to Jesus, and he immediately became the Lord's disciple, and accompanied him on his return to Galilee. Having arrived there, he at first resumed his trade, but was afterwards called to remain permanently with the Redeemer. Jesus was particularly attached to John, who was one of the three who were distinguished above the other apostles. After the ascension, John abode at Jerusalem, where Paul met him on his third journey, about the year 52. Since he had undertaken the care of the mother of Jesus we cannot well suppose that he left Jerusalem before Mary's death; and, indeed, we find that about the year 58, when Paul was at Ephesus, John was not yet living there. If we consider the great importance of Ephesus among the various churches of Asia Minor, and the dangers arising from false teachers, who were prevalent there as early as the days of Paul (Acts xx. 29), it will appear likely that John was sent to Ephesus after Paul had left that scene, about the year 65. During the time of his activity in Asia Minor he was exiled by the Roman emperor to Patmos, one of the Sporadic isles in the Ægean Sea, where, according to Revelations i. 9, he wrote the Apocalypse. Irenæus (*Adv. Hær.* v. 30), and, following him, Eusebius (*Hist. Eccles.* iii. 18), state that John beheld the visions of the Apocalypse about the close of the reign of Domitian. If this statement can be depended upon, the exile to Patmos also took place under Domitian, who died A.D. 96. Tertullian relates that in the reign of Domitian, John was forcibly conveyed to Rome, where he was thrown into a cask of oil; that he was miraculously released, and then brought to Patmos. But since no other of the ancient writers relates this circumstance, and since this mode of capital punishment was unheard of at Rome, we ought not to lay much stress upon it. Polycrates, bishop of Ephesus, writing about A.D. 200, calls him *martyr*, but it is probable that he alludes only to his exile. According to Eusebius, he returned from exile during the reign of Nerva. The three epistles of John, as also the affecting account concerning his fidelity as a spiritual pastor, given by Clemens Alexandrinus, testify that he was the pastor of a large diocese. John died at Ephesus past the age of ninety, in the reign of the Emperor Trajan. According to Jerome, he was a hundred years old, and according to Suidas, a hundred and twenty.

Gospel of St John.

JOHN, *St, Gospel of*. During the eighteenth century and the first ten years of the nineteenth, the Gospel of John was attacked, but with feeble arguments, by some English Deists, and by four German theologians. A similar attack has lately been made by Strauss, whose arguments, however, have met with little sympathy even in Germany. It may suffice to observe, that till the end of the eighteenth century, no one ever expressed a doubt respecting the genuineness of John's Gospel, except one small sect, whose scepticism was not based upon historical, but merely upon dogmatical grounds.

John's Gospel differs very much in substance from the first three Gospels. The most striking difference, more apparent, however, in form than in substance, is that of the speeches. The difference of the contents may be accounted for by supposing that John intended to confine himself to such communications as were wanting in the others, particularly with regard to the speeches of Jesus. The peculiarities of his Gospel more especially consist in the four following doctrines:—1. That of the mystical relation of the Son to the Father. 2. That of the mystical relation of the Redeemer to believers. 3. The announcement of the Holy Ghost as the comforter. 4. The peculiar importance ascribed to love.

Although there can be shown in the writings of the other evangelists some isolated dicta of the Lord, which seem to bear the impress of John, it can also be shown that they contain thoughts not originating with that disciple, but with the Lord himself. Matthew (xi. 27) speaks of the relation of the Son to the Father so entirely in the style of John, that persons not sufficiently versed in Holy Writ are apt to search for this passage in the Gospel of John. The mysti-

John, St, the Epistles of.

cal union of the Son with believers is expressed in Matt. xxviii. 20. The promise of the effusion of the Holy Ghost, in order to perfect the disciples, is found in Luke xxiv. 49. The doctrine of Paul with respect to love, in 1 Cor. xiii., entirely resembles what, according to John, Christ taught on the same subject. Paul here deserves our particular attention. In the writings of Paul are found Christian truths which have their points of coalescence only in John, viz., that Christ is *the image of the invisible God*, by whom all things are created (Col. i. 15, 16). Paul considers the Spirit of God in the Church, *the spiritual Christ*, as Jesus himself does (John xiv. 16).

That the speeches of Christ have been faithfully reported, may be seen by a comparison of the speeches of the Baptist in the Gospel of John. The Baptist's speeches bear an entirely Old Testament character; they are full of allusions to the Old Testament, and abound in sententious expressions (John iii. 27-30; i. 26-36).

Most of the earlier critics considered the Gospel of John to have had a polemico-dogmatical purport. According to Irenæus, John wrote with the intention of combating the errors of Cerinthus the Gnostic. Others suppose that his writings were directed against the disciples of John the Baptist. It is not improbable that the evangelist had in view, both in his introduction, and also in chap. xix. 34, 35, some heretical opinions of those times; but it cannot be maintained that this is the case throughout the whole of the Gospel. He himself states (xx. 31) that his work had a more general object.

One of the peculiarities of John is, that in speaking of the adversaries of Jesus, he always calls them the Jews. This observation has, in modern times, given rise to a peculiar opinion concerning the plan of John's Gospel, namely, that the Evangelist has, from the very beginning of the Gospel, the following theme before his eyes:—The eternal combat between Divine light and the corruption of mankind, exemplified by the mutual opposition subsisting between the hostile Jewish party and the manifestation of the Son of God, which combat terminates in the victory of light.

The introduction of the Gospel of John expresses this theme in speaking of the opposition of the world to the incarnate Logos. This theme is here expressed in the same manner as the leading idea of a musical composition is expressed in the overture. The Gospel is divided into two principal sections. The first extends to chap. xii. It comprehends the public functions of Jesus, and terminates with a brief summary (verses 44-50). The second section contains the history of the Passion and of the Resurrection.

The Fathers supposed that the Gospel of John was written at Ephesus, and there is some internal evidence in favour of the statement. One writer affirms that John wrote the Gospel which bears his name in Patmos, but that it was edited by the same Gaius whom Paul in the Epistle to the Romans calls *mine host*. One might be inclined to explain by this circumstance the postscript contained in John xxi. 24, 25.

JOHN, *St, the Epistles of.* For the authenticity of the First Epistle very ancient testimony may be adduced. Papias, the disciple of John, quotes some passages from it. Polycarp, also, another disciple of John, quotes a passage from this Epistle. So also Irenæus.

The author of the First Epistle describes himself, at its commencement, as an eye-witness of the life of our Lord. The style and language manifestly harmonize with those of the author of the Gospel of John. The polemics, also, which, in chap. ii. 18-26, are directed against the Docetic Gnostics, in chap. iv. 1-3 agree with the sphere of action in Asia Minor in which the Evangelist John was placed. We may, therefore, suppose that the Epistle was written to Christian congregations in Asia Minor, which were placed under the spiritual care of the apostle. It is generally admitted that chap. i. 2 refers to the Gospel. If this is correct, the apostle wrote this Epistle at a very advanced age, after he had written his Gospel. The Epistle breathes love and devotion, but also zeal for moral strictness (chap. iii. 6-8; v. 16). There is a remarkable absence of logical connection in the form of separate expressions, and in the transitions from one thought to another. Some writers have been inclined to find a reason for this in the advanced age of the writer. Old age may, perhaps, have contributed to this characteristic, but it is chiefly attributable to the mental peculiarity of the apostle. There has been no subject connected with biblical literature which has attracted more attention than this Epistle, in consequence of the controversies which have existed since the commencement of the sixteenth century, respecting the celebrated passage in 1 John v. 7, 8. We cannot enter here into the history of that controversy, which has continued with more or less of asperity to our own day. We shall merely remark that the disputed passage is found in no Greek manuscript, save only in two, both belonging to the fifteenth century; and that it has not once been quoted by any of the Greek, Latin, or Oriental fathers. It is now, therefore, generally omitted in all critical editions of the New Testament.

John.

The Second and Third Epistles of John were originally wanting in the ancient Syriac translation. From their nature, it may easily be explained how it happened that they were less generally known in ancient Christian congregations, and that the fathers do not quote them so often as other parts of Scripture, since they are very short, and treat of private affairs. The private nature of their contents removes also the suspicion that they could have been forged, since it would be difficult to discover any purpose which could have led to such a forgery.

The Second Epistle is addressed to a lady, called Kuria, which name frequently occurs in ancient writers as that of a woman.

The Third Epistle is addressed to Gaius, a person otherwise unknown. It is remarkable that the writer of this Epistle calls himself "the presbyter" or "elder." Some writers have been inclined to ascribe these letters to the presbyter John, who is sometimes spoken of in the ancient church, and to whom even the Apocalypse has been attributed; but if the presbyter John wrote these Epistles, John's Gospel also must be ascribed to the same person, of whom otherwise so little is known. This, however, is inadmissible. We may suppose that the term "presbyter" or "elder" expressed in the Epistles of John a degree of friendliness, and was chosen on account of the advanced age of the writer. The apostle Paul, also, in his friendly letter to Philemon, abstains from the title apostle. The circumstances and events in the church, to which the Second Epistle alludes, coincide with those which are otherwise known to have happened in John's congregation. Here, also, are allusions to the dangers arising from the Gnostic heresy. The admonition, in verse 10, not to receive such heretics as Christian brethren, agrees with the ancient tradition, that John made haste to quit a public bath after Cerinthus the Gnostic entered it, declaring he was afraid the building would fall down.

JOHN.—Twenty-three popes of this name have occupied the chair of St Peter. The subjoined table gives the dates of the accession and death of each.

	Succeeded.	Year of Accession.	Died.
John I.	Hormisdas	523	526
John II.	Boniface II.	532	535
John III.	Pelagius I.	560	574
John IV.	Severinus	640	642
John V.	Benedict II.	686	686
John VI.	Sergius I.	702	705
John VII.	John VI.	705	707
John VIII.	Adrian II.	872	882

John ‖ John of Salisbury.

	Succeeded.	Year of Accession.	Died.
John IX.	...	898	900
John X.	Lando	915	927
John XI.	Stephen VIII.	931	936
John XII.	Agapetus	956	964
John XIII.	Benedict V.	965	972
John XIV.	Benedict VII.	983	983
John XV.	...	985	985
John XVI.	...	986	996
John XVII.	...	997	...
John XVIII.	Sylvester II.	1003	1003
John XIX.	John XVIII.	1003	1009
John XX.	Benedict VIII.	1024	1034
John XXI.	Adrian V.	1277	1277
John XXII.	Clement V.	1316	1334
John XXIII.	Alexander V.	1410	1417

The history of the Papacy about the end of the tenth, and beginning of the eleventh centuries, is even still very obscure, and the chronology is extremely confused. It is not exxactly known whether the Johns XV. and XVI. were different persons, or the same pope twice included in the enumeration. John XVII., again, is by some denied to have ever been lawfully installed in the pontifical chair; but he is generally included in the list. For John IX., see Pope JOAN.

JOHN, *King of England*, was the son of Henry II., and the younger brother of Richard Cœur de Lion, on whose death, in 1199, he succeeded to the throne of England. He died in 1216. See ENGLAND, and BRITAIN.

JOHN, *King of France*, surnamed "The Good," was born in 1319, and succeeded his father, Philippe de Valois (Philip V.) in 1350. He was defeated at Poictiers in 1356 by the Black Prince, and died in London in 1364. French historians generally style him John II., to distinguish him from John I., the title of a posthumous son of Louis X., who died in 1316 at the age of a few months. See FRANCE.

JOHN I., *King of Castile and Leon*, was born in 1358, came to the throne in 1379, and died in 1390. John II., born in 1405, and died in 1454. See SPAIN.

JOHN I., *King of Portugal*, born in 1357, usurped the throne in 1384, and died in 1433. John II., surnamed "the Perfect," son of Alphonso and Isabella, was born in 1455, and succeeded his father in 1481. After a brilliant but stormy reign of fourteen years, he died in 1495. John III., son of Emmanuel the Great and Mary of Castile, was born in 1502, mounted the throne in 1521, and died in 1557. John IV., son of Theodore, seventh Duke of Braganza, and head of that house, was born in 1604. His native country had at this time become an appanage of Spain. He headed the Portuguese in throwing off the Spanish yoke, was elected king in 1640, and died in 1656. John V., son of Peter II. and Elizabeth of Bavaria, was born in 1689, and mounted the throne in 1705. After a forty-five years' reign of almost unbroken peace, he died in 1750. John VI., born in 1767, began at the age of twenty-six to reign in the name of his imbecile mother. Spending his life alternately in Portugal and Brazil, he settled in Portugal in 1821, and died in 1826. See PORTUGAL.

JOHN I., *King of Sweden*, was the son of Sverker the Younger, and was thence called Sverkerson. He reigned from 1216 to 1222. John II. of Sweden and I. of Denmark, was the son of Christian I. of the House of Oldenburg, and was born in 1455. He was proclaimed King of Norway and Denmark in 1483, and finally of Sweden in 1497. Expelled from the latter kingdom in 1512, he retired to Denmark, where he died in the following year. John III. of Sweden, son of Gustavus Vasa, was born in 1537, usurped the throne in 1568, and died in 1591. See SWEDEN, and DENMARK.

JOHN, or SALISBURY, a learned English ecclesiastic, and the biographer of the two archbishops of Canterbury, Anselm and Thomas à Beckett. Comparatively little is known of his personal history. He was born about the beginning of the twelfth century, and seems at an early age to have passed over to France, where Abelard, though nearing the close of his public career, was still teaching with as splendid success as in the prime of manhood. "I drank in with incredible avidity," wrote his young English admirer, "every word that fell from his lips, but he soon, to my infinite regret, retired." John then turned to other studies, and lost himself for two years in the subtleties of the scholastic logic. Grammar and rhetoric next engaged his thoughts for three years; and at the end of that period he began a seven years' course of the classics, mathematics, and theology. After a flying visit to England, John returned to France, whence he directed his steps southwards to Italy. At Rome he was kindly received by the Pope Eugene III., and afterwards by his successor Adrian IV. With the latter of these pontiffs he was an especial favourite. "Though Adrian had a mother and a brother," he wrote in his *Metalogicus*, "I fear not to say that he preferred me to them. He declared in public and in private that I was of all men he whom he loved most tenderly. His exalted position did not prevent him from admitting me to his table. He insisted that we should drink out of the same glass, and eat off the same plate." In the intervals of teaching and travelling, John had written his *Metalogicus*, an attack on the absurdity and danger of wasting so much time as it was the fashion of that age to do, in the sheerest quibbles of the wrangling art. With unsparing ridicule and invective he laughs the scholastic doctors to scorn for gravely debating such questions as "How many angels can dance at a time on the point of a needle?" or, "Whether, when a hog is carried to market by a man with a rope tied round its neck, the hog is really carried to market by the man or the rope?" So keen, indeed, is he in his onslaught on scholastic philosophy as fatal to the grace and refinement of poetry and polite literature in general, that he shuts his eyes against its real merits and uses, and sees only the ridiculous extravagances of its fanatical devotees. This work was dedicated to Thomas à Becket, then engaged with Henry II. at the siege of Toulouse; and so pleased was he with the compliment that when he was promoted to the see of Canterbury, he made its author his secretary. In this capacity, John became, as is recorded by a contemporary, the eye and hand of the bishop. In his disgrace he accompanied him to France, and, after an exile of seven years, returned with him to England, and was with him at the moment when he was put to death. He remained attached to the cathedral of Canterbury till 1176, when he was elected Bishop of Chartres. He spent the rest of his life in his diocese, and died October 25, in 1182. His greatest work was *Polycraticus, sive de nugis Curialium et Vestigiis Philosophorum libri octo*, characterized by Warton as "an extremely pleasant miscellany, replete with erudition and a judgment of men and things, which properly belongs to a more sensible and reflecting period." The work is intended to expose the frivolities of the great, and of such as spend their lives at courts; and is marked by a vein of caustic satire, sometimes verging on the extreme limits of good taste. But the general accomplishments and literary faculty displayed in it are such as one looks for in vain in almost any other book of that period. Its author's character had always stood high as a refined scholar, an elegant Latin poet, and an impressive orator. The researches of modern scholars have merely gone to confirm the idea that John was the most learned and accomplished man of his age. (*Leland*; Craik's *Hist. Eng. Lit.*; *Biog. Univ.*; *Hist. Lit. de la France*, &c., &c.)

John or Jan. St.

JOHN, or JAN, *St*, one of the Virgin Islands in the West Indies, belonging to Denmark, and lying 4 miles E. off St Thomas, in N. Lat. 18. 18., W. Long. 64. 49. It is about 9 miles long and 4 in breadth, rising to a considerable height in the centre, and having generally a very uneven surface. Exports trifling. Pop. (1850) 2228.

Johnson, Samuel.

JOHNSON, SAMUEL, one of the most eminent English writers of the eighteenth century, was the son of Michael Johnson, who was, at the beginning of that century, a magistrate of Lichfield, and a bookseller of great note in the midland counties. Michael's abilities and attainments seem to have been considerable. He was so well acquainted with the contents of the volumes which he exposed to sale, that the country rectors of Staffordshire and Worcestershire thought him an oracle on points of learning. Between him and the clergy, indeed, there was a strong religious and political sympathy. He was a zealous churchman, and, though he had qualified himself for municipal office by taking the oaths to the sovereigns in possession, was to the last a Jacobite in heart. At his house, a house which is still pointed out to every traveller who visits Lichfield, Samuel was born on the 18th of September 1709. In the child the physical, intellectual, and moral peculiarities which afterwards distinguished the man were plainly discernible; great muscular strength accompanied by much awkwardness and many infirmities; great quickness of parts, with a morbid propensity to sloth and procrastination; a kind and generous heart, with a gloomy and irritable temper. He had inherited from his ancestors a scrofulous taint, which it was beyond the power of medicine to remove. His parents were weak enough to believe that the royal touch was a specific for this malady. In his third year he was taken up to London, inspected by the court surgeon, prayed over by the court chaplains, and stroked and presented with a piece of gold by Queen Anne. One of his earliest recollections was that of a stately lady in a diamond stomacher and a long black hood. Her hand was applied in vain. The boy's features, which were originally noble and not irregular, were distorted by his malady. His cheeks were deeply scarred. He lost for a time the sight of one eye; and he saw but very imperfectly with the other. But the force of his mind overcame every impediment. Indolent as he was, he acquired knowledge with such ease and rapidity, that at every school to which he was sent he was soon the best scholar. From sixteen to eighteen he resided at home, and was left to his own devices. He learned much at this time, though his studies were without guidance and without plan. He ransacked his father's shelves, dipped into a multitude of books, read what was interesting, and passed over what was dull. An ordinary lad would have acquired little or no useful knowledge in such a way: but much that was dull to ordinary lads was interesting to Samuel. He read little Greek; for his proficiency in that language was not such that he could take much pleasure in the masters of Attic poetry and eloquence. But he had left school a good Latinist, and he soon acquired, in the large and miscellaneous library of which he now had the command, an extensive knowledge of Latin literature. That Augustan delicacy of taste, which is the boast of the great public schools of England, he never possessed. But he was early familiar with some classical writers, who were quite unknown to the best scholars in the sixth form at Eton. He was peculiarly attracted by the works of the great restorers of learning. Once, while searching for some apples, he found a huge folio volume of Petrarch's works. The name excited his curiosity, and he eagerly devoured hundreds of pages. Indeed, the diction and versification of his own Latin compositions show that he had paid at least as much attention to modern copies from the antique as to the original models.

While he was thus irregularly educating himself, his family was sinking into hopeless poverty. Old Michael Johnson was much better qualified to pore upon books, and to talk about them, than to trade in them. His business declined: his debts increased: it was with difficulty that the daily expenses of his household were defrayed. It was out of his power to support his son at either university; but a wealthy neighbour offered assistance; and, in reliance on promises which proved to be of very little value, Samuel was entered at Pembroke College, Oxford. When the young scholar presented himself to the rulers of that society, they were amazed not more by his ungainly figure and eccentric manners than by the quantity of extensive and curious information which he had picked up during many months of desultory, but not unprofitable study. On the first day of his residence he surprised his teachers by quoting Macrobius; and one of the most learned among them declared, that he had never known a freshman of equal attainments.

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At Oxford, Johnson resided during about three years. He was poor, even to raggedness; and his appearance excited a mirth and a pity, which were equally intolerable to his haughty spirit. He was driven from the quadrangle of Christ Church by the sneering looks which the members of that aristocratical society cast at the holes in his shoes. Some charitable person placed a new pair at his door; but he spurned them away in a fury. Distress made him, not servile, but reckless and ungovernable. No opulent gentleman commoner, panting for one-and-twenty, could have treated the academical authorities with more gross disrespect. The needy scholar was generally to be seen under the gate of Pembroke, a gate now adorned with his effigy, haranguing a circle of lads, over whom, in spite of his tattered gown and dirty linen, his wit and audacity gave him an undisputed ascendency. In every mutiny against the discipline of the college he was the ringleader. Much was pardoned, however, to a youth so highly distinguished by abilities and acquirements. He had early made himself known by turning Pope's Messiah into Latin verse. The style and rhythm, indeed, were not exactly Virgilian; but the translation found many admirers, and was read with pleasure by Pope himself.

The time drew near at which Johnson would, in the ordinary course of things, have become a Bachelor of Arts: but he was at the end of his resources. Those promises of support on which he had relied had not been kept. His family could do nothing for him. His debts to Oxford tradesmen were small indeed, yet larger than he could pay. In the autumn of 1731, he was under the necessity of quitting the university without a degree. In the following winter his father died. The old man left but a pittance; and of that pittance almost the whole was appropriated to the support of his widow. The property to which Samuel succeeded amounted to no more than twenty pounds.

His life, during the thirty years which followed, was one hard struggle with poverty. The misery of that struggle needed no aggravation, but was aggravated by the sufferings of an unsound body and an unsound mind. Before the young man left the university, his hereditary malady had broken forth in a singularly cruel form. He had become an incurable hypochondriac. He said long after that he had been mad all his life, or at least not perfectly sane; and, in truth, eccentricities less strange than his have often been thought grounds sufficient for absolving felons, and for setting aside wills. His grimaces, his gestures, his mutterings, sometimes diverted and sometimes terrified people who did not know him. At a dinner table he would, in a fit of absence, stoop down and twitch off a lady's shoe. He would amaze a drawing room by suddenly ejaculating a clause of the Lord's Prayer. He would conceive an unintelligible aversion to a particular alley, and perform a great circuit rather than see the hateful place. He would set his heart on touching every post in the streets through which he walked. If by any chance he missed a post, he would go back a hundred yards and repair the omission. Under the influence of his disease, his senses became morbidly torpid, and his imagination morbidly active. At one time he would stand poring on the town clock without being able to tell the hour. At another, he would distinctly hear

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his mother, who was many miles off, calling him by his name. But this was not the worst. A deep melancholy took possession of him, and gave a dark tinge to all his views of human nature and of human destiny. Such wretchedness as he endured has driven many men to shoot themselves or drown themselves. But he was under no temptation to commit suicide. He was sick of life; but he was afraid of death; and he shuddered at every sight or sound which reminded him of the inevitable hour. In religion he found but little comfort during his long and frequent fits of dejection; for his religion partook of his own character. The light from heaven shone on him indeed, but not in a direct line, or with its own pure splendour. The rays had to struggle through a disturbing medium: they reached him refracted, dulled and discoloured by the thick gloom which had settled on his soul; and, though they might be sufficiently clear to guide him, were too dim to cheer him.

With such infirmities of body and of mind, this celebrated man was left, at two-and-twenty, to fight his way through the world. He remained during about five years in the midland counties. At Lichfield, his birth-place and his early home, he had inherited some friends and acquired others. He was kindly noticed by Henry Hervey, a gay officer of noble family, who happened to be quartered there. Gilbert Walmesley, registrar of the ecclesiastical court of the diocese, a man of distinguished parts, learning, and knowledge of the world, did himself honour by patronising the young adventurer, whose repulsive person, unpolished manners, and squalid garb, moved many of the petty aristocracy of the neighbourhood to laughter or to disgust. At Lichfield, however, Johnson could find no way of earning a livelihood. He became usher of a grammar school in Leicestershire; he resided as a humble companion in the house of a country gentleman; but a life of dependence was insupportable to his haughty spirit. He repaired to Birmingham, and there earned a few guineas by literary drudgery. In that town he printed a translation, little noticed at the time, and long forgotten, of a Latin book about Abyssinia. He then put forth proposals for publishing by subscription the poems of Politian, with notes containing a history of modern Latin verse; but subscriptions did not come in; and the volume never appeared.

While leading this vagrant and miserable life, Johnson fell in love. The object of his passion was Mrs Elizabeth Porter, a widow who had children as old as himself. To ordinary spectators, the lady appeared to be a short, fat, coarse woman, painted half an inch thick, dressed in gaudy colours, and fond of exhibiting provincial airs and graces which were not exactly those of the Queensberrys and Lepels. To Johnson, however, whose passions were strong, whose eyesight was too weak to distinguish ceruse from natural bloom, and who had seldom or never been in the same room with a woman of real fashion, his Titty, as he called her, was the most beautiful, graceful, and accomplished of her sex. That his admiration was unfeigned cannot be doubted; for she was as poor as himself. She accepted, with a readiness which did her little honour, the addresses of a suitor who might have been her son. The marriage, however, in spite of occasional wranglings, proved happier than might have been expected. The lover continued to be under the illusions of the wedding-day till the lady died in her sixty-fourth year. On her monument he placed an inscription extolling the charms of her person and of her manners; and when, long after her decease, he had occasion to mention her, he exclaimed, with a tenderness half ludicrous, half pathetic, "Pretty creature!"

His marriage made it necessary for him to exert himself more strenuously than he had hitherto done. He took a house in the neighbourhood of his native town, and advertised for pupils. Above eighteen months passed away; and only three pupils came to his academy. Indeed, his appearance was so strange, and his temper so violent, that his schoolroom must have resembled an ogre's den. Nor was the tawdry painted grandmother whom he called his Titty well qualified to make provision for the comfort of young gentlemen. David Garrick, who was one of the pupils, used, many years later, to throw the best company of London into convulsions of laughter by mimicking the endearments of this extraordinary pair.

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At length Johnson, in the twenty-eighth year of his age, determined to seek his fortune in the capital as a literary adventurer. He set out with a few guineas, three acts of the tragedy of Irene in manuscript, and two or three letters of introduction from his friend Walmesley.

Never since literature became a calling in England had it been a less gainful calling than at the time when Johnson took up his residence in London. In the preceding generation a writer of eminent merit was sure to be munificently rewarded by the government. The least that he could expect was a pension or a sinecure place; and, if he showed any aptitude for politics, he might hope to be a member of parliament, a lord of the treasury, an ambassador, a secretary of state. It would be easy, on the other hand, to name several writers of the nineteenth century of whom the least successful has received forty thousand pounds from the booksellers. But Johnson entered on his vocation in the most dreary part of the dreary interval which separated two ages of prosperity. Literature had ceased to flourish under the patronage of the great, and had not begun to flourish under the patronage of the public. One man of letters, indeed, Pope, had acquired by his pen what was then considered as a handsome fortune, and lived on a footing of equality with nobles and ministers of state. But this was a solitary exception. Even an author whose reputation was established, and whose works were popular, such an author as Thomson, whose Seasons were in every library, such an author as Fielding, whose Pasquin had had a greater run than any drama since The Beggar's Opera, was sometimes glad to obtain, by pawning his best coat, the means of dining on tripe at a cookshop underground, where he could wipe his hands, after his greasy meal, on the back of a Newfoundland dog. It is easy, therefore, to imagine what humiliations and privations must have awaited the novice who had still to earn a name. One of the publishers to whom Johnson applied for employment measured with a scornful eye that athletic though uncouth frame, and exclaimed, "You had better get a porter's knot, and carry trunks." Nor was the advice bad, for a porter was likely to be as plentifully fed, and as comfortably lodged, as a poet.

Some time appears to have elapsed before Johnson was able to form any literary connection from which he could expect more than bread for the day which was passing over him. He never forgot the generosity with which Hervey, who was now residing in London, relieved his wants during this time of trial. "Harry Hervey," said the old philosopher many years later, "was a vicious man; but he was very kind to me. If you call a dog Hervey, I shall love him." At Hervey's table Johnson sometimes enjoyed feasts which were made more agreeable by contrast. But in general he dined, and thought that he dined well, on sixpenny worth of meat and a pennyworth of bread at an alehouse near Drury Lane.

The effect of the privations and sufferings which he endured at this time was discernible to the last in his temper and his deportment. His manners had never been courtly. They now became almost savage. Being frequently under the necessity of wearing shabby coats and dirty shirts, he became a confirmed sloven. Being often very hungry when he sate down to his meals, he contracted a habit of eating with ravenous greediness. Even to the end of his life, and even at the tables of the great, the sight of food affected

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him as it affects wild beasts and birds of prey. His taste in cookery, formed in subterranean ordinaries and *Alamode* beefshops, was far from delicate. Whenever he was so fortunate as to have near him a hare that had been kept too long, or a meat pie made with rancid butter, he gorged himself with such violence that his veins swelled, and the moisture broke out on his forehead. The affronts which his poverty emboldened stupid and l w-minded men to offer to him would have broken a mean spirit into sycophancy, but made him rude even to ferocity. Unhappily the insolence which, while it was defensive, was pardonable, and in some sense respectable, accompanied him into societies where he was treated with courtesy and kindness. He was repeatedly provoked into striking those who had taken liberties with him. All the sufferers, however, were wise enough to abstain from talking about their beatings, except Osborne, the most rapacious and brutal of booksellers, who proclaimed everywhere that he had been knocked down by the huge fellow whom he had hired to puff the Harleian Library.

About a year after Johnson had begun to reside in London, he was fortunate enough to obtain regular employment from Cave, an enterprising and intelligent bookseller, who was proprietor and editor of the Gentleman's Magazine. That journal, just entering on the ninth year of its long existence, was the only periodical work in the kingdom which then had what would now be called a large circulation. It was indeed, the chief source of parliamentary intelligence. It was not then safe, even during a recess, to publish an account of the proceedings of either House without some disguise. Cave, however, ventured to entertain his readers with what he called Reports of the Debates of the Senate of Lilliput. France was Blefuscu: London was Mildendo: pounds were sprugs: the Duke of Newcastle was the Nardac secretary of state: Lord Hardwicke was the Hurgo Hickrad; and William Pulteney was Wingul Pulnub. To write the speeches was, during several years, the business of Johnson. He was generally furnished with notes, meagre indeed, and inaccurate, of what had been said; but sometimes he had to find arguments and eloquence both for the ministry and for the opposition. He was himself a Tory, not from rational conviction—for his serious opinion was that one form of government was just as good or as bad as another—but from mere passion, such as inflamed the Capulets against the Montagues, or the Blues of the Roman circus against the Greens. In his infancy he had heard so much talk about the villanies of the Whigs, and the dangers of the Church, that he had become a furious partisan when he could scarcely speak. Before he was three he had insisted on being taken to hear Sacheverell preach at Lichfield Cathedral, and had listened to the sermon with as much respect, and probably with as much intelligence, as any Staffordshire squire in the congregation. The work which had been begun in the nursery had been completed by the university. Oxford, when Johnson resided there, was the most Jacobitical place in England; and Pembroke was one of the most Jacobitical colleges in Oxford. The prejudices which he brought up to London were scarcely less absurd than those of his own Tom Tempest. Charles II. and James II. were two of the best kings that ever reigned. Laud, a poor creature who never did, said, or wrote any thing indicating more than the ordinary capacity of an old woman, was a prodigy of parts and learning over whose tomb Art and Genius still continued to weep. Hampden deserved no more honourable name than that of "the zealot of rebellion." Even the ship money, condemned not less decidedly by Falkland and Clarendon than by the bitterest Roundheads, Johnson would not pronounce to have been an unconstitutional impost. Under a government the mildest that had ever been known in the world, under a government which allowed to the people an unprecedented liberty of speech and action, he fancied that he was a slave; he assailed the ministry with obloquy which refuted itself, and regretted the lost freedom and happiness of those golden days in which a writer who had taken but one-tenth part of the license allowed to him would have been pilloried, mangled with the shears, whipped at the cart's tail, and flung into a noisome dungeon to die. He hated dissenters and stock-jobbers, the excise and the army, septennial parliaments, and continental connections. He long had an aversion to the Scotch, an aversion of which he could not remember the commencement, but which, he owned, had probably originated in his abhorrence of the conduct of the nation during the Great Rebellion. It is easy to guess in what manner debates on great party questions were likely to be reported by a man whose judgment was so much disordered by party spirit. A show of fairness was indeed necessary to the prosperity of the Magazine. But Johnson long afterwards owned that, though he had saved appearances, he had taken care that the Whig dogs should not have the best of it; and, in fact, every passage which has lived, every passage which bears the marks of his higher faculties, is put into the mouth of some member of the opposition.

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A few weeks after Johnson had entered on these obscure labours, he published a work which at once placed him high among the writers of his age. It is probable that what he had suffered during his first year in London had often reminded him of some parts of that noble poem in which Juvenal had described the misery and degradation of a needy man of letters, lodged among the pigeons' nests in the tottering garrets which overhung the streets of Rome. Pope's admirable imitations of Horace's Satires and Epistles had recently appeared, were in every hand, and were by many readers thought superior to the originals. What Pope had done for Horace, Johnson aspired to do for Juvenal. The enterprise was bold, and yet judicious. For between Johnson and Juvenal there was much in common, much more certainly than between Pope and Horace.

Johnson's London appeared without his name in May 1738. He received only ten guineas for this stately and vigorous poem: but the sale was rapid, and the success complete. A second edition was required within a week. Those small critics who are always desirous to lower established reputations ran about proclaiming that the anonymous satirist was superior to Pope in Pope's own peculiar department of literature. It ought to be remembered, to the honour of Pope, that he joined heartily in the applause with which the appearance of a rival genius was welcomed. He made inquiries about the author of London. Such a man, he said, could not long be concealed. The name was soon discovered; and Pope, with great kindness, exerted himself to obtain an academical degree and the mastership of a grammar school for the poor young poet. The attempt failed, and Johnson remained a bookseller's hack.

It does not appear that these two men, the most eminent writer of the generation which was going out, and the most eminent writer of the generation which was coming in, ever saw each other. They lived in very different circles, one surrounded by dukes and earls, the other by starving pamphleteers and indexmakers. Among Johnson's associates at this time may be mentioned Boyse, who, when his shirts were pledged, scrawled Latin verses sitting up in bed with his arms through two holes in his blanket, who composed very respectable sacred poetry when he was sober, and who was at last run over by a hackney coach when he was drunk; Hoole, surnamed the metaphysical tailor, who, instead of attending to his measures, used to trace geometrical diagrams on the board where he sate cross-legged; and the penitent impostor, George Psalmanazar, who, after poring all day, in a humble lodging, on the folios of Jewish rabbis and Christian fathers, indulged himself at night with literary and theological conversation at an alehouse in the city. But the most remarkable of the persons with whom at this

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time Johnson consorted, was Richard Savage, an earl's son, a shoemaker's apprentice, who had seen life in all its forms, who had feasted among blue ribands in Saint James's Square, and had lain with fifty pounds weight of irons on his legs, in the condemned ward of Newgate. This man had, after many vicissitudes of fortune, sunk at last into abject and hopeless poverty. His pen had failed him. His patrons had been taken away by death, or estranged by the riotous profusion with which he squandered their bounty, and the ungrateful insolence with which he rejected their advice. He now lived by begging. He dined on venison and Champagne whenever he had been so fortunate as to borrow a guinea. If his questing had been unsuccessful, he appeased the rage of hunger with some scraps of broken meat, and lay down to rest under the Piazza of Covent Garden in warm weather, and, in cold weather, as near as he could get to the furnace of a glass house. Yet, in his misery, he was still an agreeable companion. He had an inexhaustible store of anecdotes about that gay and brilliant world from which he was now an outcast. He had observed the great men of both parties in hours of careless relaxation, had seen the leaders of opposition without the mask of patriotism, and had heard the prime minister roar with laughter and tell stories not over decent. During some months Savage lived in the closest familiarity with Johnson; and then the friends parted, not without tears. Johnson remained in London to drudge for Cave. Savage went to the West of England, lived there as he had lived everywhere, and, in 1743, died, penniless and heart-broken, in Bristol gaol.

Soon after his death, while the public curiosity was strongly excited about his extraordinary character, and his not less extraordinary adventures, a life of him appeared widely different from the catchpenny lives of eminent men which were then a staple article of manufacture in Grub Street. The style was indeed deficient in ease and variety; and the writer was evidently too partial to the Latin element of our language. But the little work, with all its faults, was a masterpiece. No finer specimen of literary biography existed in any language, living or dead; and a discerning critic might have confidently predicted that the author was destined to be the founder of a new school of English eloquence.

The Life of Savage was anonymous; but it was well known in literary circles that Johnson was the writer. During the three years which followed, he produced no important work; but he was not, and indeed could not be, idle. The fame of his abilities and learning continued to grow. Warburton pronounced him a man of parts and genius; and the praise of Warburton was then no light thing. Such was Johnson's reputation that, in 1747, several eminent booksellers combined to employ him in the arduous work of preparing a Dictionary of the English Language, in two folio volumes. The sum which they agreed to pay him was only fifteen hundred guineas; and out of this sum he had to pay several poor men of letters who assisted him in the humbler parts of his task.

The Prospectus of the Dictionary he addressed to the Earl of Chesterfield. Chesterfield had long been celebrated for the politeness of his manners, the brilliancy of his wit, and the delicacy of his taste. He was acknowledged to be the finest speaker in the House of Lords. He had recently governed Ireland, at a momentous conjuncture, with eminent firmness, wisdom, and humanity; and he had since become Secretary of State. He received Johnson's homage with the most winning affability, and requited it with a few guineas bestowed doubtless in a very graceful manner, but was by no means desirous to see all his carpets blackened with the London mud, and his soups and wines thrown to right and left over the gowns of fine ladies and the waistcoats of fine gentlemen, by an absent, awkward scholar, who gave strange starts and uttered strange growls, who dressed like a scarecrow, and ate like a cormorant. During some time Johnson continued to call on his patron, but, after being repeatedly told by the porter that his lordship was not at home, took the hint, and ceased to present himself at the inhospitable door.

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Johnson had flattered himself that he should have completed his Dictionary by the end of 1750; but it was not till 1755 that he at length gave his huge volumes to the world. During the seven years which he passed in the drudgery of penning definitions and marking quotations for transcription, he sought for relaxation in literary labour of a more agreeable kind. In 1749 he published the Vanity of Human Wishes, an excellent imitation of the Tenth Satire of Juvenal. It is in truth not easy to say whether the palm belongs to the ancient or to the modern poet. The couplets in which the fall of Wolsey is described, though lofty and sonorous, are feeble when compared with the wonderful lines which bring before us all Rome in tumult on the day of the fall of Sejanus, the laurels on the doorposts, the white bull stalking towards the Capitol, the statues rolling down from their pedestals, the flatterers of the disgraced minister running to see him dragged with a hook through the streets, and to have a kick at his carcase before it is hurled into the Tiber. It must be owned too that in the concluding passage the Christian moralist has not made the most of his advantages, and has fallen decidedly short of the sublimity of his Pagan model. On the other hand, Juvenal's Hannibal must yield to Johnson's Charles; and Johnson's vigorous and pathetic enumeration of the miseries of a literary life must be allowed to be superior to Juvenal's lamentation over the fate of Demosthenes and Cicero.

For the copyright of the Vanity of Human Wishes Johnson received only fifteen guineas.

A few days after the publication of this poem, his tragedy, begun many years before, was brought on the stage. His pupil, David Garrick, had, in 1741, made his appearance on a humble stage in Goodman's Fields, had at once risen to the first place among actors, and was now, after several years of almost uninterrupted success, manager of Drury Lane Theatre. The relation between him and his old preceptor was of a very singular kind. They repelled each other strongly, and yet attracted each other strongly. Nature had made them of very different clay; and circumstances had fully brought out the natural peculiarities of both. Sudden prosperity had turned Garrick's head. Continued adversity had soured Johnson's temper. Johnson saw with more envy than became so great a man the villa, the plate, the china, the Brussels carpet, which the little mimic had got by repeating, with grimaces and gesticulations, what wiser men had written; and the exquisitely sensitive vanity of Garrick was galled by the thought that, while all the rest of the world was applauding him, he could obtain from one morose cynic, whose opinion it was impossible to despise, scarcely any compliment not acidulated with scorn. Yet the two Lichfield men had so many early recollections in common, and sympathized with each other on so many points on which they sympathized with nobody else in the vast population of the capital, that, though the master was often provoked by the monkey-like impertinence of the pupil, and the pupil by the bearish rudeness of the master, they remained friends till they were parted by death. Garrick now brought Irene out, with alterations sufficient to displease the author, yet not sufficient to make the piece pleasing to the audience. The public, however, listened, with little emotion, but with much civility, to five acts of monotonous declamation. After nine representations the play was withdrawn. It is, indeed, altogether unsuited to the stage, and, even when perused in the closet, will be found hardly worthy of the author. He had not the slightest notion of what blank verse should be. A change in the last syllable of every other line would make

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the versification of the Vanity of Human Wishes closely resemble the versification of Irene. The poet, however, cleared, by his benefit nights, and by the sale of the copyright of his tragedy, about three hundred pounds, then a great sum in his estimation.

About a year after the representation of Irene, he began to publish a series of short essays on morals, manners, and literature. This species of composition had been brought into fashion by the success of the Tatler, and by the still more brilliant success of the Spectator. A crowd of small writers had vainly attempted to rival Addison. The Lay Monastery, the Censor, the Freethinker, the Plain Dealer, the Champion, and other works of the same kind, had had their short day. None of them had obtained a permanent place in our literature; and they are now to be found only in the libraries of the curious. At length Johnson undertook the adventure in which so many aspirants had failed. In the thirty-sixth year after the appearance of the last number of the Spectator appeared the first number of the Rambler. From March 1750 to March 1752, this paper continued to come out every Tuesday and Saturday.

From the first the Rambler was enthusiastically admired by a few eminent men. Richardson, when only five numbers had appeared, pronounced it equal, if not superior to the Spectator. Young and Hartley expressed their approbation not less warmly. Bubb Dodington, among whose many faults indifference to the claims of genius and learning cannot be reckoned, solicited the acquaintance of the writer. In consequence probably of the good offices of Dodington, who was then the confidential adviser of Prince Frederic, two of his Royal Highness's gentlemen carried a gracious message to the printing office, and ordered seven copies for Leicester House. But these overtures seem to have been very coldly received. Johnson had had enough of the patronage of the great to last him all his life, and was not disposed to haunt any other door as he had haunted the door of Chesterfield.

By the public the Rambler was at first very coldly received. Though the price of a number was only twopence, the sale did not amount to five hundred. The profits were therefore very small. But as soon as the flying leaves were collected and reprinted they became popular. The author lived to see thirteen thousand copies spread over England alone. Separate editions were published for the Scotch and Irish markets. A large party pronounced the style perfect, so absolutely perfect that in some essays it would be impossible for the writer himself to alter a single word for the better. Another party, not less numerous, vehemently accused him of having corrupted the purity of the English tongue. The best critics admitted that his diction was too monotonous, too obviously artificial, and now and then turgid even to absurdity. But they did justice to the acuteness of his observations on morals and manners, to the constant precision and frequent brilliancy of his language, to the weighty and magnificent eloquence of many serious passages, and to the solemn yet pleasing humour of some of the lighter papers. On the question of precedence between Addison and Johnson, a question which, seventy years ago, was much disputed, posterity has pronounced a decision from which there is no appeal. Sir Roger, his chaplain and his butler, Will Wimble and Will Honeycomb, the Vision of Mirza, the Journal of the Retired Citizen, the Everlasting Club, the Dunmow Flitch, the Loves of Hilpah and Shalum, the Visit to the Exchange, and the Visit to the Abbey, are known to everybody. But many men and women, even of highly cultivated minds, are unacquainted with Squire Bluster and Mrs Busy, Quisquilius and Venustulus, the Allegory of Wit and Learning, the Chronicle of the Revolutions of a Garret, and the sad fate of Aningait and Ajut.

The last Rambler was written in a sad and gloomy hour. Mrs Johnson had been given over by the physicians. Three days later she died. She left her husband almost broken-hearted. Many people had been surprised to see a man of his genius and learning stooping to every drudgery, and denying himself almost every comfort, for the purpose of supplying a silly, affected old woman with superfluities, which she accepted with but little gratitude. But all his affection had been concentrated on her. He had neither brother nor sister, neither son nor daughter. To him she was beautiful as the Gunnings, and witty as Lady Mary. Her opinion of his writings was more important to him than the voice of the pit of Drury Lane Theatre, or the judgment of the Monthly Review. The chief support which had sustained him through the most arduous labour of his life was the hope that she would enjoy the fame and the profit which he anticipated from his Dictionary. She was gone; and, in that vast labyrinth of streets, peopled by eight hundred thousand human beings, he was alone. Yet it was necessary for him to set himself, as he expressed it, doggedly to work. After three more laborious years, the Dictionary was at length complete.

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It had been generally supposed that this great work would be dedicated to the eloquent and accomplished nobleman to whom the Prospectus had been addressed. He well knew the value of such a compliment; and therefore, when the day of publication drew near, he exerted himself to sooth, by a show of zealous and at the same time of delicate and judicious kindness, the pride which he had so cruelly wounded. Since the Ramblers had ceased to appear, the town had been entertained by a journal called The World, to which many men of high rank and fashion contributed. In two successive numbers of the World, the Dictionary was, to use the modern phrase, puffed with wonderful skill. The writings of Johnson were warmly praised. It was proposed that he should be invested with the authority of a Dictator, nay, of a Pope, over our language, and that his decisions about the meaning and the spelling of words should be received as final. His two folios, it was said, would of course be bought by everybody who could afford to buy them. It was soon known that these papers were written by Chesterfield. But the just resentment of Johnson was not to be so appeased. In a letter written with singular energy and dignity of thought and language, he repelled the tardy advances of his patron. The Dictionary came forth without a dedication. In the preface the author truly declared that he owed nothing to the great, and described the difficulties with which he had been left to struggle so forcibly and pathetically that the ablest and most malevolent of all the enemies of his fame, Horne Tooke, never could read that passage without tears.

The public, on this occasion, did Johnson full justice, and something more than justice. The best lexicographer may well be content if his productions are received by the world with cold esteem. But Johnson's Dictionary was hailed with an enthusiasm such as no similar work has ever excited. It was indeed the first dictionary which could be read with pleasure. The definitions show so much acuteness of thought and command of language, and the passages quoted from poets, divines, and philosophers, are so skilfully selected that a leisure hour may always be very agreeably spent in turning over the pages. The faults of the book resolve themselves, for the most part, into one great fault. Johnson was a wretched etymologist. He knew little or nothing of any Teutonic language except English, which indeed, as he wrote it, was scarcely a Teutonic language; and thus he was absolutely at the mercy of Junius and Skinner.

The Dictionary, though it raised Johnson's fame, added nothing to his pecuniary means. The fifteen hundred guineas which the booksellers had agreed to pay him had been advanced and spent before the last sheets issued from the

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press. It is painful to relate that, twice in the course of the year which followed the publication of this great work, he was arrested and carried to spunging-houses, and that he was twice indebted for his liberty to his excellent friend Richardson. It was still necessary for the man who had been formally saluted by the highest authority as Dictator of the English language to supply his wants by constant toil. He abridged his Dictionary. He proposed to bring out an edition of Shakspeare by subscription; and many subscribers sent in their names, and laid down their money; but he soon found the task so little to his taste that he turned to more attractive employments. He contributed many papers to a new monthly journal, which was called the Literary Magazine. Few of these papers have much interest; but among them was the very best thing that he ever wrote, a masterpiece both of reasoning and of satirical pleasantry, the review of Jenyns's Inquiry into the Nature and Origin of Evil.

In the spring of 1758 Johnson put forth the first of a series of essays, entitled The Idler. During two years these essays continued to appear weekly. They were eagerly read, widely circulated, and, indeed, impudently pirated while they were still in the original form, and had a large sale when collected into volumes. The Idler may be described as a second part of the Rambler, somewhat livelier and somewhat weaker than the first part.

While Johnson was busied with his Idlers, his mother, who had accomplished her ninetieth year, died at Lichfield. It was long since he had seen her; but he had not failed to contribute largely, out of his small means, to her comfort. In order to defray the charges of her funeral, and to pay some debts which she had left, he wrote a little book in a single week, and sent off the sheets to the press without reading them over. A hundred pounds were paid him for the copyright; and the purchasers had great cause to be pleased with their bargain; for the book was Rasselas.

The success of Rasselas was great, though such ladies as Miss Lydia Languish must have been grievously disappointed when they found that the new volume from the circulating library was little more than a dissertation on the author's favourite theme, the Vanity of Human Wishes; that the Prince of Abyssinia was without a mistress, and the Princess without a lover; and that the story set the hero and the heroine down exactly where it had taken them up. The style was the subject of much eager controversy. The Monthly Review and the Critical Review took different sides. Many readers pronounced the writer a pompous pedant, who would never use a word of two syllables where it was possible to use a word of six, and who could not make a waiting woman relate her adventures without balancing every noun with another noun, and every epithet with another epithet. Another party, not less zealous, cited with delight numerous passages in which weighty meaning was expressed with accuracy and illustrated with splendour. And both the censure and the praise were merited.

About the plan of Rasselas little was said by the critics; and yet the faults of the plan might seem to invite severe criticism. Johnson has frequently blamed Shakspeare for neglecting the proprieties of time and place, and for ascribing to one age or nation the manners and opinions of another. Yet Shakspeare has not sinned in this way more grievously than Johnson. Rasselas and Imlac, Nekayah and Pekuah, are evidently meant to be Abyssinians of the eighteenth century: for the Europe which Imlac describes is the Europe of the eighteenth century; and the inmates of the Happy Valley talk familiarly of that law of gravitation which Newton discovered, and which was not fully received even at Cambridge till the eighteenth century. What a real company of Abyssinians would have been may be learned from Bruce's Travels. But Johnson, not content with turning filthy savages, ignorant of their letters, and gorged with raw steaks cut from living cows, into philosophers as eloquent and enlightened as himself or his friend Burke, and into ladies as highly accomplished as Mrs Lennox or Mrs Sheridan, transferred the whole domestic system of England to Egypt. Into a land of harems, a land of polygamy, a land where women are married without ever being seen, he introduced the flirtations and jealousies of our ball-rooms. In a land where there is boundless liberty of divorce, wedlock is described as the indissoluble compact. "A youth and maiden meeting by chance, or brought together by artifice, exchange glances, reciprocate civilities, go home, and dream of each other. Such," says Rasselas, "is the common process of marriage." Such it may have been, and may still be, in London, but assuredly not at Cairo. A writer who was guilty of such improprieties had little right to blame the poet who made Hector quote Aristotle, and represented Julio Romano as flourishing in the days of the oracle of Delphi.

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By such exertions as have been described, Johnson supported himself till the year 1762. In that year a great change in his circumstances took place. He had from a child been an enemy of the reigning dynasty. His Jacobite prejudices had been exhibited with little disguise both in his works and in his conversation. Even in his massy and elaborate Dictionary, he had, with a strange want of taste and judgment, inserted bitter and contumelious reflections on the Whig party. The excise, which was a favourite resource of Whig financiers, he had designated as a hateful tax. He had railed against the commissioners of excise in language so coarse that they had seriously thought of prosecuting him. He had with difficulty been prevented from holding up the Lord Privy Seal by name as an example of the meaning of the word "renegade." A pension he had defined as pay given to a state hireling to betray his country; a pensioner as a slave of state hired by a stipend to obey a master. It seemed unlikely that the author of these definitions would himself be pensioned. But that was a time of wonders. George the Third had ascended the throne; and had, in the course of a few months, disgusted many of the old friends, and conciliated many of the old enemies of his house. The city was becoming mutinous. Oxford was becoming loyal. Cavendishes and Bentincks were murmuring. Somersets and Wyndhams were hastening to kiss hands. The head of the treasury was now Lord Bute, who was a Tory, and could have no objection to Johnson's Toryism. Bute wished to be thought a patron of men of letters; and Johnson was one of the most eminent and one of the most needy men of letters in Europe. A pension of three hundred a year was graciously offered, and with very little hesitation accepted.

This event produced a change in Johnson's whole way of life. For the first time since his boyhood he no longer felt the daily goad urging him to the daily toil. He was at liberty, after thirty years of anxiety and drudgery, to indulge his constitutional indolence, to lie in bed till two in the afternoon, and to sit up talking till four in the morning, without fearing either the printer's devil or the sheriff's officer.

One laborious task indeed he had bound himself to perform. He had received large subscriptions for his promised edition of Shakspeare; he had lived on those subscriptions during some years; and he could not without disgrace omit to perform his part of the contract. His friends repeatedly exhorted him to make an effort; and he repeatedly resolved to do so. But, notwithstanding their exhortations and his resolutions, month followed month, year followed year, and nothing was done. He prayed fervently against his idleness; he determined, as often as he received the sacrament, that he would no longer doze away and trifle away his time; but the spell under which he lay resisted prayer and sacrament. His private notes at this time are made up of self-reproaches. "My indolence," he wrote on Easter eve in 1764, "has sunk into grosser sluggishness. A kind of

strange oblivion has overspread me, so that I know not what has become of the last year." Easter 1765 came, and found him still in the same state. "My time," he wrote, "has been unprofitably spent, and seems as a dream that has left nothing behind. My memory grows confused, and I know not how the days pass over me." Happily for his honour, the charm which held him captive was at length broken by no gentle or friendly hand. He had been weak enough to pay serious attention to a story about a ghost which haunted a house in Cock Lane, and had actually gone himself, with some of his friends, at one in the morning, to St John's Church, Clerkenwell, in the hope of receiving a communication from the perturbed spirit. But the spirit, though adjured with all solemnity, remained obstinately silent; and it soon appeared that a naughty girl of eleven had been amusing herself by making fools of so many philosophers. Churchill, who, confident in his powers, drunk with popularity, and burning with party spirit, was looking for some man of established fame and Tory politics to insult, celebrated the Cock Lane Ghost in three cantos, nicknamed Johnson Pomposo, asked where the book was which had been so long promised and so liberally paid for, and directly accused the great moralist of cheating. This terrible word proved effectual; and in October 1765 appeared, after a delay of nine years, the new edition of Shakspeare.

This publication saved Johnson's character for honesty, but added nothing to the fame of his abilities and learning. The preface, though it contains some good passages, is not in his best manner. The most valuable notes are those in which he had an opportunity of showing how attentively he had during many years observed human life and human nature. The best specimen is the note on the character of Polonius. Nothing so good is to be found even in Wilhelm Meister's admirable examination of Hamlet. But here praise must end. It would be difficult to name a more slovenly, a more worthless edition of any great classic. The reader may turn over play after play without finding one happy conjectural emendation, or one ingenious and satisfactory explanation of a passage which had baffled preceding commentators. Johnson had, in his Prospectus, told the world that he was peculiarly fitted for the task which he had undertaken, because he had, as a lexicographer, been under the necessity of taking a wider view of the English language than any of his predecessors. That his knowledge of our literature was extensive is indisputable. But, unfortunately, he had altogether neglected that very part of our literature with which it is especially desirable that an editor of Shakspeare should be conversant. It is dangerous to assert a negative. Yet little will be risked by the assertion, that in the two folio volumes of the English Dictionary there is not a single passage quoted from any dramatist of the Elizabethan age, except Shakspeare and Ben. Even from Ben the quotations are few. Johnson might easily, in a few months, have made himself well acquainted with every old play that was extant. But it never seems to have occurred to him that this was a necessary preparation for the work which he had undertaken. He would doubtless have admitted that it would be the height of absurdity in a man who was not familiar with the works of Æschylus and Euripides to publish an edition of Sophocles. Yet he ventured to publish an edition of Shakspeare, without having ever in his life, as far as can be discovered, read a single scene of Massinger, Ford, Decker, Webster, Marlow, Beaumont, or Fletcher. His detractors were noisy and scurrilous. Those who most loved and honoured him had little to say in praise of the manner in which he had discharged the duty of a commentator. He had, however, acquitted himself of a debt which had long lain heavy on his conscience, and he sank back into the repose from which the sting of satire had roused him. He long continued to live upon the fame which he had already won. He was honoured by the University of Oxford with a Doctor's degree, by the Royal Academy with a professorship, and by the King with an interview, in which his Majesty most graciously expressed a hope that so excellent a writer would not cease to write. In the interval, however, between 1765 and 1775 Johnson published only two or three political tracts, the longest of which he could have produced in forty-eight hours, if he had worked as he worked on the Life of Savage and on Rasselas.

But, though his pen was now idle, his tongue was active. The influence exercised by his conversation, directly upon those with whom he lived, and indirectly on the whole literary world, was altogether without a parallel. His colloquial talents were indeed of the highest order. He had strong sense, quick discernment, wit, humour, immense knowledge of literature and of life, and an infinite store of curious anecdotes. As respected style, he spoke far better than he wrote. Every sentence which dropped from his lips was as correct in structure as the most nicely balanced period of the Rambler. But in his talk there were no pompous triads, and little more than a fair proportion of words in *osity* and *ation*. All was simplicity, ease, and vigour. He uttered his short, weighty, and pointed sentences with a power of voice, and a justness and energy of emphasis, of which the effect was rather increased than diminished by the rollings of his huge form, and by the asthmatic gaspings and puffings in which the peals of his eloquence generally ended. Nor did the laziness which made him unwilling to sit down to his desk prevent him from giving instruction or entertainment orally. To discuss questions of taste, of learning, of casuistry, in language so exact and so forcible that it might have been printed without the alteration of a word, was to him no exertion, but a pleasure. He loved, as he said, to fold his legs and have his talk out. He was ready to bestow the overflowings of his full mind on anybody who would start a subject, on a fellow-passenger in a stage coach, or on the person who sate at the same table with him in an eating-house. But his conversation was nowhere so brilliant and striking as when he was surrounded by a few friends, whose abilities and knowledge enabled them, as he once expressed it, to send him back every ball that he threw. Some of these, in 1764, formed themselves into a club, which gradually became a formidable power in the commonwealth of letters. The verdicts pronounced by this conclave on new books were speedily known over all London, and were sufficient to sell off a whole edition in a day, or to condemn the sheets to the service of the trunk-maker and the pastrycook. Nor shall we think this strange when we consider what great and various talents and acquirements met in the little fraternity. Goldsmith was the representative of poetry and light literature, Reynolds of the arts, Burke of political eloquence and political philosophy. There, too, were Gibbon, the greatest historian, and Jones the greatest linguist, of the age. Garrick brought to the meetings his inexhaustible pleasantry, his incomparable mimicry, and his consummate knowledge of stage effect. Among the most constant attendants were two high-born and high-bred gentlemen, closely bound together by friendship, but of widely different characters and habits; Bennet Langton, distinguished by his skill in Greek literature, by the orthodoxy of his opinions, and by the sanctity of his life; and Topham Beauclerk, renowned for his amours, his knowledge of the gay world, his fastidious taste, and his sarcastic wit. To predominate over such a society was not easy. Yet even over such a society Johnson predominated. Burke might indeed have disputed the supremacy to which others were under the necessity of submitting. But Burke, though not generally a very patient listener, was content to take the second part when Johnson was present; and the club itself, consisting of so many eminent men, is to this day popularly designated as Johnson's club

Among the members of this celebrated body was one to whom it has owed the greater part of its celebrity, yet who was regarded with little respect by his brethren, and had not without difficulty obtained a seat among them. This was James Boswell, a young Scotch lawyer, heir to an honourable name and a fair estate. That he was a coxcomb and a bore, weak, vain, pushing, curious, garrulous, was obvious to all who were acquainted with him. That he could not reason, that he had no wit, no humour, no eloquence, is apparent from his writings. And yet his writings are read beyond the Mississippi, and under the Southern Cross, and are likely to be read as long as the English exists, either as a living or as a dead language. Nature had made him a slave and an idolater. His mind resembled those creepers which the botanists call parasites, and which can subsist only by clinging round the stems and imbibing the juices of stronger plants. He must have fastened himself on somebody. He might have fastened himself on Wilkes, and have become the fiercest patriot in the Bill of Rights Society. He might have fastened himself on Whitfield, and have become the loudest field preacher among the Calvinistic Methodists. In a happy hour he fastened himself on Johnson. The pair might seem ill matched. For Johnson had early been prejudiced against Boswell's country. To a man of Johnson's strong understanding and irritable temper, the silly egotism and adulation of Boswell must have been as teasing as the constant buzz of a fly. Johnson hated to be questioned; and Boswell was eternally catechizing him on all kinds of subjects, and sometimes propounded such questions as, "What would you do, sir, if you were locked up in a tower with a baby?" Johnson was a water drinker and Boswell was a winebibber, and indeed little better than a habitual sot. It was impossible that there should be perfect harmony between two such companions. Indeed, the great man was sometimes provoked into fits of passion, in which he said things which the small man, during a few hours, seriously resented. Every quarrel, however, was soon made up. During twenty years the disciple continued to worship the master: the master continued to scold the disciple, to sneer at him, and to love him. The two friends ordinarily resided at a great distance from each other. Boswell practised in the Parliament House of Edinburgh, and could pay only occasional visits to London. During those visits his chief business was to watch Johnson, to discover all Johnson's habits, to turn the conversation to subjects about which Johnson was likely to say something remarkable, and to fill quarto notebooks with minutes of what Johnson had said. In this way were gathered the materials, out of which was afterwards constructed the most interesting biographical work in the world.

Soon after the club began to exist, Johnson formed a connection less important indeed to his fame, but much more important to his happiness, than his connection with Boswell. Henry Thrale, one of the most opulent brewers in the kingdom, a man of sound and cultivated understanding, rigid principles, and liberal spirit, was married to one of those clever, kind-hearted, engaging, vain, pert, young women, who are perpetually doing or saying what is not exactly right, but who, do or say what they may, are always agreeable. In 1765 the Thrales became acquainted with Johnson, and the acquaintance ripened fast into friendship. They were astonished and delighted by the brilliancy of his conversation. They were flattered by finding that a man so widely celebrated preferred their house to any other in London. Even the peculiarities which seemed to unfit him for civilised society, his gesticulations, his rollings, his puffings, his mutterings, the strange way in which he put on his clothes, the ravenous eagerness with which he devoured his dinner, his fits of melancholy, his fits of anger, his frequent rudeness, his occasional ferocity, increased the interest which his new associates took in him. For these things were the cruel marks left behind by a life which had been one long conflict with disease and with adversity. In a vulgar hack writer, such oddities would have excited only disgust. But in a man of genius, learning, and virtue, their effect was to add pity to admiration and esteem. Johnson soon had an apartment at the brewery in Southwark, and a still more pleasant apartment at the villa of his friends on Streatham Common. A large part of every year he passed in those abodes, abodes which must have seemed magnificent and luxurious indeed, when compared with the dens in which he had generally been lodged. But his chief pleasures were derived from what the astronomer of his Abyssinian tale called "the endearing elegance of female friendship." Mrs Thrale rallied him, soothed him, coaxed him, and, if she sometimes provoked him by her flippancy, made ample amends by listening to his reproofs with angelic sweetness of temper. When he was diseased in body and in mind, she was the most tender of nurses. No comfort that wealth could purchase, no contrivance that womanly ingenuity, set to work by womanly compassion, could devise was wanting to his sick room. He requited her kindness by an affection pure as the affection of a father, yet delicately tinged with a gallantry, which, though awkward, must have been more flattering than the attentions of a crowd of the fools who gloried in the names, now obsolete, of Buck and Maccaroni. It should seem that a full half of Johnson's life, during about sixteen years, was passed under the roof of the Thrales. He accompanied the family sometimes to Bath, and sometimes to Brighton, once to Wales and once to Paris. But he had at the same time a house in one of the narrow and gloomy courts on the north of Fleet Street. In the garrets was his library, a large and miscellaneous collection of books, falling to pieces and begrimed with dust. On a lower floor he sometimes, but very rarely, regaled a friend with a plain dinner, a veal pie, or a leg of lamb and spinage, and a rice pudding. Nor was the dwelling uninhabited during his long absences. It was the home of the most extraordinary assemblage of inmates that ever was brought together. At the head of the establishment Johnson had placed an old lady named Williams, whose chief recommendations were her blindness and her poverty. But, in spite of her murmurs and reproaches, he gave an asylum to another lady who was as poor as herself, Mrs Desmoulins, whose family he had known many years before in Staffordshire. Room was found for the daughter of Mrs Desmoulins, and for another destitute damsel, who was generally addressed as Miss Carmichael, but whom her generous host called Polly. An old quack doctor named Levett, who bled and dosed coal-heavers and hackney coachmen, and received for fees crusts of bread, bits of bacon, glasses of gin, and sometimes a little copper, completed this strange menagerie. All these poor creatures were at constant war with each other, and with Johnson's negro servant Frank. Sometimes, indeed, they transferred their hostilities from the servant to the master, complained that a better table was not kept for them, and railed or maundered till their benefactor was glad to make his escape to Streatham, or to the Mitre Tavern. And yet he, who was generally the haughtiest and most irritable of mankind, who was but too prompt to resent anything which looked like a slight on the part of a purse-proud bookseller, or of a noble and powerful patron, bore patiently from mendicants, who, but for his bounty, must have gone to the workhouse, insults more provoking than those for which he had knocked down Osborne and bidden defiance to Chesterfield. Year after year Mrs Williams and Mrs Desmoulins, Polly and Levett, continued to torment him and to live upon him.

The course of life which has been described was interrupted in Johnson's sixty-fourth year by an important event. He had early read an account of the Hebrides, and had been much interested by learning that there was so near

him a land peopled by a race which was still as rude and simple as in the middle ages. A wish to become intimately acquainted with a state of society so utterly unlike all that he had ever seen frequently crossed his mind. But it is not probable that his curiosity would have overcome his habitual sluggishness, and his love of the smoke, the mud, and the cries of London, had not Boswell importuned him to attempt the adventure, and offered to be his squire. At length, in August 1773, Johnson crossed the Highland line, and plunged courageously into what was then considered, by most Englishmen, as a dreary and perilous wilderness. After wandering about two months through the Celtic region, sometimes in rude boats which did not protect him from the rain, and sometimes on small shaggy poneys which could hardly bear his weight, he returned to his old haunts with a mind full of new images and new theories. During the following year he employed himself in recording his adventures. About the beginning of 1775, his Journey to the Hebrides was published, and was, during some weeks, the chief subject of conversation in all circles in which any attention was paid to literature. The book is still read with pleasure. The narrative is entertaining; the speculations, whether sound or unsound, are always ingenious; and the style, though too stiff and pompous, is somewhat easier and more graceful than that of his early writings. His prejudice against the Scotch had at length become little more than matter of jest; and whatever remained of the old feeling had been effectually removed by the kind and respectful hospitality with which he had been received in every part of Scotland. It was, of course, not to be expected that an Oxonian Tory should praise the Presbyterian polity and ritual, or that an eye accustomed to the hedgerows and parks of England should not be struck by the bareness of Berwickshire and East Lothian. But even in censure Johnson's tone is not unfriendly. The most enlightened Scotchmen, with Lord Mansfield at their head, were well pleased. But some foolish and ignorant Scotchmen were moved to anger by a little unpalatable truth which was mingled with much eulogy, and assailed him whom they chose to consider as the enemy of their country with libels much more dishonourable to their country than anything that he had ever said or written. They published paragraphs in the newspapers, articles in the magazines, sixpenny pamphlets, five shilling books. One scribbler abused Johnson for being blear-eyed; another for being a pensioner: a third informed the world that one of the Doctor's uncles had been convicted of felony in Scotland, and had found that there was in that country one tree capable of supporting the weight of an Englishman. Macpherson, whose Fingal had been proved in the Journey to be an impudent forgery, threatened to take vengeance with a cane. The only effect of this threat was that Johnson reiterated the charge of forgery in the most contemptuous terms, and walked about, during some time, with a cudgel, which, if the impostor had not been too wise to encounter it, would assuredly have descended upon him, to borrow the sublime language of his own epic poem, "like a hammer on the red son of the furnace."

Of other assailants Johnson took no notice whatever. He had early resolved never to be drawn into controversy; and he adhered to his resolution with a steadfastness which is the more extraordinary, because he was, both intellectually and morally, of the stuff of which controversialists are made. In conversation, he was a singularly eager, acute, and pertinacious disputant. When at a loss for good reasons, he had recourse to sophistry; and when heated by altercation, he made unsparing use of sarcasm and invective. But when he took his pen in his hand, his whole character seemed to be changed. A hundred bad writers misrepresented him and reviled him; but not one of the hundred could boast of having been thought by him worthy of a refutation, or even of a retort. The Kenricks, Campbells, MacNicols, and Hendersons, did their best to annoy him, in the hope that he would give them importance by answering them. But the reader will in vain search his works for any allusion to Kenrick or Campbell, to MacNicol or Henderson. One Scotchman, bent on vindicating the fame of Scotch learning, defied him to the combat in a detestable Latin hexameter.

Johnson, Samuel.

"Maxime, si tu vis, cupio contendere tecum."

But Johnson took no notice of the challenge. He had learned, both from his own observation and from literary history, in which he was deeply read, that the place of books in the public estimation is fixed, not by what is written about them, but by what is written in them; and that an author whose works are likely to live is very unwise if he stoops to wrangle with detractors whose works are certain to die. He always maintained that fame was a shuttlecock which could be kept up only by being beaten back, as well as beaten forward, and which would soon fall if there were only one battledore. No saying was oftener in his mouth than that fine apophthegm of Bentley, that no man was ever written down but by himself.

Unhappily, a few months after the appearance of the Journey to the Hebrides, Johnson did what none of his envious assailants could have done, and to a certain extent succeeded in writing himself down. The disputes between England and her American colonies had reached a point at which no amicable adjustment was possible. Civil war was evidently impending; and the ministers seem to have thought that the eloquence of Johnson might with advantage be employed to inflame the nation against the opposition here, and against the rebels beyond the Atlantic. He had already written two or three tracts in defence of the foreign and domestic policy of the government; and those tracts, though hardly worthy of him, were much superior to the crowd of pamphlets which lay on the counters of Almon and Stockdale. But his Taxation No Tyranny was a pitiable failure. The very title was a silly phrase, which can have been recommended to his choice by nothing but a jingling alliteration which he ought to have despised. The arguments were such as boys use in debating societies. The pleasantry was as awkward as the gambols of a hippopotamus. Even Boswell was forced to own that, in this unfortunate piece, he could detect no trace of his master's powers. The general opinion was that the strong faculties which had produced the Dictionary and the Rambler were beginning to feel the effect of time and of disease, and that the old man would best consult his credit by writing no more.

But this was a great mistake. Johnson had failed, not because his mind was less vigorous than when he wrote Rasselas in the evenings of a week, but because he had foolishly chosen, or suffered others to choose for him, a subject such as he would at no time have been competent to treat. He was in no sense a statesman. He never willingly read or thought or talked about affairs of state. He loved biography, literary history, the history of manners; but political history was positively distasteful to him. The question at issue between the colonies and the mother country was a question about which he had really nothing to say. He failed, therefore, as the greatest men must fail when they attempt to do that for which they are unfit; as Burke would have failed if Burke had tried to write comedies like those of Sheridan; as Reynolds would have failed if Reynolds had tried to paint landscapes like those of Wilson. Happily, Johnson soon had an opportunity of proving most signally that his failure was not to be ascribed to intellectual decay.

On Easter eve 1777, some persons, deputed by a meeting which consisted of forty of the first booksellers in London,

Johnson, Samuel.

called upon him. Though he had some scruples about doing business at that season, he received his visitors with much civility. They came to inform him that a new edition of the English poets, from Cowley downwards, was in contemplation, and to ask him to furnish short biographical prefaces. He readily undertook the task, a task for which he was pre-eminently qualified. His knowledge of the literary history of England since the Restoration was unrivalled. That knowledge he had derived partly from books, and partly from sources which had long been closed; from old Grub Street traditions; from the talk of forgotten poetasters and pamphleteers who had long been lying in parish vaults; from the recollections of such men as Gilbert Walmesley, who had conversed with the wits of Button; Cibber, who had mutilated the plays of two generations of dramatists; Orrery, who had been admitted to the society of Swift; and Savage, who had rendered services of no very honourable kind to Pope. The biographer therefore sate down to his task with a mind full of matter. He had at first intended to give only a paragraph to every minor poet, and only four or five pages to the greatest name. But the flood of anecdote and criticism overflowed the narrow channel. The work, which was originally meant to consist only of a few sheets, swelled into ten volumes, small volumes, it is true, and not closely printed. The first four appeared in 1779, the remaining six in 1781.

The Lives of the Poets are, on the whole, the best of Johnson's works. The narratives are as entertaining as any novel. The remarks on life and on human nature are eminently shrewd and profound. The criticisms are often excellent, and, even when grossly and provokingly unjust, well deserve to be studied. For, however erroneous they may be, they are never silly. They are the judgments of a mind trammelled by prejudice and deficient in sensibility, but vigorous and acute. They therefore generally contain a portion of valuable truth which deserves to be separated from the alloy; and, at the very worst, they mean something, a praise to which much of what is called criticism in our time has no pretensions.

Savage's Life Johnson reprinted nearly as it had appeared in 1744. Whoever, after reading that life, will turn to the other lives will be struck by the difference of style. Since Johnson had been at ease in his circumstances he had written little and had talked much. When, therefore, he, after the lapse of years, resumed his pen, the mannerism which he had contracted while he was in the constant habit of elaborate composition was less perceptible than formerly; and his diction frequently had a colloquial ease which it had formerly wanted. The improvement may be discerned by a skilful critic in the Journey to the Hebrides, and in the Lives of the Poets is so obvious that it cannot escape the notice of the most careless reader.

Among the Lives the best are perhaps those of Cowley, Dryden, and Pope. The very worst is, beyond all doubt, that of Gray.

This great work at once became popular. There was, indeed, much just and much unjust censure: but even those who were loudest in blame were attracted by the book in spite of themselves. Malone computed the gains of the publishers at five or six thousand pounds. But the writer was very poorly remunerated. Intending at first to write very short prefaces, he had stipulated for only two hundred guineas. The booksellers, when they saw how far his performance had surpassed his promise, added only another hundred. Indeed, Johnson, though he did not despise, or affect to despise money, and though his strong sense and long experience ought to have qualified him to protect his own interests, seems to have been singularly unskilful and unlucky in his literary bargains. He was generally reputed the first English writer of his time. Yet several writers of his time sold their copyrights for sums such as he never ventured to ask. To give a single instance, Robertson received four thousand five hundred pounds for the History of Charles V.; and it is no disrespect to the memory of Robertson to say that the History of Charles V. is both a less valuable and a less amusing book than the Lives of the Poets.

Johnson, Samuel.

Johnson was now in his seventy-second year. The infirmities of age were coming fast upon him. That inevitable event of which he never thought without horror was brought near to him; and his whole life was darkened by the shadow of death. He had often to pay the cruel price of longevity. Every year he lost what could never be replaced. The strange dependants to whom he had given shelter, and to whom, in spite of their faults, he was strongly attached by habit, dropped off one by one; and, in the silence of his home, he regretted even the noise of their scolding matches. The kind and generous Thrale was no more; and it would have been well if his wife had been laid beside him. But she survived to be the laughing-stock of those who had envied her, and to draw from the eyes of the old man who had loved her beyond any thing in the world, tears far more bitter than he would have shed over her grave. With some estimable, and many agreeable qualities, she was not made to be independent. The control of a mind more steadfast than her own was necessary to her respectability. While she was restrained by her husband, a man of sense and firmness, indulgent to her taste in trifles, but always the undisputed master of his house, her worst offences had been impertinent jokes, white lies, and short fits of pettishness ending in sunny good humour. But he was gone; and she was left an opulent widow of forty, with strong sensibility, volatile fancy, and slender judgment. She soon fell in love with a music-master from Brescia, in whom nobody but herself could discover anything to admire. Her pride, and perhaps some better feelings, struggled hard against this degrading passion. But the struggle irritated her nerves, soured her temper, and at length endangered her health. Conscious that her choice was one which Johnson could not approve, she became desirous to escape from his inspection. Her manner towards him changed. She was sometimes cold and sometimes petulant. She did not conceal her joy when he left Streatham: she never pressed him to return; and, if he came unbidden, she received him in a manner which convinced him that he was no longer a welcome guest. He took the very intelligible hints which she gave. He read, for the last time, a chapter of the Greek Testament in the library which had been formed by himself. In a solemn and tender prayer he commended the house and its inmates to the Divine protection, and, with emotions which choked his voice and convulsed his powerful frame, left for ever that beloved home for the gloomy and desolate house behind Fleet Street, where the few and evil days which still remained to him were to run out. Here, in June 1783, he had a paralytic stroke, from which, however, he recovered, and which does not appear to have at all impaired his intellectual faculties. But other maladies came thick upon him. His asthma tormented him day and night. Dropsical symptoms made their appearance. While sinking under a complication of diseases, he heard that the woman whose friendship had been the chief happiness of sixteen years of his life, had married an Italian fiddler; that all London was crying shame upon her; and that the newspapers and magazines were filled with allusions to the Ephesian matron and the two pictures in Hamlet. He vehemently said that he would try to forget her existence. He never uttered her name. Every memorial of her which met his eye he flung into the fire. She meanwhile fled from the laughter and hisses of her countrymen and countrywomen to a land where she was unknown, hastened across Mount Cenis, and learned, while passing a merry

Johnston, Arthur.

Christmas of concerts and lemonade parties at Milan, that the great man with whose name hers is inseparably associated, had ceased to exist.

He had, in spite of much mental and much bodily affliction, clung vehemently to life. The feeling described in that fine but gloomy paper which closes the series of his Idlers seemed to grow stronger in him as his last hour drew near. He fancied that he should be able to draw his breath more easily in a southern climate, and would probably have set out for Rome and Naples but for his fear of the expense of the journey. That expense, indeed, he had the means of defraying; for he had laid up about two thousand pounds, the fruit of labours which had made the fortune of several publishers. But he was unwilling to break in upon this hoard, and he seems to have wished even to keep its existence a secret. Some of his friends hoped that the government might be induced to increase his pension to six hundred pounds a-year, but this hope was disappointed, and he resolved to stand one English winter more. That winter was his last. His legs grew weaker; his breath grew shorter; the fatal water gathered fast, in spite of incisions which he, courageous against pain, but timid against death, urged his surgeons to make deeper and deeper. Though the tender care which had mitigated his sufferings during months of sickness at Streatham was withdrawn, he was not left desolate. The ablest physicians and surgeons attended him, and refused to accept fees from him. Burke parted from him with deep emotion. Windham sate much in the sick room, arranged the pillows, and sent his own servant to watch at night by the bed. Frances Burney, whom the old man had cherished with fatherly kindness, stood weeping at the door; while Langton, whose piety eminently qualified him to be an adviser and comforter at such a time, received the last pressure of his friend's hand within. When at length the moment, dreaded through so many years, came close, the dark cloud passed away from Johnson's mind. His temper became unusually patient and gentle; he ceased to think with terror of death, and of that which lies beyond death; and he spoke much of the mercy of God, and of the propitiation of Christ. In this serene frame of mind he died on the 13th of December 1784. He was laid, a week later, in Westminster Abbey, among the eminent men of whom he had been the historian,—Cowley and Denham, Dryden and Congreve, Gay, Prior, and Addison.

Since his death the popularity of his works—the Lives of the Poets, and, perhaps, the Vanity of Human Wishes, excepted—has greatly diminished. His Dictionary has been altered by editors till it can scarcely be called his. An allusion to his Rambler or his Idler is not readily apprehended in literary circles. The fame even of Rasselas has grown somewhat dim. But though the celebrity of the writings may have declined, the celebrity of the writer, strange to say, is as great as ever. Boswell's book has done for him more than the best of his own books could do. The memory of other authors is kept alive by their works. But the memory of Johnson keeps many of his works alive. The old philosopher is still among us in the brown coat with the metal buttons and the shirt which ought to be at wash, blinking, puffing, rolling his head, drumming with his fingers, tearing his meat like a tiger, and swallowing his tea in oceans. No human being who has been more than seventy years in the grave is so well known to us. And it is but just to say that our intimate acquaintance with what he would himself have called the anfractuosities of his intellect and of his temper, serves only to strengthen our conviction that he was both a great and a good man. (T. B. M.)

JOHNSTON, Arthur, an eminent Latin poet and scholar, was the fifth son of George Johnston of Caskieben, by Christian, the daughter of Lord Forbes, and was born in 1587 at his father's estate of Caskieben in Aberdeenshire. He received the rudiments of his education at Kintore, whence he proceeded to Marischal College, Aberdeen. It is not certain whether he remained long enough at that university to take his degree. Probably he did not, as he is known to have gone to the Continent while a mere youth, and to have graduated as M.D. at Padua in 1610. In a beautiful Latin elegy, addressed to a friend, he supplies some of the details of his personal history. From it we learn that he twice crossed the Alps, and twice visited Rome; that he had travelled in Germany, the Netherlands, Denmark, and England; that he resided twenty years in France; and that two wives who were of different nations had borne him thirteen children. In all these wanderings he seems to have assiduously cultivated the practice of Latin verse composition; and, according to Sir Thomas Urquhart, "before he was full three and twenty years of age, he was laureated poet at Paris, and that most deservedly." His fame as a Latin poet even reached his own country, and lost nothing when he entered the lists as the champion of his contemporary Buchanan. A small witling of the day, George Eglisham by name, had bitterly attacked Buchanan's version of the 104th psalm, and produced in contrast a version of his own. Instead of seriously refuting Eglisham's criticisms, Johnston merely ridiculed them in a satire, as elegant as it was bitter, published in 1619, under the title of *Consilium Collegii Medici Parisiensis de Manid G. Eglishemii* [afterwards *Hypermori Medicastri*], *quam prodidit scripto, cui titulus Duellum Poeticum*, &c. The whole story forms a curious prototype of the celebrated *Frenzy of John Dennis*.

Johnston seems to have returned to Scotland about the year 1625, and shortly afterwards—probably about the year 1628—to have been appointed physician to Charles I. Aberdeen became his first head-quarters, and there, in 1632, he published his *Parerga, Epigrammata*, and some minor poetical pieces. In 1637 he was made rector of King's College, but after his appointment as royal physician, most of his time was spent at the English court, and he was only able to visit Aberdeen at occasional intervals. His attachment to his native county, however, remained undiminished; and as soon as his means enabled him to do so, he purchased an estate there. Though he published several of his works in London, such as his *Cantici Salomonis Paraphrasis Poetica*, 1633, and his *Musæ Aulicæ*, 1635, he reserved to Aberdeen the honour of publishing the greatest and best known of all his writings, which appeared there in 1637 under the title of *Paraphrasis Poetica Psalmorum Davidis*. This, as it was the greatest, seems also to have been the last of his works, if we except his contributions to the *Deliciæ Poetarum Scotorum*, brought out at Amsterdam about the same date. It had been written many years before, and parts of it had been shown in MS. to the most eminent scholars of Great Britain and the Continent. Like all its author's works it displays a masterly command of Latin diction, and an almost unequalled skill in versifying. Buchanan's version of the Psalms, produced some years before, had preoccupied that field; and Johnston's appearing when it did, had the air of being designed to vie with that of his great contemporary. Comparisons were of course instituted between the rival works, and though the critics awarded the palm to Buchanan they were unanimous in placing Johnston's next to his, and both very far above every other attempt of the kind that had appeared up to that day. Posterity has confirmed this verdict. In his original pieces Johnston exhibits much fancy and poetical feeling, and a refined taste. He paid great attention to the harmony of rhythm, for which he had an exquisite ear. He preferred the elegiac distich to every other form of verse; and, besides his minor pieces, all his psalms are written in that metre except the 119th. Each part of that psalm is rendered in a different measure, adapted to the varieties of movement and idea. Johnston's diction is for

Johnstone, Robert ‖ Joinery.

the most part singularly pure, though he sometimes employs a word or phrase not to be found in Horace or Virgil. There have been several editions of Johnston's entire works; and numerous editions of his version of the Psalms.

JOHNSTONE, ROBERT, a Scottish historian, held at one time in great repute, was born at Edinburgh in the latter half of the 16th century. Little is known of his personal history beyond this, that he migrated to London, amassed a large fortune there, bequeathed considerable sums to the University of Edinburgh, and to various towns in Annandale (the nursery of his family), and died in 1639. He was long remembered for his *Historia Rerum Britannicarum, &c. ab anno* 1572 *ad annum* 1628, Amst. 1655. This history of his own times was intended by the author as a continuation of Buchanan's work, and really possesses very considerable merits. The narrative is judiciously constructed, the reflections are often very sagacious, and the analysis of character sometimes extremely acute. In point of style it falls far short of its model, yet its general tenor is correctly classical.

JOHNSTONE, a manufacturing town of Scotland in the county of Renfrew, situate on the Black Cart Water, 10 miles W. of Glasgow, with which it is connected by railway and canal. Johnstone is a modern town, with well-built houses and open streets. Its increase in size and population has been rapid on account of the introduction of cotton mills and iron foundries. At the beginning of the present century there were only from 10 to 20 houses in the village, while in 1851 there were 311. The manufactures of the place now include cotton, iron, machinery, and brass. Pop. (1851) 5872.

Johore ‖ Joinery.

JOHORE, the capital of an independent principality of the same name, in the southern part of the Malay peninsula, on the River Johore, about 20 miles from its mouth, in N. Lat. 1. 40., E. Long. 104. 5. It was founded in 1511 by the inhabitants of Malacca, who fled thither after the capture of their city by the Portuguese. It subsequently rose to be a place of considerable importance, but it now consists of only about 30 huts. The inhabitants trade in pepper, tin, gold, sago, and elephants' teeth.

JOIGNY, a town of France, capital of a cognominal arrondissement, in the department of Yonne. It stands on the right bank of the Yonne, along which is a handsome quay, and extends up the steep acclivity of a hill, the summit of which is crowned by the ruins of an ancient castle. The town itself is surrounded by old walls, with six gates, and has two suburbs, one of which, on the opposite bank of the river, is accessible by a stone bridge. The streets are narrow, steep, and irregular. Chief public buildings are the cathedral, two hospitals, communal college, theatre, and cavalry barracks. Manufactures comprise coarse woollens, linen, leather, brandy, and vinegar. Pop. (1851) 6056.

JOINERY

Is one of the useful arts which contributes most materially to the comfort and convenience of man. As the arts of joinery and carpentry are often followed by the same individual, it appears at first view natural to conclude that the same principles are common to both these arts; but a closer examination of their objects leads us to a different conclusion.

Carpentry defined.

The art of Carpentry is directed almost wholly to the support of weight or pressure, and therefore its principles must be found in the mechanical sciences. In a building it includes all the rough timber work necessary for support, division, or connection; and its proper object is to give firmness and stability. (See CARPENTRY.)

Joinery defined.

The art of Joinery has for its object the addition in a building of all the fixed wood work necessary for convenience or ornament. It is the *Intestinum opus* of Vitruvius and Varro, and the *Menuiserie des bâtimens* of the French. In Italy it is called *legname*, carpentry being called *grosso legname*, expressions very analogous to our "whitesmith" and "blacksmith."

The joiner's works are many of them of a complicated nature, and require to be executed in an expensive material; therefore joinery requires much skill in that part of geometrical science which treats of the projection and description of lines, surfaces, and solids, as well as an intimate knowledge of the structure and nature of wood.

It may also be remarked, that the rough labour of the carpenter renders him in some degree unfit to produce that kind of accurate and neat workmanship which is expected from a modern joiner.

Progress of joinery in England.

In early times, very little that resembles modern joinery was known; every part was rude, and joined in the most [illegible] manner. The first dawnings of the art appear in the [illegible] stalls, pulpits, and screens of our cathedrals and churches; but even in these it is of the most simple kind, and [illegible] to the carver for everything that is worthy of regard. Whether in these monuments the carver and the joiner [illegible] one and the same person we cannot now determine, though we imagine, from the mode of joining in some of them, that this was the case.

During several centuries joinery seems to have been gradually improving, but nothing appears to have been written on the art before 1677, when Mr Joseph Moxon, a Fellow of the Royal Society, published a work entitled *Mechanick Exercises, or the Doctrine of Handyworks*. In this work the tools and common operations in joinery are described with a collection of the terms then in use. It must have been a valuable work at that time, but to a master in the art it would convey little if anything that was new. Sash-windows were introduced into England some time before the date of Moxon's work, but he has not noticed them. According to the observations of Dr Thomson, this important improvement had not found its way into Sweden at the time he wrote.[1]

With the revival of classic art great changes took place in every sort of construction. Forms began to be introduced in architecture which could not be executed at a moderate expense without the aid of new principles, and these principles were discovered and published by practical joiners. As might naturally be expected, these authors had but confused notions, with a scanty portion of geometrical knowledge; and, accordingly, their descriptions are often obscure, and sometimes erroneous. The change from the heavy mullioned casement and its guard of iron bars to the sash windows, necessitated some new method of protection, and boxing shutters were invented. The framed wainscot of small pannels gave way to the large bolexion moulded pannelling. Heavy doors, which were formerly hung on massive posts, or in jambs of cut stone, were now framed in light pannels, and hung in moulded dressings of wood. The scarcity of oak timber, and the expense of working it, led to the importation of fir timber from the North, which gradually superseded all other material except for the choicest and dearest works. But, of all introductions, that of the geometrical staircase, or stair supported by the wall only, invented, says Palladio, by the famous Luigi Cor-

[1] *Travels in Sweden*, p. 8.

naro (the first English example of which is said to have been erected by Sir Christopher Wren in St Paul's), led to the greatest changes in the art of joinery, inasmuch as the lines for their setting out necessitated a very considerable knowledge of geometry.

The hand-rails of these stairs offered most difficulties, and an imperfect attempt to remove them was first made by Halfpenny, in his *Art of Sound Building*, published in 1725. Price, the author of the *British Carpenter*, published in 1733, was more successful, and his remarks show a considerable degree of knowledge of the true nature and object of his researches.

The publication of Price's work must have produced a considerable sensation among joiners, for it was soon followed by many other works of different degrees of merit. Of these the works of Langley and Pain were the most popular.

The establishment of the principles of joinery on the sound basis of geometrical science was reserved for Nicholson. In his *Carpenter's Guide*, and *Carpenter and Joiner's Assistant*, published in 1792, he has made some most valuable corrections and additions to the labours of his predecessors.

Corresponding improvements were also made in the practice of joinery, for which we are much indebted to the late Mr James Wyatt. But the art is still far short of perfection. In fact, in some respects it seems to have retrograded. It is seldom we find large glued-up pannels will now stand well. Mouldings of great girth give at the mitres, doors wind, and skirtings shrink from the floors, in a way seldom seen in old houses. Our sashes, perhaps, are made better than the heavy barred windows of a century and a half ago. In no other respect, however, has joinery made the progress which has been made in other arts. The improved state of machinery has also done but little for its excellence, though the circular saw-bench, the planing machines, the moulding machines, and the mortising machines, have done much to reduce the cost of labour. This last machine was suggested by us in the last edition of this work (1830), our attention having been drawn to it from the improvements in the art of block-making (see BLOCK-MACHINERY), and we are glad to find it is now used in most of the large establishments through the country.

Progress of joinery in France.

The principles of joinery were cultivated in France by a very different class of writers. The celebrated Blondel had given details for the construction of shutters, wainscoting, doors, hinges, fastenings, &c., in his work *Palais et Maisons de Campagne*. In the extensive work of Frezier, entitled *Coupé des Pierres et des Bois*, 3 vols. 4to, 1739, all the leading principles are given and explained with tedious minuteness, offering a striking contrast to the brevity of our English writers. The first elementary work on that part of geometrical science which contains the principles of joinery appeared in France in 1705, from the pen of the celebrated Gaspard Monge, who gave it the name of *Géometrie Déscriptive*. Much of what has been given as new in English works had been long known on the Continent; but there does not appear to have been much, if any, assistance derived from these foreign works by any writer prior to Nicholson. In fact, this writer has been the founder of all the subsequent works on the subject: Peter Nicholson's *Carpenter and Joiner's Assistant* has been published again and again, in various forms, with additions from time to time, by different hands. For revived mediæval and Elizabethan joinery, particularly as adapted to windows and staircases, Weale's *Carpentry*, 4to, 1849, will be found of great value; and most modern improvements are given in Laxton's *Examples of Building Construction*, now in course of publication.

The most celebrated French work which treats of joinery is Rondelet's *L'Art de Bâtir*. It is also the best foreign work on the subject that we have seen; but it is little adapted to the state of joinery in England. In practice the French joiners are very much inferior to our own. Their work is rough, slovenly, and often clumsy, and at the best is confined to external effect. The neatness, soundness, and accuracy, which is common to every part of the works of an English joiner, is scarcely to be found in any part of the works of a French one. The little correspondence, in point of excellence, between their theory and practice, leads us to think that their theoretical knowledge is confined to architects, engineers, &c., instead of being diffused among workmen, as it is in this country. Rondelet's work occupied fourteen years (from 1802 to 1816), in publication, since which *Nosban, Manuel de Menuiserie*, 4to, 1849; and *Thiollet et Roux, Nouveau Recueil de Menuiserie* for 1837, are the most celebrated works published in France. The latter is expressly to be commended. Much also may be learned from the famous work of Col. Emy—*Traité de la Charpente*, atlas, fol., 1847—particularly with regard to framing.

In cabinet-work the French workmen are certainly superior, at least as far as regards external appearance; but when use, as well as ornament, is to be considered, our own countrymen must certainly carry away the palm. The appearance of French furniture is much indebted to a superior method of polishing, which is now generally known in this country.[1] For many purposes, however, copal varnish (such as coachmakers use) is preferable; it is more durable, and bears an excellent polish.

Geometrical knowledge necessary.

Geometry is useful in all, and absolutely necessary in some parts of a joiner's business; but it is absurd to encounter difficulties in execution, and to sacrifice good taste, convenience, economy, and comfort, merely for the purpose of displaying a little skill in that science. It is, however, a common fault among such architects as are better acquainted with geometrical rules than with the production of visible beauties, to form designs for no other purpose than to create difficulties in the execution.

But, when geometrical science is properly directed, it gives the mind so clear a conception of the thing to be executed, that the most intricate piece of work may be conducted with all the accuracy it requires.

Practice of joinery.

The practice of joinery is best learned by observing the methods of good workmen, and endeavouring to imitate them. But the sooner a workman begins to think for himself the better; he ought always to endeavour to improve on the processes of others, either so as to produce the same effect with less labour, or to produce better work.[2]

We intend, in this article, to give a plain and simple exposition of the most valuable principles of the art of joinery, which will, we hope, place many parts of the practice under a new point of view, and ultimately tend to improve them.

Cabinet-making.

Cabinet-making, or that part of the art of working in wood which is applied to furniture, has little affinity with joinery, though the same materials and tools be employed in both. Correctness and strict uniformity are not so essential in moveables as in the fixed parts of buildings; they are also more under the dominion of fashion, and therefore are not so confined by rules as the parts of buildings.

Cabinet-making offers considerable scope for taste in beautiful forms, and also in the choice and arrangement of

[1] The method of making and using the French polish is minutely described in Dr Thomson's *Annals of Philosophy*, vol. xi., pp. 119 and 371.

[2] Descriptions of the tools, with instructions for using them, may be found in Moxon's work before quoted, and in Nicholson's *Mechanical Exercises*, Taylor, London, 1812.

Joinery.

coloured woods. It requires considerable knowledge of perspective, and also that the artist should be able to sketch with freedom and precision.

If the cabinet-maker intend to follow the higher departments of his art, it will be necessary to study the different kinds of architecture, in order to make himself acquainted with their peculiarities, so as to impress his works with the same character as the rooms they are to furnish.

In as far as regards materials, and the principles of joining work, the cabinet-maker will find some useful information in the second and third sections of this article. Many curious works on furniture were published in the reigns of Louis XIV. and XV., also by Chambers and the Adams. Cruden's *Joiner's and Cabinet-Maker's Darling*, 8vo, 1770, is also a curious book. In ornamental composition he may derive much benefit from Tatham's *Etchings of Ancient Ornamental Architecture*, London, 1799; Percier and Fontaine's *Recueil des Décorations Intérieures comprenant tout ce qui a rapport à l'Ameublement*, Paris, 1812; and, for general information, the *Cabinet Dictionary* and the *Cabinet-Maker and Upholsterer's Drawing-Book*, of Sheraton, may be consulted. But the most important works that could be consulted are the various publications relative to the Great Exhibitions in London and Paris, 1851 and 1855, where some of the finest specimens in the world were exhibited. The most accessible to the English reader are those given in the *Art Journal* and *Illustrated London News*.

SECT. I.—ON MAKING WORKING DRAWINGS.

1. In this section we propose to lay before the reader the most important part of the principles of describing, on a plane surface, the lines necessary for determining bevels, forming moulds, or any other purpose required in the practice of joinery. The limits within which such an article as joinery must be confined, in a work like this, will not permit us to enter much into detail on the various points to be illustrated in this section; but we hope, by judicious selection, to place under one point of view the principles that are most useful to the joiner.

Projection of Bodies.

Nature of projection illustrated.

2. A clear idea of the nature of projection is so essential in making working drawings, that, in our endeavours to illustrate it, we cannot proceed upon principles too simple. In the first stage of such an inquiry, experiment furnishes at once the most clear and satisfactory evidence, particularly to those who are not familiar with mathematical subjects.

If some small pieces of wood, or pieces of wire, were joined together, so as to represent the form of a solid body, a cube for example, and if this figure were held between the sun and the surface of a plane board, then the shadow of the figure upon the board would be its projection upon that plane. From this simple experiment it will appear, that the projection of any line placed in the direction of the sun's rays will be a point: the projection of any line parallel to the plane will be of the same length as the line itself, and the projection of any line inclined to the plane will be always shorter than that line.

3. We have supposed the board to be placed at any angle with the direction of the rays of the sun; but, for our present purpose, it is sufficient to consider them to fall perpendicularly upon it; hence it is obvious, that to project a straight line upon a plane, a perpendicular to the plane should be let fall from each end of the line, and the line joining the points where the perpendiculars meet the plane will be the projection required.

When a projection is made upon a horizontal plane, it is usually called a *plan* of the body. When the projection is upon a vertical plane, it may be an *elevation* or a *section* of the body; it is a section when a portion is supposed to be cut off; and the plane of projection is usually parallel to the plane of the section.

Joinery.

4. Bodies may be divided into three classes, according to the kinds of surfaces by which they are bounded. The first class comprehends those which are bounded by plane surfaces, such as cubes, prisms, pyramids, and the like. The second class contains those which are bounded in part by plane surfaces, and the rest by curved surfaces, as cylinders, cones, &c. The third including those which are bounded by curved surfaces only, as spheres, spheroids, &c.

The projections of the first class of bodies will consist of straight lines; those of the second class, of curved as well as straight lines; and those of the third class, of curved lines only.

Projection of lines.

5. Let ABCD and CDEF (fig. 1), be two plane surfaces, connected by a joint at CD, so that while the plane CDEF remains horizontal, the plane ABCD may be placed perpendicular to it, and thus represent a vertical plane. Then, if a line be so placed in space that ab is its projection on the vertical plane, and $a'b'$ its projection on the horizontal plane, its projection on any other vertical plane, HGEC, may be determined. This is easily effected, for we have seen, that if a perpendicular be drawn to the plane from each end of the given line, they will give the positions of the ends of the line in the projection (art. 3.) Now, the same thing will be done, by drawing $a'a''$ and $b'b''$ perpendicular to EC, and setting off the points a'' and b'' at the same height above EC respectively, as a and b are above CD, then the line $a''b''$ is the projection required.

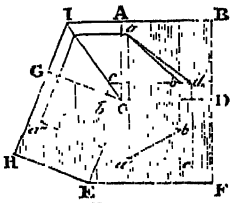


Fig. 1.

The heights may be transferred from one vertical plane to another when they are both supposed to be laid flat, by drawing the line IC, so as to bisect the angle ECD, and if cb be parallel to CD, meeting IC in c, then a line drawn parallel to EC, from the point c, will give the height of the point b'', and so may be found the height of any other point.

To determine the length of a projected line.

6. In the particular case we have drawn, none of the projections represent the real length of the given line. To obtain this length, draw $a'e$ parallel to CD, and with the radius ab' describe the arc $b'e$ cutting $a'e$ in e; draw de perpendicular to CD, cutting the line cb in d; join ad, and it is the length of the given line.

Projection of planes.

The real lengths of lines frequently are not given, therefore another general method of finding them will be useful, and which may be stated as follows:—the length of an inclined line projected upon a plane is equal to the hypothenuse of a right-angled triangle, of which one side is the projection upon the plane, and the other side is the difference between the perpendicular distances of the extremes of the line from the plane.

7. In fig. 2, $a'b'cd$ represents the horizontal projection, or plan, of a rectangular surface, and the elevation ab shows its inclination; and its projection against another vertical plane, making any angle ECD with the former, or plane of elevation, is shown by $a''b''c'd'$. GC being perpendicular to EC, and AC perpendicular to CD, the heights may be transferred by means of arcs of circles described from C as a centre. This is a better method than that by bisecting the angle given in fig. 1; but neither of them so good, in practice, as setting off the heights with the compasses, or with a lath. In our figures it is desira-

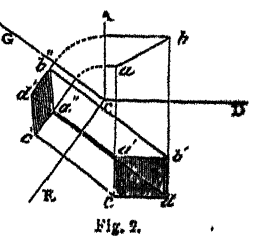


Fig. 2.

Joinery.

ble to show the connection of corresponding parts as much as possible; therefore, the reader will bear in mind that many of the operations we describe may be done with fewer lines when the operator is fully master of his subject.

8. It may be further noticed in this place, that when a point is to be determined in one line by the intersection of another, the lines should cross each other as nearly at right angles as possible; for, when the intersecting lines cross very obliquely, a point cannot be determined with any tolerable degree of accuracy.

Projection of curved surfaces.

9. A curved line can seldom be projected by any other means than by finding a number of points through which the curve may be traced. Rules for all these cases, and for the development of surfaces, will be found under the heads GEOMETRY, CONIC SECTIONS, PROJECTION, &c., &c., and would swell our work to too great a length were we to repeat them. They are also more applicable to the carpenter than the joiner. An exceedingly good practical treatise is furnished in Weale's *Carpentry*, 4to, 1849, vol. i., where full directions are given to find the lines for the development of circular niches, circular-headed sashes, domes, niches, groins, &c., &c.

To determine the Angle formed by two Inclined Planes.

To find the angle of planes inclined to one another.

10. The angle made by two planes which cut one another, is the angle contained by two straight lines drawn from any (the same) point in the line of their common section, at right angles to that line; the one in the one plane, and the other in the other. This angle is the same as that which the joiner takes with his bevel, the bevel being always applied so that its legs are square from the arris, or common section of the planes.

If two lines, AB and CD, be drawn upon a piece of pasteboard, at right angles to one another, crossing at the point E, and the pasteboard be cut half through, according to the line AB, so that it may turn upon that line as a joint; then, to whatever angle, CED (fig. 3), the parts may be turned, the lines EC and ED will be always in the same plane. Also, a line FD, drawn from any point D, in the line ED, to any point F, in the line EC, will be always in the same plane. From these self-evident properties of planes, it is easy to determine the angle formed by any two planes, when two projections, or one projection and the development of the surfaces, are given.

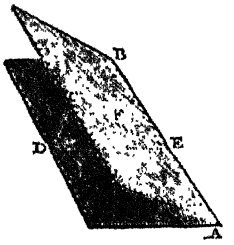


Fig. 3.

11. Let ABC (fig. 4), be the plan of part of a pyramid, and BD the elevation of the arris, or line formed by the common section of the planes in respect to the line EB; EB being the projection of that arris upon the plan.

Draw AC perpendicular to EB, cutting it in any point E, and from E draw EF perpendicular to DB. With the radius EF, and centre E, cross EB in *f*, and join A*f* and *f*C; then the angle A*f*C is the angle formed by the planes of the pyramid.

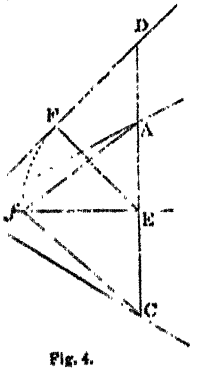


Fig. 4.

The angle may be constructed when the plan and elevation of any two lines drawn in the planes, so as to intersect in the arris, are given; but as these projections are not often given in drawings of joiners' work, we have inserted the preceding, though it be a less general method.

The backing, or angle for the back of hip-rafters in carpentry, and of hipped sky-lights, is found in this manner; ABC being, in that case, supposed to be the plan of an angle of the roof or sky-light, and DB the inclination of the hip-rafter.

Joinery.

12. To show how the angle formed by two planes may be found when the plan and development are given, let it be required to find the angle contained by the two faces of a square pyramid, fig. 5. Let ABC be the plan of a square pyramid, draw *a*C perpendicular to, and bisecting AB, and make *a*C equal to the slant height of the pyramid; then with the centre C, and radius AC, describe the arc A 1 2 3, and make A 1, 1 2, 2 3, respectively equal to AB. Join C 1, C 2, C 3, and the four triangles will show respectively the four surfaces of the pyramid.

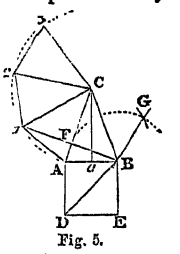
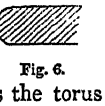


Fig. 5.

Next draw FB perpendicular to AC, and with the radius BF, and centre B, describe the arc FG. Then, with the radius DB, and centre F, cross the former arc in G, join BG, and FBG is the angle formed by the two inclined faces of the pyramid.

Mouldings

Used in joinery are generally composed of parts of circles, and differ somewhat from those used in stone. (See ARCHITECTURE.) Those which present the convex side to the eye are fig. 6, which is merely a rounded edge; fig. 7, if of small size, a bead; if large (fig. 8), a torus: fig. 9 shows the torus and bead together; if there is a deep sinking under a bead (fig. 10), it is called a quirked or cock bead; if there be two such sinkings, so as to show three quarters of a circle in the bead, it is called (fig. 11), a double quirked bead; two or more beads, side by side (fig. 12), are called reeds; the fourth part of a circle, or half a bead (fig. 13), is called an ovolo, or quarter round.


Fig. 6.

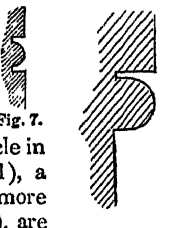

Fig. 7.

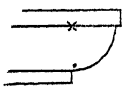
Fig. 8.


Fig. 9.


Fig. 10.


Fig. 11.


Fig. 12.


Fig. 13.

13. A moulding composed of two convex parts is also called an ovolo, and is delineated thus,—Let the points A, B (fig. 14), represent the height of the moulding and extremities of the curves, from C as a centre draw any circle at pleasure, touching a perpendicular let fall from A, join AB and draw a line parallel to this, touching the circle at D, join DC and produce it towards E, then join DB and make the angle DBE, equal to BDE. From E as a centre draw the rest of the curve BD.

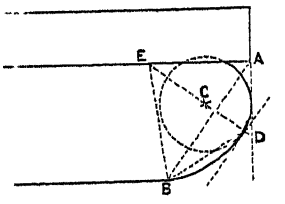
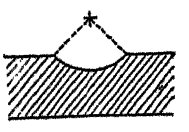
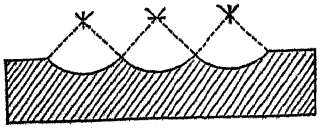


Fig. 14.


Fig. 15.


Fig. 16.

14. In concave mouldings, a simple curved grooving (fig.

Joinery. 13), is called a hollow, two or more such grooves (fig. 16), are called flutes; a hollow forming the fourth of a circle (fig. 17), is called a cavetto; if the curve die into a plane face, and the line be continued (fig. 18), it is a scape or listel, a deep hollow, generally used as a base moulding (fig. 19), is called a scotia, it is set out thus,—Let *ab* be the height of the required moulding, divide the same into three equal parts,

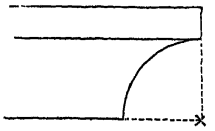


Fig. 17.

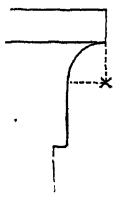


Fig. 18.

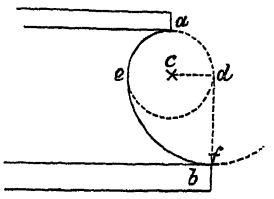


Fig. 19.

one of which will be at *c*, from which as a centre draw the circle *aed*; draw *ed* parallel through *c*, and from *d*, with the distance *de*, draw the quarter circle *ef*.

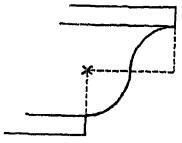


Fig. 20.

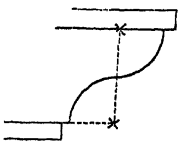


Fig. 21.

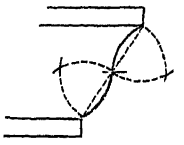


Fig. 22.

15. In mouldings which are partly convex and partly concave, there are two sorts, the cyma recta and cyma reversa, or ogee; these may be drawn in two ways, as they are required to be bolder or flatter (figs. 20, 21, 22, 23). Grecian mouldings are all drawn on similar principles, but are parts of conic sections instead of circles: they are often struck by hand.

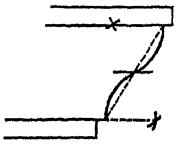


Fig. 23.

A plain square sinking on the edge of a board (fig. 24), for the purposes of framing, is called a *rebate;* if away from the edge (fig. 25), a *groove;* placed under a cap (fig. 26), or as a necking (fig. 27), it is called a *fillet;* three such



Fig. 24.



Fig. 25.



Fig. 26.

fillets under an ovolo, when composing part of the capital of a column (fig. 28), are called *annulets.*

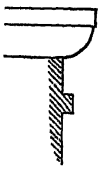


Fig. 27.

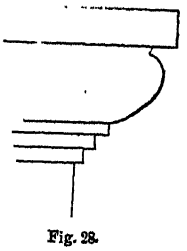


Fig. 28.

In all kinds of framing, the mouldings which rise above the styles are called bolextion mouldings. See *infra*, fig. 44.

Raking Mouldings.

Raking mouldings. 16. When an inclined or raking moulding is intended to join with a level moulding, at either an exterior or an interior angle, the form of the level moulding being given, it is necessary that the form of the inclined moulding should be determined, so that the corresponding parts of the surfaces of the two mouldings should meet in the same plane, this plane being the plane of the mitre. It may be otherwise expressed, by saying that the mouldings should mitre truly together. Joinery.

If the angle be a right angle, the method of finding the form of the inclined moulding is very easy; and as it is not very difficult for any other angle, it may perhaps be best to give a general method, and to illustrate it by examples of common occurrence.

General Method of describing a Raking Moulding, when the Angle and the Rake, or inclination of the Moulding, is given.

17. Let ABC (fig. 29), be the plan of the angle of a building, piece of framework, or any other body, which is to have a level moulding on the side AB; and this level moulding is to mitre with an inclined moulding on the side BC. Also, let CBD be the angle the inclined moulding makes with a level or horizontal line BC. General method.

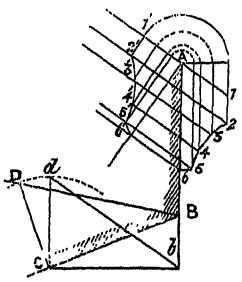


Fig. 29.

Produce AB to *b*, and draw C*b* perpendicular to AB; also make DC perpendicular to BC, and *d*C perpendicular to *b*C. Set off C*d* equal to CD, and join *bd;* then the inclined moulding must be drawn on lines parallel to *bd*.

Let 1, 2, 3, 4, &c., be any number of points in the given section of the level moulding; from each of these points, draw a line parallel to *bd*, and draw A6' perpendicular to *bd*. Set off the points 1', 2', 3', 4', &c., at the same distances, respectively from the line A6', as the corresponding points 1, 2, 3, 4, &c., are from the line AB, and through the points 1', 2', 3', &c., draw the moulding. The moulding thus found will mitre with the given one; also, supposing the inclined moulding to be given, the level one may be found in like manner.

If the angle ABC be less than a right angle, the whole process remains the same; but when it is a right angle, BD coincides with *bd;* and the method of describing the moulding becomes the same as that usually given; as it does not then require the preparatory steps which are necessary when the angle is any other than a right angle.

18. It is in pediments, chiefly, that the method of forming raking mouldings is of use. Fig. 30 represents part of a pediment; AB is that part of the level moulding which mitres with the inclined moulding; all that part of the cornice below B being continued along the front, the lower members of the raking cornice stop upon it, and, therefore, do not require to be traced from the other. For pediments.

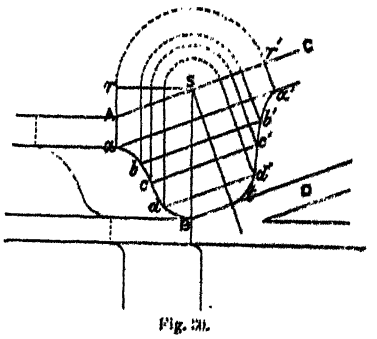


Fig. 30.

In that part of the cornice marked AB, set off a sufficient number of points; and from each of these points draw

Joinery.

a line parallel to the rake, or inclination of the pediment. Also, let a vertical line be drawn to each of the same points from the horizontal line *rs*. Make S*t* perpendicular to the inclination of the pediment, and with a slip of paper, or by means of arcs of circles, transfer the distances on *r*S to the line *r*'S, and from the points thus found, draw lines parallel to S*t*; the intersection of these, with the inclined lines, will determine the form of the moulding, as is indicated by the letters.

When a pediment has a cornice with modillions, the caps of the modillions require to be traced by the same method.

For skirtings, &c.

19. It sometimes happens that an inclined base-moulding has to mitre with a level one at an angle; and as the same thing occurs still more frequently with other moulding, such as cornices under the steps of stairs, &c., we shall give another example, which will serve still farther to illustrate the method of proceeding in such cases.

In fig. 31 a raking base-moulding is shown, where the

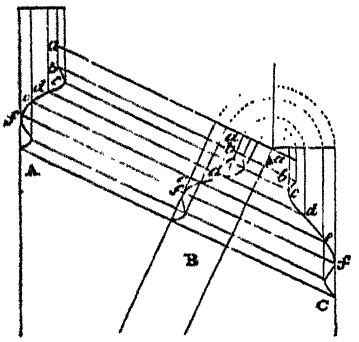


Fig. 31.

inclined moulding B is traced to mitre with the horizontal moulding C; and the horizontal moulding A is traced to mitre with the inclined one B. The preceding examples being understood, the lines and letters in the figure will be sufficient to show the mouldings are traced. On the same principle the lines for the angle bars of shop sashes, may be readily found.

Remarks on mouldings.

20. Mouldings being almost the only part of modern joiners' work which can, in strictness, be called ornamental, and consequently that in which the taste of the workman is most apparent, we shall offer a remark or two that may have their use. The form of moulding should be distinct and varied, forming a bold outline of a succession of curved and flat surfaces, disposed so as to form distinct masses of light and shade. If the mouldings be of considerable length, a greater distinction of parts is necessary than in short ones.

Mouldings for the internal part of a building should not, however, have much projection; the proper degree of shade may always be given, with better effect, by deep sinkings judiciously disposed. The light in a room is not sufficiently strong to relieve mouldings, without resorting to this method; and hence it is that quirked mouldings are so much esteemed.

SECT. II.—ON THE CONSTRUCTION OF JOINERS' WORK.

Qualifications of a good joiner.

21. The goodness of joiners' work depends chiefly upon the care that has been bestowed in joining the materials. In carpentry, framing owes its strength to the form and position of its parts; but in joinery, the strength of a frame depends upon the strength of the joinings. The importance, therefore, of fitting the joints together as accurately as possible, is obvious. It is very desirable that a joiner should be a quick workman, but it is still more so that he should be a good one; that he should join his materials with firmness and accuracy; that he should make surfaces even and smooth, mouldings true and regular, and the parts intended to move so that they may be used with ease and freedom. It is also of the greatest importance that the work when thus put together, should be constructed of such sound and dry materials, and on such principles, that the whole should bear the various changes of temperature, and of moisture and dryness, so that the least possible shrinkage or swelling should take place. This last point will be treated further on.

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Where dispatch is considered as the chief excellence of a workman, it is not probable that he will strive to improve himself in his art further than to produce the greatest quantity of barely tolerable work with the least quantity of labour. In some articles of short duration, dispatch in the manufacture may be of greater importance; but in works that ought to remain firm for years, it certainly is bad economy to spare a few shillings' worth of labour at the risk of being annoyed with a piece of bad work as long as it will hold together.

We have seen, with no small degree of pleasure, the effect of encouraging good workmanship in the construction of machinery, and would recommend that a like encouragement should be given to superior workmen in other arts.

Joining Angles.

On joining angles.

22. When the length of a joint at an angle is not considerable, it is sufficient to cut the joint, so that when the parts are joined, the plane of the joint shall bisect the angle. This kind of joint is shown for two different angles, by fig. 32, and is called a mitre.

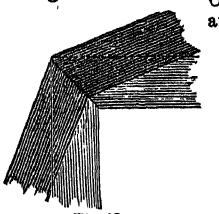


Fig. 32.

When an angle of considerable length is to be joined, and the kind of work does not require the joining should be concealed, fig. 33 is often employed; the small bead renders the appearance of the joint less objectionable, because any irregularities, from shrinkage, are not seen in the shade of the quirk of the head.

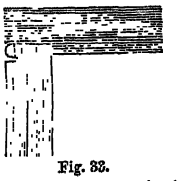


Fig. 33.

A bead upon an angle, where the nature of the thing does not determine it to be an arris, is attended with many advantages; it is less liable to be injured, and admits of a secure joint, without the appearance of one. Fig. 34 shows a joint of this description, which should always be used in passages.

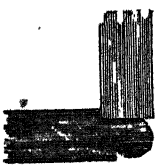


Fig. 34.



Fig. 35.



Fig. 36.

Fig. 35 represents a very good joint for an exterior angle, whether it be a long or short one. Such a joint may be nailed both ways. But the joint represented by fig. 36 is superior to it; the parts being drawn together by the form of the joint itself, they can be fitted with more accuracy, and joined with certainty. The angles of pilasters are often joined, as fig. 36.



Fig. 37.

Interior angles are commonly joined, as

Joinery.

shown by fig. 37. If the upper or lower edge be visible, the joint is mitred, as in fig. 32, at the edge only, the other part of the joint being rebated as in fig. 35. In this manner are put together the skirting and dado at the interior angles of rooms, the backs, and back-linings of windows, the jambs of door-ways, and various other parts of joiners' work.

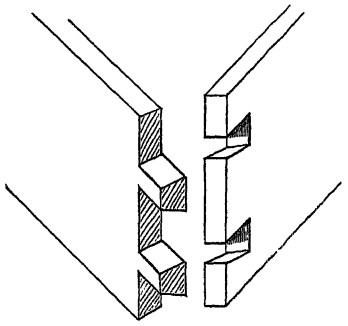


Fig. 38.

Fig. 38 is an excellent method of joining angles for drawers, frames for lead cisterns, boxes, &c., and is commonly called a dovetail; if a portion of the junction is cut off at an angle of 45° (fig. 39), while the portion at *b* is dovetailed, it is called a *mitre dovetail;* while if the portion at *a* (fig. 40), passes the other portion at right angles, it is called a *lap-dovetail.*

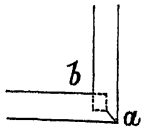


Fig. 39.

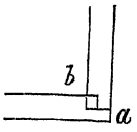


Fig. 40.

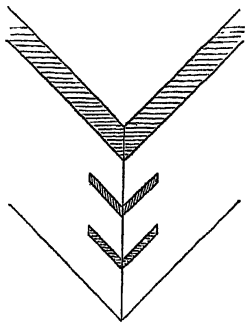


Fig. 41.

A very good joint is shown at fig. 41, the angles being brought together at an angle of 45°, two or more saw curfs are cut with a dovetail saw, and thin pieces of wood glued in as shown; this is called a keyed mitre.

Framing.

The object of framing.

23. Frames in joinery are usually connected by mortise tenon joints, with grooves to receive pannels. Doors, window-shutters, &c., are framed in this manner. The object in framing is, to reduce the wood into narrow pieces, so that the work may not be sensibly affected by its shrinkage; and, at the same time, it enables us to vary the surface without much labour. Besides this, as the strains from the grain of the wood are in different directions, the work is prevented from winding on its face.

From this view of the subject, the joiner will readily perceive, that neither the parts of the frame nor the pannels should be wide. And as the frame should be composed of narrow pieces, it follows that the pannels should not be very long, otherwise the frame will want strength. The pannels of framing should not be more than 15 inches wide, and 4 feet long, and pannels so large as this should be avoided as much as possible.[1] The width of the framing is commonly about one-third of the width of the pannel.

It is of the utmost importance in framing that the tenons and mortises should be truly made. After a mortise has been made with the mortise chisel, it should be rendered perfectly even with a float; an instrument which differs from a single cut, or float file, only by having larger teeth. An inexperienced workman often makes his work fit too tight in one place, and too easy in another, hence the mortise is split by driving the parts together, and the work is never firm; whereas if the tenon fill the mortise equally, without using any considerable force in driving the work together, it is found to be firm and sound. The thickness of tenons should be about one-fourth of that of the framing, and the width of a tenon should never exceed about five times its thickness, otherwise, in wedging, the tenon will become bent, and bulge out of the sides of the mortise. If the rail be wide, two mortises should be made, with a space of solid wood between; fig. 42 shows the tenons for a wide rail.

Joinery.

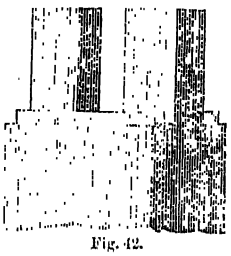


Fig. 42.

If the tenon occurs at the end of a piece of framing, it must be set back a little, so as to allow sufficient solid wood to form a sound mortise; this is called a haunching (see *e*, fig. 43).

In thick framing, the strength and firmness of the joint is much increased by putting a cross or feather tongue in on each side of the tenon; these tongues are about an inch in depth, and are easily put in with a plough proper for such purposes. The projected figure of the end of a rail (fig. 42), shows these tongues put in, in the style there are grooves ploughed to receive them.

Sometimes these projections are left in the solid wood itself, in which case they are called *stump tenons.*

Sometimes, in thick framing, a double tenon in the thickness is made; but we give the preference to a single one, when tongues are put in the shoulders, as we have described; because a strong tenon is better than two weak ones, and there is less difficulty in fitting one than two.

The pannels of framing should be made to fill the grooves, so as not to rattle, and yet to allow the pannels to shrink without splitting. When the mouldings are stuck on the framing, as is often the case in large stuff, it becomes necessary to find the lines to bring the angles together. In square framing, this is done simply by cutting *ab, cd* at a mitre; but if the framing be oblique angle, it is done by scribing; the angle at *ab* being determined by eye, *cd* is cut parallel thereto.

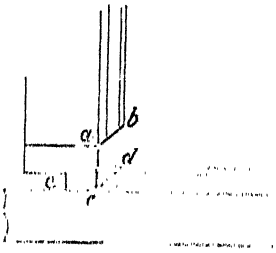


Fig. 43.

Where large projecting or bolexion mouldings are used the French have a very excellent way of framing (fig. 44), which it would be well to imitate in this country. Here C is the pannel round which the moulding B is framed and mitred, the whole is then framed into A, which is a section both of the styles and rails.

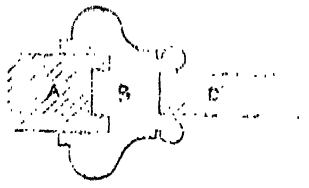


Fig. 44.

Joining curved pieces.

24. When a frame consists of curved pieces, they are often joined by means of pieces of hard wood called keys. Fig. 45 is the head of a Gothic window frame, joined with a key, with a plan of the joint below it. A cross tongue is put in on each side of the key, and the joint is tightened by means of the wedges *a, a.*

It is, however, a better method to join such pieces by means of a screw

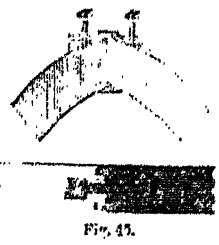


Fig. 45.

[1] Pannels of external doors and shutters may be rendered more secure by boring them, and inserting iron wires. See *Trans. of the Society of Arts*, vol. xxv., p. 106.

bolt instead of a key, the cross tongues being used whichever method is adopted. Where the ends of the bolts cannot be allowed to project, they should be fixed as *bed-bolts.*

Joining with Glue.

Joining with glue.

25. It is seldom possible to procure boards sufficiently wide for pannels without a joint, on account of heart shakes, which open in drying. In cutting out pannels, for good work, shaken wood should be carefully avoided. That part near the pith is generally the most defective.

If the pannels be thick enough to admit of a cross or feather tongue in the joint, one should always be inserted, for then, if the joint should fail, the surfaces will be kept even, and it will prevent light passing through. A very good way also is to glue a piece of strong canvas on the back of the pannel when the work is not intended to be seen on both sides.

Sometimes plane surfaces of considerable width and length are introduced in joiners' work, as in dado, window backs, &c.; such surfaces are commonly formed of inch, or inch and quarter boards joined with glue, and a cross or feather tongue ploughed into each joint. When the boards are glued together, and have become dry, tapering pieces of wood, called keys, are grooved in, across the back, with a dovetail groove. These keys preserve the surface straight, and also allow it to shrink and expand with the changes of the weather.

Glueing up curved work.

26. It would be an endless task to describe all the methods that have been employed to glue up bodies of such varied forms as occur in joinery; for every joiner forms methods of his own, and merely from his being most familiar with his own process, he will perform his work, according to it, in a better manner than by another, which, to an unprejudiced mind, has manifestly the advantage over it. The end and aim of the joiner, in all these operations, is to avoid the peculiar imperfections and disadvantages of his materials, and to do this with least expense of labour or material. The straightness of the fibres of wood renders it unfit for curved surfaces, at least when the curvature is considerable. Hence short pieces are glued together as nearly in the form desired as can be, and the apparent surface is covered with a thin veneer; or the work is glued up in pieces that are thin enough to bend to the required form. Sometimes a thin piece of wood is bent to the required form upon a cylinder or saddle, and blocks are jointed and glued upon the back; when the whole is completely dry it will preserve the form that had been given to it by the cylinder. The curve should be made a little "quicker" than the curve intended, as the stuff will always spring back a trifle on being released.

A piece of work glued up in thicknesses should be very well done; but it too often happens that the joints are visible, irregular, and in some places open; therefore other methods have been tried.

Bending by steaming or boiling.

27. If a piece of wood be boiled in water for a certain time, then taken out and immediately bent into any particular form, and it be retained in that form till it be dry, a permanent change takes place in the mechanical relations of its parts; so that though, when relieved, it will spring back a little, yet it will not return to its natural form.

The same effect may be produced by steaming wood; but though both these methods have been long practised to a considerable extent in the art of ship-building, we are not aware that any general principles have been discovered, either by experiment or otherwise, that will enable us to apply it to an art like joinery, where so much precision is required. We are not aware that it has been tried; but, before it can be rendered extensively useful, the relation between the curvature to which it is bent, and that which it assumes, when relieved, should be determined, and also the degree of curvature which may be given to a piece of a given thickness.

The time that a piece of wood should be boiled, or steamed, in order that it may be in the best state for bending, should be made the subject of experiments; and this being determined, the relation between the time and the bulk of the piece should be ascertained.

A novel and very simple and effective way of boiling sash-bars or thin articles has been done thus (fig. 46). Take a piece of common cast-iron pipe of sufficient diameter, stop

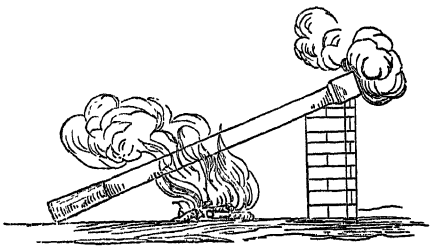


Fig. 46.

up one end with a plug of wood driven tight, fill the pipe with water, raise one end in a sloping position, leaning it on a pile of bricks, and kindle a fire as shown in the diagram.

For the joiner's purposes we imagine that the process might be greatly improved, by saturating the convex side of each piece with a strong solution of glue, immediately after bending it. By filling, in this manner, the extended pores, and allowing the glue to harden thoroughly before relieving the pieces, they would retain their shape better.

Glueing up wooden columns.

28. Large pieces of timber should never be used in joinery, because they cannot be procured sufficiently dry to prevent them splitting with the heat of a warm room. Therefore, the external part of columns, pilasters, and works of a like kind, should be formed of thin pieces of dry wood; and, if support be required, a post, or an iron pillar, may be placed within the exterior column. Thus, to form columns of wood, so that they shall not be liable to split, narrow pieces of wood are used, not exceeding five inches in width. These are jointed like the staves of a cask, and glued together, with short blocks glued along at each joint.

Fig. 47 is a plan of the lower end of a column glued up in staves; the bevel at A is used for forming the staves, that at B is used for adjusting them when they are glued together. A similar plan must be made for the upper end of the column, which will give the width of the upper end of the staves. The bevels taken from the plan, as at A and B, are not the true bevels; but they are those generally used, and are very nearly true, when the columns are not much diminished. To find the true bevels, the principle we have given in art. 19 should be applied. The same method may be adopted for forming large pillars for tables, &c.

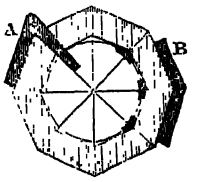


Fig. 47.

If a column have flutes, with fillets, the joints should be in the fillets, in order to make the column as strong as possible; also, if a column be intended to have a swell in the middle, proper thickness of wood should be allowed for it.

Small columns, table legs, &c.

When columns or pillars are small, they may be made of dry wood; and to secure them against splitting a hole should be bored down the axis of each column.

Fixing Joiners' Work.

Fixing work together.

29. We have hitherto confined our remarks to that part of joinery which is performed at the bench; but by far the most important part remains to be considered. For, how-

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ever well a piece of work may have been prepared, if it be not properly fixed, it cannot fulfil its intended purpose. As in the preceding part, we shall state the general principles that ought to be made the basis of practice, and illustrate those principles by particular examples.

If the part to be fixed consist of boards jointed together, but not framed, it should be fixed so that it may shrink or swell without splitting or winding. The nature of the work will generally determine how this may be effected. Let us suppose that a plain back of a window is to be fixed. Fig. 48 is a section showing B the back of the window, A the window-sill, D the floor, C the skirting, and E the wall of the house. The back is supposed to be prepared, as we have stated in art. 29, and that it is kept straight by a dovetailed key *a*. Now, let the back be firmly nailed to the window-sill A, and let a narrow piece *d*, with a groove, and cross tongue, in its upper edge, be fixed to bond timbers or plugs in the wall; the tongue being inserted also into a corresponding groove in the lower edge of the back of B. It is obvious, that the tongue being loose, the back B may contract or expand, as a pannel in a frame. The dado of a room should be fixed in the same manner. In the principal rooms of a house, the skirting C is usually grooved into the floor D, and fixed only to the narrow piece *d*, which is called a ground. By fixing in this manner, the skirting covers the joint, which would otherwise soon be open by the shrinking of the back, and from the skirting being grooved into the floor, but not fastened to it, there cannot be an open joint between the skirting and floor. When it is considered, that an open joint, in such a situation, must become a receptacle for dust, and a harbour for insects, the importance of adopting this method of fixing skirting will be apparent. As grooving a floor is attended with considerable labour, and as the boards will sometimes twist, it is more common now to nail a small fillet to the floor, against which the back of the skirting rests, and, of course, has every room for expansion.

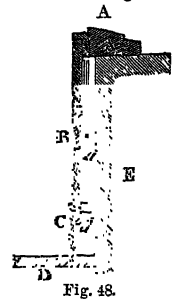


Fig. 48.

Fixing skirting for rooms.

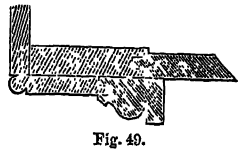
In fixing any board above five or six inches wide, similar precautions are necessary; otherwise it is certain to split when the house becomes inhabited. We may, in general, either fix one edge, and groove the other, so as to leave it at liberty, or fix it in the middle, and leave both edges at liberty.

Fixing landings of stairs, tops of tables, &c.

Sometimes a wide board, or a piece consisting of several boards, may be fixed by means of buttons, screwed to the back, which turn into grooves in the framing, bearers, or joists, to which it is to be fixed. If any shrinking takes place the buttons slide in the grooves. In this manner the landing of stairs are fixed, and it is much the best mode of fixing the top of a table to its frame.

Forming architraves, &c.

30. The extension of the principle of ploughing and tongueing work together is one of the most important of the improvements that have been introduced by modern joiners. It is an easy, simple, and effectual method of combination, and one that provides against the greatest defect of timber work, its shrinkage. By means of this method, the bold mouldings of Gothic architecture can be executed with a comparatively small quantity of material; and even in the mouldings of modern architecture it saves much labour. For example, the moulded part of an architrave may be joined with the plain part, as shown by fig. 49. If this method be compared with the old method of glueing one piece upon another, its advantage will be more evident.


Fig. 49.

Fixing grounds.

31. The architraves, skirtings, and surbase mouldings, are fixed to pieces of wood called *grounds*; and as the straightness and accuracy of these mouldings must depend upon the care that has been taken to fix the grounds truly; it will appear, that fixing grounds, which is a part often left to inferior workmen, in reality requires much skill and attention; besides, they are almost always the guide for the plasterer. Where the plasterer's work joins the grounds, they should have a small groove ploughed in the edge to form a key for the plaster. In old work the ground was generally hidden, but in modern work it is frequently shown, which is a saving of stuff: thus, instead of architraves being prepared as in fig. 49, they are made thus (fig. 50)—A is the rebated and beaded door-jambs, B the ground which is generally splayed at the back as a key to the plastering instead of being grooved. On this a thin piece of stuff is bradded to form the double-faced architrave, instead of sinking out of the solid, and on this the ogee, or ovolo moulding, is nailed. Again, with base mouldings A (fig. 51), is the ground fixed against the wall, on the top of which B is nailed as the upper moulding, and C forms the skirting and lower moulding.

Joinery.

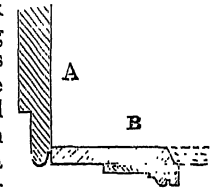


Fig. 50.

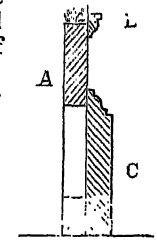


Fig. 51.

Laying floors.

32. In our remarks on construction, we must not omit to say a few words on laying floors, because it will give us an opportunity of pointing out a defect which might be easily remedied. The advice of Evelyn, to tack the boards down only the first year, and nail them down for good the next, is certainly the best, when it is convenient to adopt it; but, as this is very seldom the case, we must expect the joints to open more or less. Now, these joints always admit a considerable current of cold air, and also, in an upper room, unless there be a counter floor, the ceiling below may be spoiled by spilling a little water, or even by washing the floor. To avoid this, we would recommend a tongue to be ploughed into each joint, according to the old practice. When the boards are narrow, they might be laid without any appearance of nails, in the same way as a dowelled floor is laid, the tongue serving the same purpose as the dowels. In this case we would use cross or feather tongues for the joints. A new system of floors has lately been used in London, to which the name of "Victoria floors" has been given. A rough floor of boards, three quarters of an inch thick, is first laid, and the rest of the joiners' work fixed, and the plastering finished. When all is done, an inch or inch and quarter floor of plank, ripped down the middle, and consequently very little more than five inches wide, is laid; the rough boarding being first covered with a layer of shavings, or old newspapers, or other waste paper. The boards are then dowelled on one edge and nailed on the other, and a very sound floor is thus formed, which neither springs nor creaks. We should fear, however, that insects would harbour between the boards, and if frequently washed the damp would get in between the joints, and remain some time in the paper.

Folding floors censured.

There is a method sometimes used in laying floors, which workmen call folding; according to this method, two boards are laid, and nailed at such a distance apart, that the space is a little less than the aggregate width of the boards intended for it; these boards are then put to their places, and, on account of the narrowness of the space left for them, they rise like an arch between its abutments. The workmen force them down by jumping upon them. Accordingly, the boards are never soundly fixed to the joists, nor can the floor be laid with any kind of evenness or accuracy. We merely notice this method here, in order that it may be avoided, except in very common work.

Joinery.

Heading joints.

As boards can seldom be got long enough to do without joints, it is usual, except in very inferior work, to join the ends with a tongued joint, as shown in fig. 52, where B is the joist. The etched board is first laid, and nailed to the joist.

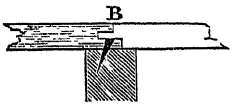


Fig. 52.

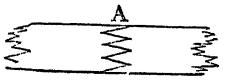


Fig. 53.

In oak floors, the ends are forked together sometimes, as shown at A (fig. 53), in order to render the joints less conspicuous.

The joints should be kept as distant from one another as possible.

Hinging.

Hinging.

33. It requires a considerable degree of care to hang a door, a shutter, or any other piece of work in the best manner. In the hinge, the pin should be perfectly straight, and truly cylindrical, and the parts accurately fitted together.

The hinges should be placed so that their axes may be in the same straight line, as any defect in this respect will produce a considerable strain upon the hinges every time the hanging part is moved, will prevent it from moving freely, and is injurious to the hinges.

In hanging doors, centres are often used instead of hinges; but, on account of the small quantity of friction in centres, a door moves too easily, so that a slight draft of air accelerates it so much in falling to, that it shakes the building, and is disagreeable. We have seen this in some degree remedied by placing a small spring to receive the shock of the door.

The greatest difficulty, in hanging doors, is to make them to clear a carpet, and be close at the bottom when shut. To do this, that part of the floor which is under the door, when shut, may be made to rise above a quarter of an inch above the general level of the floor, which, with placing the hinges so as to cause the door to rise as it opens, will be sufficient, unless the carpet should be a very thick one. Several mechanical contrivances have been used for either raising the door, or adding a part to spring close to the floor as the door shuts. The best method now in use, and the simplest, is the invention of the skew-butt hinge. The parts of this which bear on each other are made with a double bevel, so that, if more than half opened, the door falls against the wall by its own weight; if less than half open, it closes itself.

34. Various kinds of hinges are in use. Sometimes they are concealed, as in the kind of joints called rule joints; others project, and are intended to let a door fold back over projecting mouldings, as in pulpit doors. When hinges project, the weight of the door acts with an increased leverage upon them, and they soon get out of order, unless they be strong and well fixed.

Room doors.

The door of a room should be hung so that, in opening the door, the interior of the room cannot be seen through the joint. This may be done by making the joint according to fig. 54. The bead should be continued round the door, and a common butt-hinge answers for it.

The proper bevel for joints of a door.

The proper bevel for the edge of a door or sash may be found by drawing a line from the centre of motion C (fig. 55) to *e*, the interior angle of the rebate; draw *ed* perpendicular to C*e*, which gives the bevel required. In practice the bevel is usually made less, leaving an open space in the joint when the door is shut; this is done on account of the interior angle of the rebate often being filled with paint.

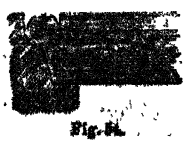


Fig. 54.



Fig. 55.

Joinery.

Stairs.

Stairs.

35. The construction of stairs is generally considered the highest department of the art of joinery, therefore we treat of it under a distinct head.

The principal object to be attended to in stairs is, that they afford a safe and easy communication between floors of different levels. The strength of a stair ought to be apparent as well as real, in order that those who ascend it may feel conscious of safety. In order to make the communication safe, it should be guarded by a railing of proper height and strength; in order that it may be easy, the rise and width, or tread, of the steps should be regular and justly proportioned to each other, with convenient landings; there should be no winding steps, and the top of the rail should be of a convenient height for the hand.

Proper proportion for stairs.

The first person that attempted to fix the relation between the height and width of a step, upon correct principles, was, we believe, Blondel, in his *Cours d'Architecture*. His formula is applicable to very large buildings, but not to ordinary dwellings. Mr Ashpitel, who has investigated the subject at great length, gives the following rules for buildings of seven different classes:—

Tread breadth in inches.	Rise height in inches.	Tread breadth in inches.	Rise height in inches.
If 12	5½	If 10	6½
„ 11½	5⅝	„ 9½	6⅝
„ 11	6	„ 9	7
„ 10½	6½		

These dimensions give angles of ascent varying from 24° to 37°. Of course the projection of the nosing is not reckoned.

Different kinds of stairs.

36. The forms of staircases are various. In towns, where space cannot be allowed for convenient forms, they are often made triangular, circular, or elliptical, with winding steps, or of a mixed form, with straight sides and circular ends. In large mansions, and in other situations, where convenience and beauty are the chief objects of attention, winding steps are never introduced when it is possible to avoid them. Good stairs, therefore, require less geometrical skill than those of an inferior character.

The best architectural effect is produced by rectangular staircases, with ornamented railing and newels. In Gothic structures scarcely any other kind can be adopted, with propriety, for a principal staircase. Modern architecture admits of greater latitude in this respect; the end of the staircase being sometimes circular, and the hand-rail continued, beginning either from a scroll or a newel.

Rectangular staircase.

37. When a rectangular staircase has a continued rail, it is necessary that it should be curved so as to change gradually from a level to an inclined direction. This curvature is called the *ramp* of the rail. The plan of a staircase of this kind is represented by ABCD (fig. 56); and fig. 58 shows a section of it, supposing it to be cut through at *ab*, on the plan.

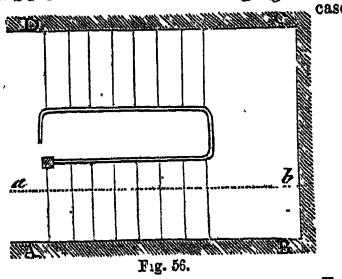


Fig. 56.

To find the cap for newel.

The hand-rail is supposed to begin with a newel at the bottom, and the form of the cap of the newel ought to be determined, so that it will mitre with the hand-rail. Let H (fig. 57) be the section of the hand-rail, and *ab* the radius of the newel; then the form of the cap may be traced at C by the methods we have already described. (Arts. 17, 18, and 19).

Joinery.

The sections of hand-rails are of various shapes; some of the most common ones are too small; a hand-rail should never be less than would require a square, of which the side is $2\frac{1}{2}$ inches, to circumscribe it.

Height for rail, &c.

For the level landings of a staircase the height of the top of the hand-rail should never be more than about 40 inches, and in any part of the inclined rail the height of its upper side above the middle of the width of the step should be 40 inches, less the rise of one step, when measured in a vertical direction.

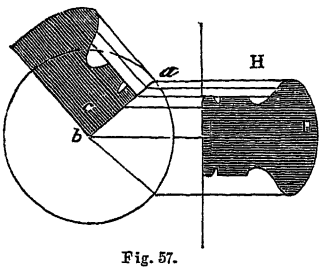


Fig. 57.

To describe the ramps of rails.

To describe the ramps, let *rs* (fig. 58) be a vertical line drawn through the middle of the width of the step; set *ru* equal to *rs*, and draw *ut* at right angles with the back of the rail, cutting the horizontal line *st* in *t*. From the point *t*, as a centre, describe the curve of the rail. When there is a contrary flexure, as in the case before us, the method of describing the lesser curve is the same.

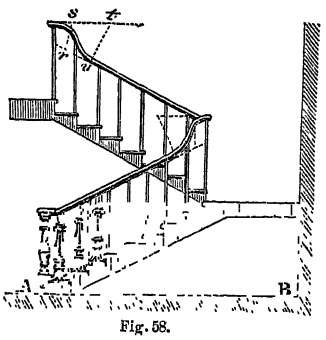


Fig. 58.

To describe a spiral.

38. The hand-rail of a stair generally begins with a scroll, and the first step of the stair is generally finished with what is called a curtail or form, corresponding as much as possible to the scroll.

There are a great variety of geometrical spirals, which are described and investigated under their proper heads; but as they all finish on a point, and as all architectural scrolls and volutes finish on a circle or eye, the usual mathematical scrolls are inapplicable. The earliest spiral adapted to architecture was that of De Lorme. Since that several systems have been invented, particularly that of Goldmann, but the best is clearly that derived from the Ionic volute, and is drawn thus—

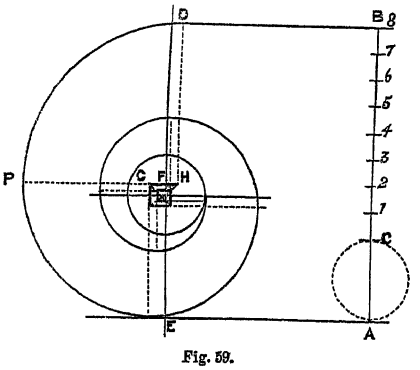


Fig. 59.

The height, eye, and number of revolutions of the improved spiral being given to describe the curve, let AB (fig. 59) be the total height, and AC the intended height of the eye, and let the spiral be required to make two revolutions. Divide BC into four times as many parts as there are revolutions required ($4 \times 2 = 8$), because there are four quadrants in every revolution. Draw any line DE equal to the height of the spiral. Set down from D half the number of parts, and one other part ($4 + 1 = 5$), this is the top of the eye. Set down half AC at O, and describe the eye; then at O set up half a part to F, and make FG, FH = OF; then (fig. 60) draw OG, OH, GI, and from O draw a line parallel to GH, and divide the same into as many parts as there are to be revolutions. Fig. 60 is for one, fig. 61 for two revolutions. Divide the part O1 at X, and proceed to draw the quarter circles, as in the diagram; HD being the first opening of the compasses, HP the next, and H, G, I, K, L, M, and N being the centres.

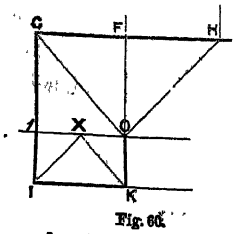


Fig. 60.

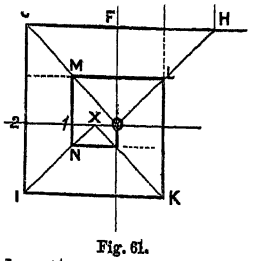


Fig. 61.

Joinery.

To describe the scroll.

To describe the scroll let AB (fig. 62) be the width across, usually about 10 or 12 inches; let EB be the intended diameter of the eye; and let the scroll be required to make one revolution and a half, or six quadrants (these are shown at greater size by the side of fig. 63), then proceed as last directed, and complete the scroll, also dot in the lines of the nosings and risers.

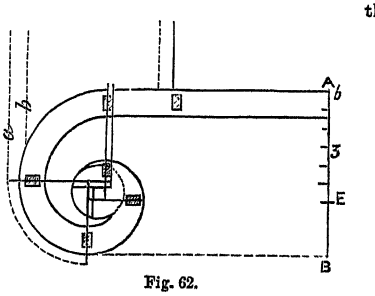


Fig. 62.

The curtail step.

For the curtail step transfer the lines of nosings *a*, and the lines of the risers *b*, to another place, as fig. 63, and set out the thickness of the veneer within the line of nosing, the part within this represents the solid block of the curtail. The places of the ballusters are shown in fig. 62.

The hand-rail.

It is obvious that in every geometrical staircase, the half of a cylinder placed upright in the well-hole would touch the wreathed string in all parts, another a little less would touch all parts of the hand-rail. Let us suppose ACB (fig. 64), to be the plan of half a cylinder so set upright in the well-hole, and let us suppose A′E to be the height of the same. Divide the curved line ACB into any convenient number of parts, and set the same off by compasses on the straight line from C to A′ and C to B′. Or, in case ACB is a semicircle, divide the line AB, draw the diameter CD, making *a*D equal to three-fourths of the radius, and draw DA, DB′, and the rest of the lines through the points of division, as shown in the diagram. Then A′B′ is the stretch out or length of the circumference ACB unrolled. But A′E is said to be the whole height. From E set down the respective heights of the winders, step by step, as shown. Now let G

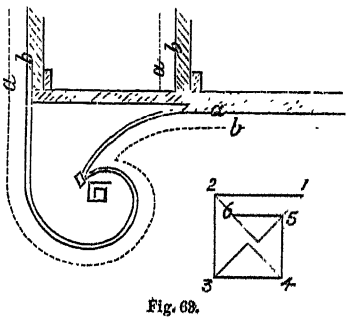


Fig. 63.

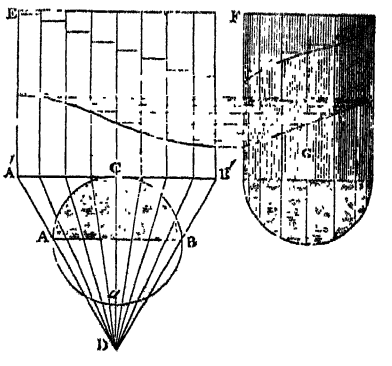


Fig. 64.

Joinery.

be the representation of the cylinder, with the different lines squared up and across, these will give a representation of the curve at which the winders must ascend, and which, of course, must regulate the hand-rail. The other faint lines show the edge of the covering, and is the same as finding a mould for a soffit.

39. Let us now turn to fig. 67. This represents the plan of a staircase, beginning with a scroll, and having steps winding round the circular part of the well-hole.

In the first place, let the end of the steps be developed according to the method we have just given (fig. 65 shows this development). Now the hand-rail ought to follow the inclination of a line drawn to touch the nosings of the steps,

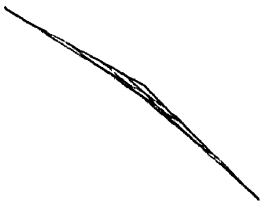


Fig. 66.

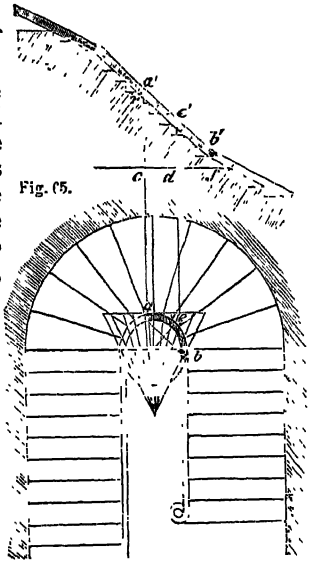


Fig. 67.

except where there is an abrupt transition from the rake of the winding to that of the other steps; at such places it must be curved,—the curve may be drawn by the help of intersecting lines, as in fig. 66, if the workman cannot trust to his eye.

Development of the circular part.

The part which is shaded in fig. 65 represents the hand-rail and ends of the steps when spread out, and the hand-rail is only drawn close to the steps for convenience, as it would require too much space to raise it to its proper position. This development of the rail is called the falling-mould.

The falling mould.

We will now refer to fig. 68, and will suppose the inner semicircle of ACB to be the plan of the well-hole; *e*A, *a*B, the width of the rail, then the outer shaded part ACB will be the plan of the rail on the level; ADEB is the cylinder referred to before—ADE being the angle at which the stairs ascend. Now we have shown before (Conic Sections) that the oblique section of a circular cylinder is an ellipse, if the cylinder be circular the lines may then be found by a trammel. Be it of what section it may the delineation of a cylinder cut at any angle ADE may be found by dividing it into equal parts, and setting up the ordinates *a*1, *b*2, &c., as shown. This delineation is a *plan on the oblique*, or the face-mould of the rail, to be cut "on the plumb."

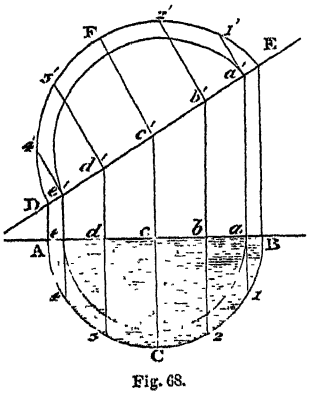


Fig. 68.

The face mould.

The wood used for hand-rails being of an expensive kind, it becomes of some importance to consider how the plank may be cut so as to require the least quantity of material for the curved part of the rail. Now, if we were to suppose the rail executed, and a plain board laid upon the upper side of it, the board would touch the rail at three points; and a plank laid in the same position as the board would be that out of which the rail could be cut with the least waste of material.

Joinery.

Let it be required to find the moulds for the part *ab* of the rail (fig. 67), and to avoid confusing the lines in our small figure, the part *ab* has been drawn to a larger scale in fig. 69. The plain board mentioned above would touch the rail at the points marked C and B in the plan; draw the line CB, and draw a line parallel to CB, so as to touch the curve at the point E. Then E is the other point on the plan; and *a'*, *e'*, and *b'*, are the heights of these points in the development (fig. 65).

To find the face-moulds, by another method.

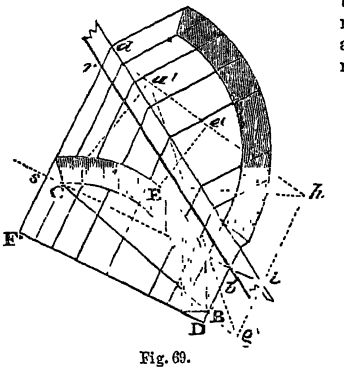


Fig. 69.

Erect perpendiculars to CB, from the points C, E, and B (fig. 69), and set off C*a'*, on fig. 69, equal to *a'c* (fig. 65); E*e'* equal to *d'e'*, and B*b'* equal to *f'b'*. Through the points C and E, draw the dotted line C*h*; through *a'e'* draw a line to meet CE in *h*; and through the points *a'b'*, draw a line to meet CB in *g*; then join *hg*, and make C*i* perpendicular to *hg*.

Now, if C*d* be equal to C*a*, and perpendicular to C*i*; and *di* be joined, it will be the angle which the plank makes with the horizontal plane, or plan. Therefore, draw FD parallel to C*i*, and find the section by the process before described. This section is the same thing as would be obtained by projecting vertical lines from each point in the hand-rail against the surface of a board, laid to touch it in three points. The inexperienced workman will be much assisted in applying the moulds if he acquires a clear notion of the position when executed.

To find the thickness of the plank.

To find the thickness of the plank, take the height to the under side of the rail *cr* in the development (fig. 65), and set it off from *s*, in the line C*i*, to *r*, in fig. 69; from the point *r* draw a line parallel to *di*, and the distance between those parallel lines will be the thickness of the plank.

To apply the moulds.

The mould (fig. 69), which is traced from the plan, is called the *face-mould*. It is applied to the upper surface of the plank, which being marked, a bevel should be set to the angle *id*C, and this bevel being applied to the edge will give the points to which the mould must be placed to mark out the under side. It is then to be sawn out, and wrought true to the mould. In applying the bevel, care should be taken to let its stock be parallel to the line *di*, if the plank should not be sufficiently wide for *di* to be its arris. In the method fig. 68, ADE, on the rise of the stair, is the bevel.

After the rail is truly wrought to the face-mould, the falling-mould (fig. 65), being applied to its convex side, will give the edge of the upper surface, and the surface itself will be formed by squaring from the convex side, holding the stock of the square always so that it would be vertical if the rail were in its proper situation. The lower surface is to be parallel to the upper one.

The sudden change of the width of the ends of the steps causes the soffit line to have a broken or irregular appearance; to avoid it, the steps are made to begin to wind before the curved part begins. Different methods of proportioning the ends of the steps are given by Nicholson, Roubo, Rondelet, and Krafft. We cannot in this place enter into a detail of these methods, nor can we give the varied systems of cutting the rail in the spring and in the plumb, about which so much has been written, but for the reader's information a list of the principal writers on staircases is subjoined:—

Joinery.

Price, in his *British Carpenter*, 4to, 1735; Langley, *Builders' Complete Assistant*, 8vo, 1738; Frezier, *Coupe des Pierres et des Bois*, 4to, 1739; Roubo, *L'Art de Menuisier*, folio, 1771; Skaife, *Key to Civil Architecture*, 8vo, 1774; Nicholson, *Carpenters' New Guide*, 4to, 1792; *Carpenters' and Joiners' Assistant*, 4to, 1792; *Architectural Dictionary*, 4to; *Transactions Society of Arts*, &c., for 1814; *Treatise on the Construction of Staircases and Hand-rails*, 4to, 1820; Rondelet, *Traité de l'Art de Bâtir*, tome iv. 4to, 1814; Krafft, *Traité sur l'Art de la Charpenter*, part ii., folio, 1820; Jeakes, *Orthogonal System of Handrailing*, 1849; Ashpitel on *Hand-rails and Staircases*, 4to, 1851; and Riddell, *Handrailing Simplified*, folio, Philadelphia, 1856.

SECT. III.—ON MATERIALS.

Importance of the subject.

40. There is no art in which it is required that the structure and properties of wood should be so thoroughly understood as in joinery. The practical joiner, who has made the nature of timber his study, has always a most decided advantage over those who have neglected this most important part of the art.

In the article ANATOMY, *Vegetable* (vol. iii., pp. 61 and 82), the structure of wood is described; in this place, therefore, we shall only show how the joiner may, in a great measure, avoid the warping caused by its irregular texture.

Boards cut in a particular direction will not retain their form.

41. It is well known that wood contracts less in proportion, in diameter, than it does in circumference; hence a whole tree always splits in drying. Mr Knight has shown that, in consequence of this irregular contraction, a board may be cut from a tree that can scarcely be made by any means to retain the same form and position when subjected to various degrees of heat and moisture. From the ash and the beech he cut some thin boards, in different directions relatively to their transverse septa, so that the septa crossed the middle of some of the boards at right angles, and lay nearly parallel with the surfaces of others. Both kinds were placed in a warm room, under perfectly similar circumstances. Those which had been formed by cutting across the transverse septa, as at A in fig. 70, soon changed their form very considerably, the one side becoming hollow, and the other round; and in drying, they contracted nearly 14 per cent. in width.

Difference in shrinkage.

The other kind, in which the septa were nearly parallel to the surfaces of the boards, as at B in fig. 70, retained, with very little variation, their primary form, and did not contract in drying more than three and a half per cent. in width.[1]

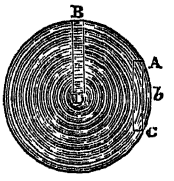


Fig. 70.

As Mr Knight had not tried resinous woods, two specimens were cut from a piece of Memel timber; and to render the result of our observation more clear, conceive fig. 70 to represent the section of a tree, the annual rings being shown by circles. BD represents the manner in which one of our pieces was cut, and AC the other. The board AC contracted 3·75 per cent. in width, and became hollow on the side marked *b*. The board BD retained its original straightness, and contracted only 0·7 per cent. The difference in the quantity of contraction is still greater than in hard woods.

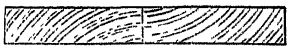
From these experiments, the advantages to be obtained merely by a proper attention in cutting out boards for pannels, &c., will be obvious; and it will also be found that pannels cut so that the septa are nearly parallel to their faces, will appear of a finer and more even grain, and require less labour to make their surfaces even and smooth.

Curving in the direction of the width.

But as this system would necessitate the rejection of all but the heart of the tree for superior work, a method has lately been pursued which it is said was first used by the billiard-table makers. Let AC (fig. 71) represent the piece above referred to by the same letters. It will become hollow on the side marked *b*, no doubt because the rings of the wood when cut across are relieved from tension, and endeavour to expand themselves. To counteract this it is customary, in all good work, to rip the plank down the centre, and then to "turn the stuff inside out" as it is popularly called. This is done by reversing the wood end for end, so as to bring the heart against heart, and the outside against outside (without which the glue joints are sometimes liable to fly); and also so as to reverse the circular parts of the grain, as is shown in fig. 72.



Fig. 71.


Fig. 72.

In wood that has the larger transverse septa, as the oak, for example, boards cut as BD will be figured, while those cut as AC will be plain.

Cause of pieces curving in the direction of their length.

42. There is another kind of contraction in wood whilst drying, which causes it to become curved in the direction of its length. In the long styles of framing we have often observed it; indeed, on this account, it is difficult to prevent the style of a door, hung with centres, from curving, so as to rub against the jamb. A very satisfactory reason for this kind of curving has been given by Mr Knight,[1] which also points out the manner of cutting out wood, so as to be less subject to this defect, which it is most desirable to avoid. The interior layers of wood, being older, are more compact and solid than the exterior layers of the same tree; consequently, in drying, the latter contract more in length than the former. This irregularity of contraction causes the wood to curve in the direction of its length, and it may be avoided by cutting the wood so that the parts of each piece shall be as nearly of the same age as possible. But as this would also necessitate the rejection of a great deal of stuff, a simpler method is found, which is always to turn the heart of the wood outwards. Thus, in framing a door, the heart should always go against the jambs, and the sap side to the pannels.

Changes produced by the weather.

43. Besides the contraction which takes place in drying, wood undergoes a considerable change in bulk with the variations of the atmosphere. In straight-grained woods the change in length is nearly insensible;[2] hence they are sometimes employed for pendulum rods; but the lateral dimensions vary so much, that a wide piece of wood will serve as a rude hygrometer.[3] The extent of variation decreases in a few seasons, but it is of some importance to the joiner to be aware, that even in very old wood, when the surface is removed, the extent of variation is nearly the same as in new wood.

It appears, from Rondelet's experiments,[4] that in wood of a mean degree of dryness, the extent of contraction and expansion, produced by the usual changes in the state of the atmosphere, was—

$$\text{In fir wood, from } \frac{1}{360} \text{ to } \frac{1}{75} \text{ part of its width;}$$

$$\text{And, in oak, from } \frac{1}{412} \text{ to } \frac{1}{84} \text{ part of its width.}$$

Consequently, the mean extent of variation in fir is $\frac{1}{124}$, and in oak, $\frac{1}{140}$; and, at this mean rate, in a fir board about 12½ inches wide, the difference in width would be

[1] *Philosophical Transactions*, part ii. for 1817; or *Philosophical Magazine*, vol. l., p. 437.
[2] Mr Ramsden and General Roy made some experiments on the expansion in length. See *Account of the Trig. Survey*, vol. i., pp. 46 and 49.
[3] See *Philosophical Transactions*, Lowthorpe's Abridg., vol. ii., p. 37.
[4] *Traité Théorétique et Pratique de l'Art de Bâtir*, article MENUISERIE, tome iv., p. 425, 1814.

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$\frac{1}{10}$th of an inch. This will show the importance of attending to the maxims of construction we have already laid before the reader; for, if a board of that width should be fixed at both edges, it must unavoidably split from one end to the other.

Kinds of wood.

44. The kinds of wood commonly employed in joinery are,—the oak, the different species of pine, mahogany, and sometimes lime-tree and poplar.

Oak.

Of the oak, there are two species common in this island; that which Linnæus has named *Quercus robur* is the most valuable for joiners' work; it is of a finer grain, less tough, and not so subject to twist as the other kind. Oak is also imported from the Baltic ports, from Germany, and from America. These foreign kinds being free from knots, of a straighter grain, and less difficult to work, they are used in preference to our home species. Foreign oak is also much used for cabinet-work; and lately, the fine curled oak that is got from excrescences produced by pollard, and other old trees, has been used with success in furniture. When well managed, it is very beautiful, and makes a pleasing variety. It is relieved by inlaid borders of black or white wood, but these should be sparingly used. Borders of inlaid brass, with small black lines, give a rich effect to the darker coloured kinds.

Fir.

The greater part of joiners' work is executed in fir, imported from the north of Europe. Yellow fir is used for outside work, as doors, sashes, and for floors where there is likely to be much wear. Some very good red pine deals have been imported from Canada. Inside work is almost always framed of white fir. Some very good pannels when not too wide, and excellent mouldings, are made of American pine. White fir is often used for internal work, and yellow pine is much used for mouldings. Joint-Stock Companies.

The forest of Braemar, in Aberdeenshire, furnishes yellow fir of an excellent quality, little inferior to the best foreign kinds.

Larch.

For the general purpose of joinery, the wood of the larch tree seems to be the best; this useful tree thrives well on our native hills. We have seen some fine specimens of this wood from Blair-Athol. It makes excellent steps for stairs, floors, framing, and most other articles.

Mahogany.

Mahogany, in joinery, is only used where painted work is improper, as for the hand-rails of stairs, or for the doors and windows of principal rooms. For doors it is not now so often used as it was formerly; its colour is found to be too gloomy to be employed in large masses. In cabinet-work it is almost the only kind used for ornamental work.

Lime-tree.

Lime-tree, and the different species of poplar, make very good floors for inferior rooms, and may often be used for other purposes, in places where the carriage of foreign timber would render it more expensive. Lime-tree is valuable for carved work, and does not worm-eat; but carving is at present seldom used in joinery.

For farther information on wood, in addition to the works referred to, the reader may consult Evelyn's *Silva*, Dr Hunter's edition; Duhamel, *Du Transport, de la Conservation, et de la Force des Bois*, Paris, 1767; Barlow's *Essay on the Strength and Stress of Timber*, 1817; Tredgold's *Elementary Principles of Carpentry*, sect. x., 1820; and the article DRY-ROT.[1] (T. T—D.) (A. A.)

JOINT-STOCK COMPANIES are a species of partnership in which a number of persons contribute funds or "stock" for the accomplishment of some trading or other profitable object. The peculiarity from which the term is derived is the contribution of stock apart from joint management. In an ordinary partnership the members bring more or less of their own personal management into the affairs of the company; and although, in peculiar circumstances, a partner may abstain from any interference, such a person, called in the trading world "a sleeping partner," is treated by the law in all respects as if he participated in the privileges and responsibilities of his working brethren. The distinctive peculiarity of the joint-stock company is, that the members throw their stock into the venture without directly participating in the management, which may be either in the hands of a selected number of the shareholders, or in that of persons who do not contribute at all to the undertaking. The subject thus presents considerations stretching far beyond the boundary of the mere laws affecting the rights and obligations of individual partners into the field of politics and history. It is at once obvious that these arrangements, by which the wealth of indefinite numbers can be concentrated in the hands of a few, are capable of creating a political influence which will have more or less the character of a ruling or governing power, according to the strength of the otherwise constituted authorities with which it may come in contact. It was by this sort of concentration of the wealth of many in the hands of a few that some of the religious societies of the middle ages became formidable rivals of the monarchies; the Society of the Knights Templars rising conspicuously above all others, and threatening to establish a sort of corporate empire, presiding over the European monarchies. Subsequently the Jesuits, in their government of Paraguay, afforded evidence of the power at the command of clever men regulating a common fund, which alarmed crowned heads no less than the usurping tenor of their doctrines. The great union of the Hanse towns, before which the robber monarchies and aristocracies of Central Europe fell, was again an instance of the power of concentrated wealth when measured against pure monarchical and aristocratic authority; and the expanding resources of the republic of Venice, and of other wealthy oligarchies, seemed to be raising a new ruling power which would gradually absorb and supersede the old dynasties, whether autocratic or aristocratic, by which nations were ruled. The expansion of trade by the discovery of America and a new passage to India, and still more perhaps the recasting of the political state of Europe by the Reformation, broke up these great concentrated masses, and distributed the power of collective wealth into smaller groups. Still the influence of joint-stock associations has ever, from time to time, arisen in formidable rivalry with other forms of political power, sometimes creating an effectual barrier to political oppression, but at others threatening the liberties and just rights of communities by a spirit of aggrandizement and rapacity. Perhaps the most curious single instance of a struggle between concentrated wealth and a ruling dynasty will be found in the history of Russia. The merchants of Novogorod increased in wealth and influence until they became a virtual republican government, gradually absorbing under their influence the surrounding territory. "Who can resist God and the great Novogorod?" became a saying of the fifteenth century. The Grand Dukes of Muscovy commenced a systematic war against this royal company of merchants, and it seemed for some time a question whether Russia should be ruled by a commercial company or an autocracy. After many scenes of cruelty and rapacity, the latter prevailed. But the influence of Novogorod was not entirely extinguished until the foundation of St Petersburg drew the northern trade of Russia into a

[1] When the roof of Westminster Hall was under repair, an opportunity was taken to examine the wood of which it is constructed; and it was found to be of oak, and not of chestnut, as stated in the article DRY-ROT, vol. viii., p. 213. The oak has been of an excellent kind, but is now much worm-eaten.

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new channel, where it came effectually under imperial control.

British history affords many memorable instances of the influence of joint-stock operations. It became the policy of the crown, from Queen Elizabeth's reign downwards, to cherish commercial combinations, as a balance against the power of the aristocracy, and sometimes the body thus started with a stock of exclusive privileges acquired an influence dangerous alike to the authority of the crown and the rights of the subject. The Russian Company, which had been licensed just before the accession of Elizabeth, acquired so much influence under her fostering care as to spread its transactions into Persia on the one hand, and embark in the whale fishery of Spitzbergen on the other. This potent body was in use to send ambassadors to the Grand Duke of Muscovy. But his successors, the czars, were not inclined to encourage such fellowship, and gradually enfeebled the haughty corporation by restricting its foreign privileges, and encouraging the rival company of Holland. The celebrated Turkey or Levant Company was chartered in 1581. Just eighteen years afterwards was formed, under far less pompous auspices, that East India Company which has been destined to rule over a greater empire than that of Julius Cæsar or Charlemagne. (See INDIA.) Many African and American companies were formed in the seventeenth century, and created much excitement by their aggressions and rivalries. The Scots, excited by witnessing the enterprise and prosperity of England, in which the invidious navigation law of Charles II. prohibited them from participating, resolved to establish a great national joint-stock company for themselves. In 1695 they formed the "African Company," better known as the Darien project, subscribing a capital of L.400,000 the greater portion of which was paid up. This was held in its day to be a marvellous pecuniary effort for a portion of the empire which, a century and a half later, entered on railway projects involving in one year an outlay of sixteen millions. The company obtained from the Scottish parliament more absolute powers than even the great corporations of England; being authorized to hold a monopoly of certain trades, to occupy and govern territories, and to make peace and war. It commenced the execution of a variety of projects on a grand scale, and their disastrous result was a signal instance of that unscrupulous spirit of aggrandizement and oppression to which trading corporations are so liable. The Scottish company, probably, like many of the other bodies of adventurers, committed some questionable acts, but none sufficient to justify the rancorous hatred of the English rival companies, which, while the Scots were prevented, as an alien nation, from having their share in the English companies, denounced the corporation set up by the nation, which they thus counted separate and independent, for an infringement of a monopoly purely English. King William was too dependent on the monied power in England to hold an even balance of justice between opponents so unequally matched, and the Scottish colony was ruined.

Among the English companies of that age, several were successively established for trading with Africa and America. Their chief object and source of gain was one that would be fortunately held in detestation by the greater portion of British speculators at the present day,—the supply of captured negroes to the plantations, foreign as well as British. The culmination of these projects in the great South Sea scheme of 1719 is a well-known chapter in English history. The names of the many preposterous satellite schemes by which it was surrounded have often been cited as instances of folly calculated to tax the credulity of soberer periods, as projects in which the inhabitants of the wisest of nations actually embarked. If it were any consolation to find their neighbours guilty of greater follies than their own, the British of that age might find such consolation in a view of the French Mississippi scheme. The corporate power thus created not only professed to absorb the trade, finance, and banking of France, but projected the creation of a transatlantic empire, which, from its centre in Louisiana, should gradually absorb the American continent.

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Since the passing of the Patents Act in the reign of James I., the crown alone was precluded from granting powers of trading monopoly in royal charters, and the companies which, since that period, have obtained any monopolies in England beyond those created by the simple instance of their large capital, have held their powers from parliament. The crown continued to grant monopolies in foreign trade till 1693, when, in the celebrated question of the old East India Company, the practice was condemned by a vote of the House of Commons. A remarkable instance lately occurred of an attempt by some enterprising men to carry out a project something like that of the East India Company, independently of authority either from the crown or parliament. It was represented that the islands of New Zealand were admirably suited for colonization, and should be immediately attached to the British colonial empire by the right of occupancy. There was, however, a strong disinclination on the part of British statesmen at that period to encumber the imperial government with the management of additional colonies. The adventurers conceived the idea of occupying the islands with independent British emigrants. The novelty of their views, and the energy and eloquence with which these were enforced, attracted a number of ardent spirits around them, who were taught that in these happy islands, possessed of all the advantages of our British climate without its drawbacks, they were to found that empire of Anglo-Saxon origin, by which the southern portion of the world was to be eventually ruled. It seemed hard that the government, declining to occupy the colonies, should discourage this project; but there were many grounds for dreading from it evil consequences, among which the most obvious and immediate was, that when the colony began slightly to prosper, it would attract the cupidity of some other European power, from which it could not be protected without an interference which might involve the British government in formidable disputes. Hence, in the year 1840, the British flag was hoisted in New Zealand, and although "The New Zealand Company" was incorporated, and afterwards became the medium for the disposal of large tracts of land, its position was so humble in comparison with the splendid visions entertained by its promoters, that after a long series of intricate disputes, they resigned their charter to the government in 1850.

The chief objects for which joint-stock companies have lately been constituted are Banking, Insurance, works for the supply of cities with Water and Gas, Canals, Shipping, and Harbours, and, at the head of all, Railways. The railway system, indeed, is the form in which both the government and the people have of late felt the pressure of joint-stock power, and known the influence of which it is susceptible. The history and effect of the railway system will be found under its proper head; and it is only necessary here to remark, that although there has been, throughout the rise and progress of the system, a contest on the part of the legislature to keep the interests of the public at large duly protected against the natural consequences of endowing a body of affluent companies with a monopoly of the function of conveying persons and property from place to place, yet the result is felt to be, that the companies have got, on the whole, more power than a watchful legislature should have confided to them. As each railway work required the sanction of an act of parliament, it was supposed that the interests of the public must be safe in the hands of the legislature. But when railway bills crowded in, it was impossible for the members of the legislature at large to take

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up their merits; and there was no staff of official persons entrusted with the responsibility of testing the fairness and propriety of their provisions. The sections of parliament which adjusted railway measures were not only subjected to misrepresentation and persuasion, but sometimes counted in their own body men deeply embarked in the interests of particular lines. It was absolutely necessary that the legislature at large should, for the sake of the public safety and convenience, create restrictions, to which all railway companies must be amenable. Some regulating acts were accordingly passed, but not so early as effectually to serve the intended purpose. The alarming climax which railway speculation reached in 1846, when the legislature in one session passed bills authorizing an expenditure of 130 millions, produced a reaction, on which some thinkers have looked with complacency, believing that it has beneficially enfeebled, through losses and difficulties, a power which might otherwise have become formidable and extremely unmanageable.

In the meantime, legislation was demanded to apply a general constitution to those joint-stock companies which did not conduct such important operations, or exercise such large powers, as to require or easily to afford a special act of parliament to each. After several tentative measures, and along with a special act applicable to banking, the Joint-Stock Companies Regulation Act of 1844 was passed (7th and 8th Vict., c. 110). When it had been more than ten years in force, it was urged by the promoters of a revised measure that it had missed the true object of such an act, in as far as it hampered, by too many directions and restrictions, the trading operations of joint-stock companies; and it was maintained that the true policy of such a measure should be in the first place to fix the limits under which joint-stock companies might legally act, and then incorporate effectual provisions for the enforcement of the obligations legally incurred in connection with them; while within these limits they should be left at perfect freedom to conduct their operations, like private traders, in their own way. Meanwhile the prevalence, soon after the European convulsions of 1848, of opinions among the working classes inimical to property and the rights of capital, suggested to some political economists that the law of partnership fatally discouraged the humbler classes from investing their savings in profitable speculations, by the principle which rendered every one engaged in a commercial adventure, however humble his interest in it, liable for all the debts incurred by the company. Reference was made to the system of partnerships, *en commandite*, practised in France and various other nations, by which, when certain traders united as an active partnership, liable with their whole means for the debts which might be incurred through the operations in which they shared, certain other persons not admitted to the management might have shares in the concern, *en commandite*, without being responsible for losses beyond the extent of the capital embarked by them. In 1850 a committee of the House of Commons reported on the best means of providing investments for the middle and working classes, expressing an opinion, that although false expectations might be formed of the probable advantage to accrue to them by a participation in profits, yet that a measure for the removal of the existing difficulties would be peculiarly acceptable to them, "and would tend to satisfy them that they are not excluded from fair competition by laws throwing obstacles in the way of men with small capital."

In 1854, a commission, consisting of eminent lawyers and capitalists, reported on the assimilation of the commercial law of England and Scotland, and also on the question, whether the law of partnership liability should be altered. Among the lawyers there was a predominant aversion to a change, founded chiefly on the risk of persons whose responsibility was limited, recklessly undertaking projects beyond the proper means at their disposal; and the capitalists took the conventional view, that there is always capital enough in the country for the proper amount of commercial speculation, without giving much weight to the moral and social reasons for which it was thought advantageous to facilitate the safe investment of savings and other small sums of money. The fall of several establishments in which people of the middle classes invested their fortunes, and an exposure of fraud and recklessness in the conduct of the managing partners of these establishments, showed that there was a fatal rottenness in the existing system. It was argued, that with liability known to be limited, and publicity and responsibility attending all acts of partnership management, such calamities would not occur, whatever others might supersede them.

Joinville ‖ Joinville, Sire de Jean.

The Joint-Stock Act of 1856 (19th and 20th Vict., c. 47), was passed, partly to amend those defects in the act of 1844 which have been already alluded to, and partly to make an effective provision for investments with limitation of responsibility. Banking and insurance companies are, for reasons which the promoters stated that they bent before rather than admitted, excluded from its operation. The number of persons associating under it must amount to seven at least; whenever the number of partners is less they all become personally liable for all the obligations incurred. No body consisting of more than twenty persons is entitled to carry on "any trade or business having gain for its object" without coming under the act, and being registered accordingly. All shares are to be held absolutely, and not in trust or security. If the directors of such a company declare a dividend while the company is insolvent, or which in itself creates insolvency, they incur personal liability. On the application of a fifth in number and value of the shareholders, the board of trade may appoint inspectors to examine and report on the affairs of a company; and there is a provision for appointing "official liquidators" when the affairs of such a company have to be wound up. If the liability of the partners is to be limited, the word "limited" must be the last word in the name or firm of the company. This act has not been long enough in force to allow any conclusion to be formed on its practical success. (J. H. B.)

JOINVILLE, a town of France, department of Haute-Marne, and arrondissement of Vassy, on the left bank of the Marne, 23 miles N. of Chaumont. Pop. 3000.

JOINVILLE, JEAN, SIRE DE, author of the *Histoire de St Louis*, and one of the ornaments of his age, was born in 1223 or 1224. Sprung from an ancient and noble house of Champagne, he spent the first years of his life with Thibaut, king of Navarre, at whose court, then one of the most refined in Europe, he learned all the knightly graces and accomplishments. When St Louis set out on his first crusade in 1248, Joinville accompanied him at the head of several hundred men raised on his own estates, fought by his side in the bloody engagements that followed the capture of Damietta, and shared the fate of the greater part of the French army in being taken prisoner by the infidels after the disastrous campaign of Massoura. Escaping with difficulty on the payment of a heavy ransom, he followed his royal leader into the Holy Land, enjoyed his confidence and friendship, was with him in every battle of the campaign, and finally returned with him to France in 1254 on board the same ship. He had thus advantages for studying the character and actions of the hero-saint, such as were open to no other chronicler of the time. Accordingly, the *Histoire de St Louis, IX. du nom par Jehan Sire de Joinville*, written with a charming simplicity both of style and thought, is as interesting as the Chronicles of Froissart. In delineating his king, Joinville gives us unconsciously a portrait of himself. The gay, free-handed knight, careless of life and money, witty, shrewd, slightly worldly, proud of his rank, yet fond of society in all its grades, stands out in strong

Joliba || Jomelli.

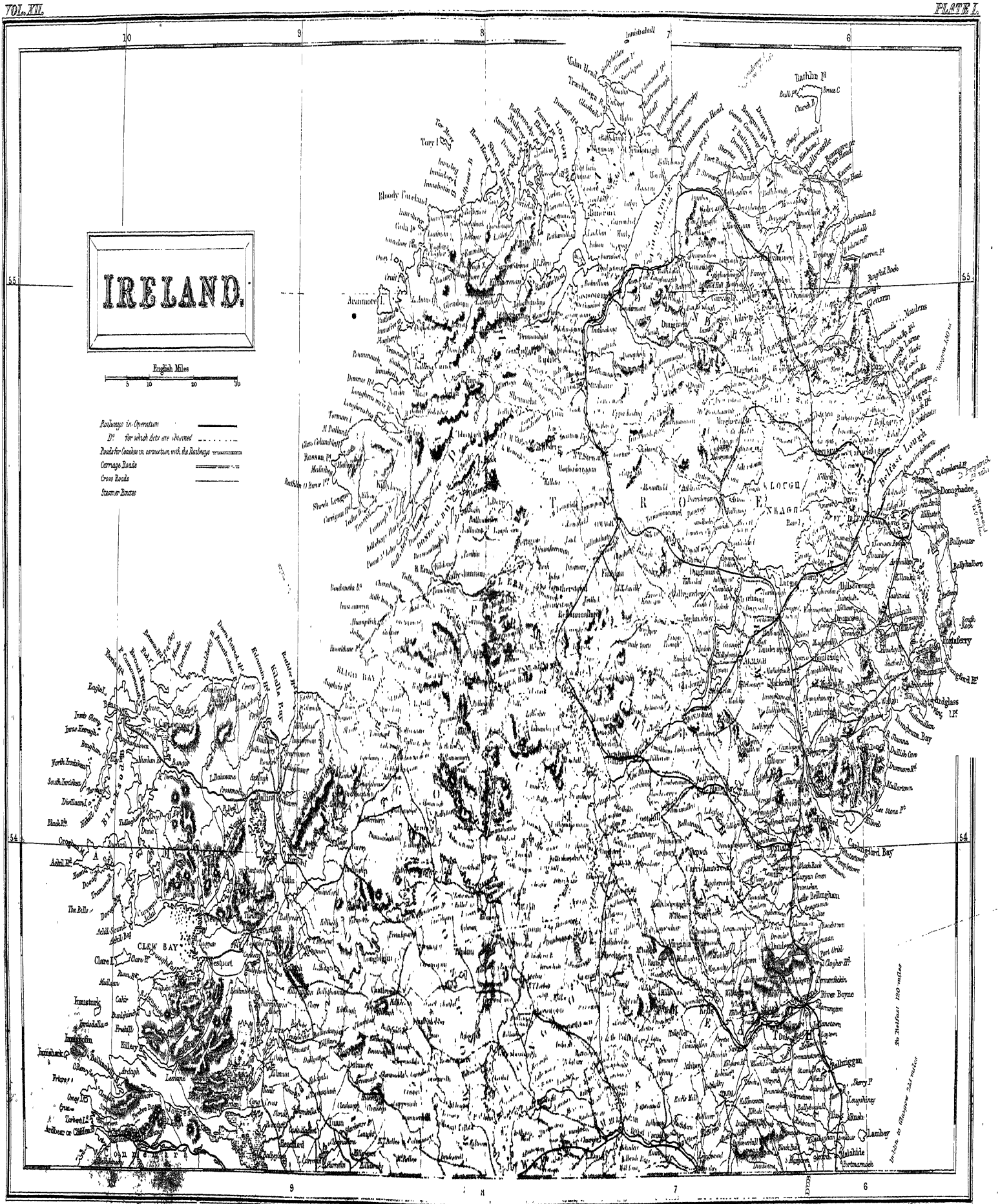
and curious contrast with the self-denied, austere, and saintly king. Yet, contrasted as their natures were, the two men lived together on terms of brotherly familiarity. At one time the king asks his friend whether he would not rather be a leper than commit a mortal sin? To which Joinville, who abhors lying, naïvely replies, that he would rather commit thirty mortal sins than be a leper. At another, he asks him if he ever washed the feet of the poor on Holy Thursday, and Joinville replies "that he never will wash the feet of these rascals." Joinville's respect for Louis's noble nature and splendid intellect increased in proportion as he knew him better, and he records many notable instances of both. On their return to France, they continued as intimate as ever, and Louis very often invited his old brother-in-arms to eat at his own table, "à cause du subtile sens qu'il connaissait en lui." When the French king set out in 1259 on his second crusade, so disastrous to himself and thousands of other brave men, Joinville declined to go with him, alleging as his excuse the ruin that in his absence had overtaken his estates. Joinville's grief when he learned the fate of the expedition was very poignant. From this time he seldom appeared at the court of Louis's successors; but when Louis X. was preparing to invade the Netherlands, Joinville, though in his ninety-second year, joined the army at Arras. He died not long after; but the exact date of his death is unknown. The best editions of Joinville's work are those of 1668, with curious and learned dissertations by Ducange; and of 1761, edited by Mellot, Sallier, and Chaperonnier, and printed at the royal press. The previous editions, of which there are several, are all more or less incomplete.

JOLIBA. See NIGER.

JOMELLI, NICOLO, one of the greatest composers of the Neapolitan school, was born at Aversa, a small town near Naples, in 1714. Having learned to sing and to play on the harpsichord, under the canon Muzillo, he went in 1730 to Naples, where he studied under Prota and Mancini, and afterwards under Feo and Leo. His earlier compositions were *Cantatas*, which indicated his talent for dramatic music. The success of his first opera, *L'errore amoroso*, determined him to cultivate theatrical composition. Next year, 1738, he composed his first serious opera, *Odoardo;* and in 1740 went to Rome, where he was patronized by Cardinal York. After having composed several works at Rome and at Bologna, he returned to Naples, where his opera of *Eumene* was received with great favour. During his residence at Bologna, he had studied church-music under Padre Martini. In 1745 he visited Vienna, and there formed a lasting friendship with Metastasio. When he brought out at Venice his opera of *Merope*, it produced such an effect that the Council of Ten appointed him director of the conservatory for orphan girls. He there composed his first church-music, which was much admired. In 1748, having been called to Rome, he composed his opera of *Artaserse;* and, by the influence of Cardinal Albani, was next year made chapel-master of St Peter's in the Vatican. In 1754 he resigned that office, in order to occupy the place of chapel-master and court-composer to the Duke of Wurtemberg at Stuttgart. There he remained about eighteen years, and his style underwent a great change through the influence of the German music which he was constantly hearing. His modulation became more bold and varied, and his instrumentation more powerful. He wrote about thirty operas in Germany. When he returned to Naples in 1772, his Germanized style did not please his countrymen; and even his *Armida*, one of his finest operas, was not popular. His *Demofoonte*, another fine work, was still less liked at Naples; and his *Ifigenia*, in 1773, was ill-performed, and failed completely. He was then attacked by apoplexy, but rallied, and his last composition was his admirable *Miserere*. He died at Naples on 28th August 1774. In the fourth volume of Dr Burney's *History of Music*, pp. 566-70, there is an account of Jomelli's funeral, and remarks on his works and character by his friend Saverio Mattei, the poet. Jomelli's known compositions are, —forty operas; five cantatas; four oratorios; thirty-four church compositions. (G. F. G.)

Jomelli.

END OF VOLUME TWELFTH.

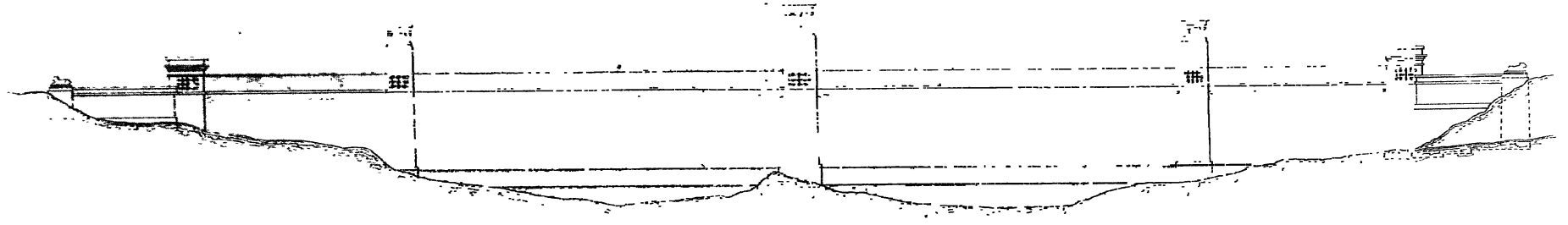


IRELAND, NORTHERN PART

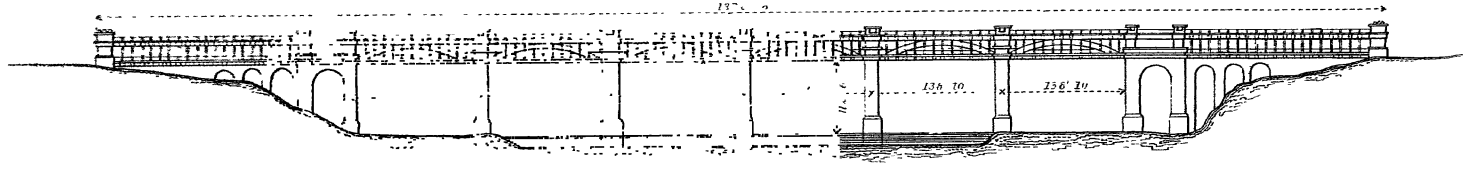

Skyne Pt.
Roundstone
Cranckardy
Myle R.
Bird Rocks
Carrigeen Castle
Galway
Connaught
Galway Co.
Letternullen H.
Gallin H.
Garrowbeg
Clarenbeg
Branock
Isles of Arranmore
Arran Is.
Inishmaan
Doolin
Killinny
Kilmurvy
GALWAY BAY
Ballyvaughan B.
Burrin Quay
Black Pt.
Ballyvaughan
Corofin
Kilfenora
Ennistymon
Lahinch
Liscannor Bay
Liscannor
Hags Hd.
Ramskerry Lo.
Dunbeg Pt.
Fillard Hd.
Ballard Hd.
Kilkee B.
Kilkee
Kilbaldrons
Clonderalaw
Cloughaninny Cas.
Loop Head
Carrigaholt
Kilmacduan
Kilmacduan Cas.
RIVER SHANNON
R. Clohir
Glanlin
Kerry Pt.
Tarbert
Ballylongford
Ballylongford Bay
Ballylongford Cas.
Ballylongford Pt.
Ballylongford Is.
Ballylongford Creek
Ballylongford Bridge
Ballylongford Lo.
Ballylongford Hd.

IRON BRIDGES.

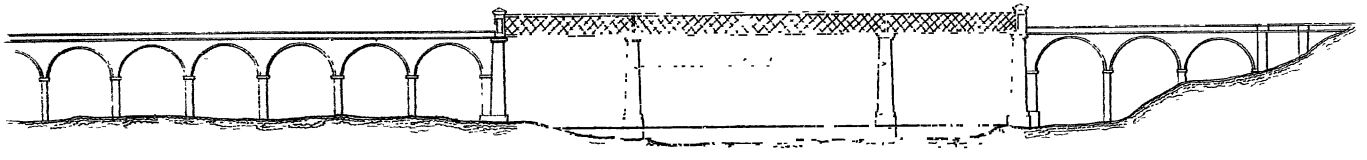
BRITANNIA TUBULAR BRIDGE.

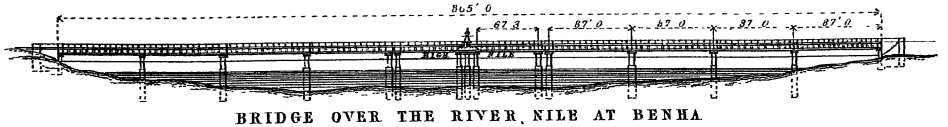


HIGH LEVEL BRIDGE NEWCASTLE

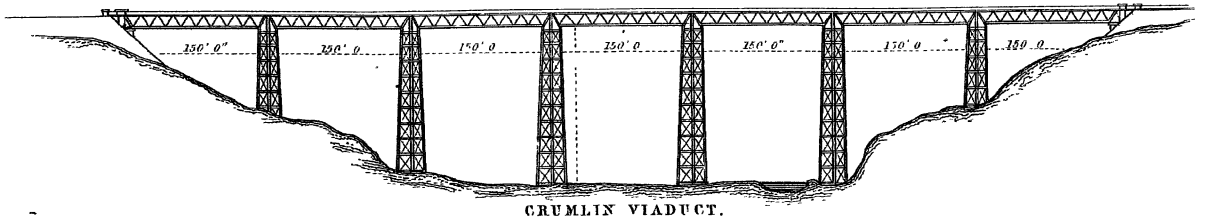


BOYNE VIADUCT

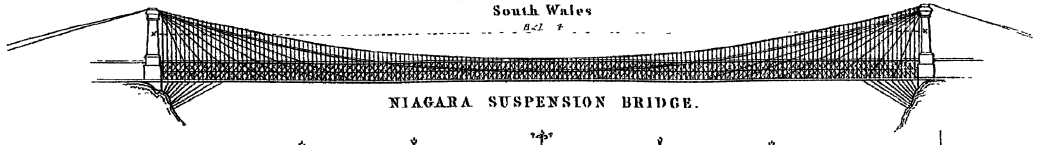




BRIDGE OVER THE RIVER NILE AT BENHA
Egyptian Railway



CRUMLIN VIADUCT.
South Wales



NIAGARA SUSPENSION BRIDGE.



SOUTHWARK BRIDGE.

100 50 0 100 200 300 400 500 Feet

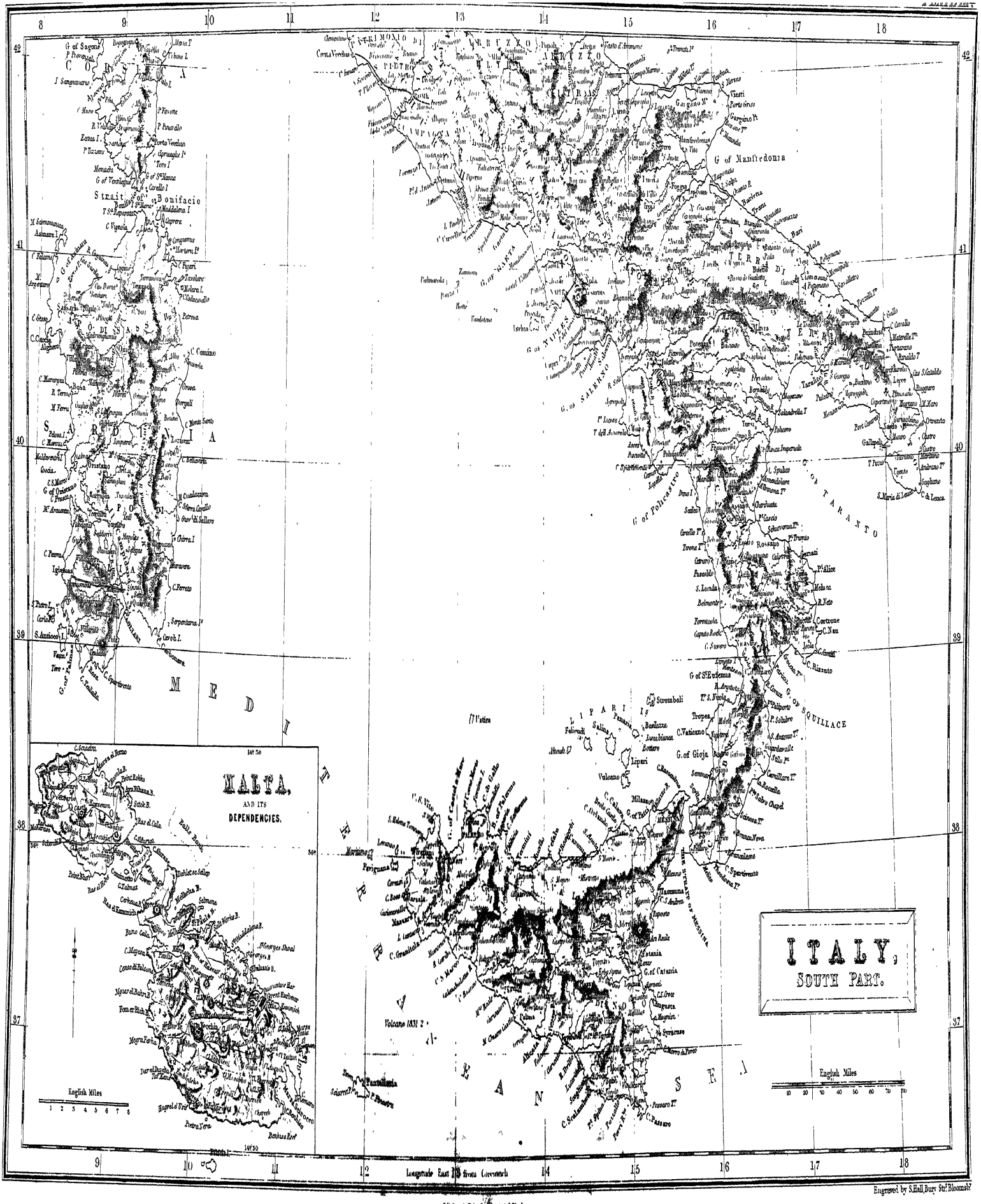
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ITALY,
SOUTH PART.
MALTA,
AND ITS
DEPENDENCIES.
Strait of Bonifacio
G of Manfredonia
G of Taranto
G of Policastro
G of Salerno
G of Gioja
G of St Eufemia
Strait of Messina
Volcano 1831 ft
Stromboli
Lipari Is
Longitude East from Greenwich
English Miles
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